

Pierre Duhem and Neo-Thomist Interpretations of Physical Science

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In 1879, Pope Leo XIII demanded that Catholic philosophers and theologians adopt scholastic philosophy and especially Thomism in their studies and teaching.

Although not primarily about science, the encyclical *Aeterni Patris* expressed the hope that scholastic philosophy would be a means to understand and even to further science. The thesis examines how neo-Thomists in France and Belgium tried to understand contemporary physical science from the time of the papal mandate to the outbreak of the First World War. These geographical and temporal limits coincide with the immediate sphere of influence of Pierre Duhem (1861-1916), the well-known Catholic physicist, philosopher of science, and historian of science.

After putting *Aeterni Patris* into historical context and focusing both on its own agenda with regard to the philosophy of science and on the challenges that it faced in a scientific climate, the thesis identifies the major centres of neo-Thomism in the two countries and shows that Duhem was historically connected to all of them. Neo-Thomists were especially determined to re-establishhylomorphism by arguing that mechanical theories of the universe were deficient. Duhem too critiqued mechanism; but his criticism and agenda differed from that of the self-proclaimed neo-Thomists, by arguing that physical theory is not a metaphysical explanation. The thesis first examines the relation between physics and metaphysics through case studies of contemporary debates into which Duhem also entered: human freedom, creation in time, and the proof for the existence of God the Prime Mover. A more theoretical look at the relation shows both that Duhem developed some of his ideas in the philosophy of science in response to neo-Thomist criticism and that his thought in

turn influenced some leading figures in the movement. It is argued that Jacques Maritain's *Distinguer pour unir* depends heavily albeit unconsciously on Duhem's work. This proves that Duhem's thought is compatible with one influential school of neo-Thomism and even contributed to its development. The thesis concludes by making the necessary distinctions to counter arguments that Duhem was hostile to the neo-Thomist enterprise on account of his Pascalian inspiration, his friendship with Maurice Blondel, and his panning of Thomas in the *Système du monde*.

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Table of Abbreviations

<i>AimSPT</i>	<i>Aim and Structure of Physical Theory</i>
<i>AnnPhilChr</i>	<i>Annales de philosophie chrétienne</i>
ArchAcSci	Archives of the Académie des Sciences in Paris
ArchICP	Archives of the Institut catholique de Paris
ArchSaulchoir	Archives of the Dominican library, Le Saulchoir, Paris
<i>RevPhil</i>	<i>Revue de philosophie</i>
<i>RevQuestSci</i>	<i>Revue des questions scientifiques</i>
<i>RevThom</i>	<i>Revue thomiste</i>
<i>SéancesSSTA</i>	This is the standard title for the minutes of the meetings of the Société de Saint-Thomas d'Aquin in Paris. The minutes were published in the <i>AnnPhilChr</i> . The standard reference to these minutes is <i>SéancesSSTA</i> , date, <i>AnnPhilChr</i> , vol (year), pp.

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INTRODUCTION

La pensée de Duhem ne mérite pas une thèse. – *François Russo, s.j.*¹

In 1964, François Russo advised Joseph O'Malley that the thought of Pierre Duhem (1861-1916) was not worth a thesis. His negative assessment, however, discouraged neither O'Malley nor a significant number of other historians and philosophers, for several major works and theses, and numerous articles, have been written in the last thirty-five years on Duhem and on various aspects of his work as physicist, philosopher of science, and historian of science. Jean-François Stoffel, in his recent doctoral dissertation, has shown that most of the continuing interest in Duhem has focused on his philosophical (30%) and historical (23%) achievement and on the 'Duhem-Quine thesis' (22%). He notes that only 4% of the works have addressed Duhem as a Christian, and only 1% have made significant use of archival materials.²

There is no doubt that the 'Duhem-Quine thesis' is important to claims made on behalf of the sociology of scientific knowledge, but it would be as wrong to see in Duhem a partisan of SSK as it was in the past to group him among empirical positivists. Duhem's holism is a much more nuanced position that may require a class of its own. Nevertheless, scholars have attempted to capture his thought in one of the better known categories.³ Stanley Jaki, for example, has said that 'while

¹ From a letter, posted in December 1964, from Russo to Joseph O'Malley who at the time was writing a thesis on 'Material Being and Scientific Knowledge According to Pierre Duhem'. See Stanley Jaki, *Reluctant Heroine: The Life and Work of Hélène Duhem* (Edinburgh: Scottish Academic Press, 1992), p. 264. Jaki notes that the words were underlined for emphasis.

² Jean-François Stoffel, 'Entre projet scientifique et projet apologétique, le phénoménalisme problématique de Pierre Duhem' (Ph. D. dissertation, 1998, Faculté des sciences philosophiques: Institut supérieur de philosophie: Université catholique de Louvain), p. 50.

³ Stoffel has conveniently provided a list of 15 different labels which have been attributed to Duhem to capture various aspects of his thought and its development in philosophy, religion, and politics ('Entre projet', p. 1).

Duhem provided some clues about the true category to which his philosophy of physics belonged, he did not elaborate them and much less did he put on his philosophy the only label, Neothomist, appropriate to it in ultimate analysis'.⁴

Roberto Maiocchi, on the other hand, has written that it is both a historical and theoretical error to place Duhem among neo-Thomists: historical, because it was precisely the neo-Thomists who criticized most severely his understanding of the relation between science and faith; and 'theoretical because between the standpoint of Duhem and that of the neo-Thomists there was an irreducible divergence of principle'. Yet a few pages later, in a footnote, Maiocchi concedes that perhaps Maritain's philosophy of science can be seen as an argument for divergences among neo-Thomists themselves, but dismisses such an objection on the grounds that Maritain began to be taken seriously only in the 1920s. Making the required distinctions would have taken Maiocchi too far afield from his focus of interest.⁵

Another scholar who addressed the question of Duhem and neo-Thomism is Niall Martin in a book on the importance of religion to Duhem's thought. Martin makes Duhem out to be a 'passionate anti-scholastic' and says that 'if Maritain represents the orthodox neo-Scholastic Thomist position, Duhem's views must by contrast inevitably be seen as subversive'.⁶ Martin has made it abundantly clear that one cannot assume that Duhem was a neo-Thomist merely on account of (1) his devotion to Catholicism, (2) his interest in the Middle Ages, and (3) his writing on history and philosophy in the wake of Pope Leo XIII's encyclical *Aeterni Patris*

⁴ Stanley Jaki, *Scientist and Catholic: Pierre Duhem* (Front Royal, VA: Christendom Press, 1991), p. 22.

⁵ Roberto Maiocchi, *Chimica e Filosofia: Scienza, epistemologia, storia e religione nell'opera di Pierre Duhem* (Firenze: La Nuova Italia, 1985), pp. 322-3, and p. 329.

⁶ Niall Martin, *Pierre Duhem: Philosophy and History in the Work of a Believing Physicist* (La Salle, IL: Open Court, 1991), p. 53 and p. 98.

(1879), which urged Catholic philosophers and theologians to return to the wisdom of Thomas. But the present thesis will nevertheless argue that Martin is ultimately wrong on the question of Duhem and neo-Thomism. Duhem's friendship with Blondel and his penchant for Pascal, two facts upon which Martin relies heavily, are not a sufficient argument to sever Duhem from the neo-Thomists. Martin, for example, makes no mention of the neo-Thomist Gardeil's published report – entirely favourable – of Duhem's intervention at the Brussels Congress in 1894, except as an entry in the bibliography; nor can one find any mention of Lacombe's defense of Duhem in the *Revue thomiste* as one of the school. The latter omission is perhaps more glaring, for it had been discussed by Jaki in an earlier work. It should hardly come as a surprise, then, not to find in Martin's work relevant archival material, such as letters from Duhem to Gardeil and letters from Gardeil and Mansion to Duhem, which discussed neo-Thomist philosophy of science. Perhaps Martin's attempts to separate Duhem from neo-Thomism are best explained by his disdain for the philosophical enterprise, coupled with his respect for Duhem as a thinker. Such an attitude toward neo-Thomism is not likely to inspire the effort needed to make some distinctions.

One of the aims of the present thesis is to redress Martin's assessment of Duhem vis-à-vis neo-Thomism, but the original motivation was a personal interest in Duhem and in neo-Thomism. My interest in Thomas dates from my seminary studies for the Catholic priesthood which were organized around his *Summa Theologiae*, which I found to be full of eminent good sense. Later, when I read Duhem's *Aim and Structure of Physical Theory*, I also found it full of common sense. Thus I was puzzled to discover that there was a certain distrust of Duhem among neo-Thomists.

I first thought that an investigation of the relation between Duhem and neo-Thomism would be a mere history of ideas. But, as this thesis aims to show, there was, in fact, a lot of historical interaction between Duhem and some of the key thinkers of the movement. Some of this interaction was restricted to addressing published works. Yet in several instances it became more personal, with frequent correspondence and even social visits. The thesis makes two claims: (1) Duhem's philosophy of science was compatible with positions adopted by some of the more sophisticated neo-Thomists such as Mansion, Lacombe, Gardeil, Maritain, and, later on, Renoirte, and (2) although Duhem continued to be viewed with distrust on account of his denial that physical theory could provide a metaphysical explanation, it was his ideas, through the debates which they engendered, that influenced the brighter thinkers of the movement and helped them to distinguish between physics and metaphysics. The thesis specifically does not argue that Duhem was primarily motivated by Thomas's works or the desire to implement *Aeterni Patris*.

The reader might be puzzled to know by what criteria Duhem's thought can be labelled neo-Thomist. The criteria I have used – and which I suspect Jaki must have also used – are best expressed by a passage from Jacques Maritain's *Distinguish in Order to Unite*:

One is a Thomist because one has repudiated every attempt to find a philosophical truth in any system fabricated by an individual (even though that individual be called *ego*) and because one wants to seek out what is true – for oneself, indeed, and by one's own reason – by allowing oneself to be taught by the whole range of human thought in order not to neglect anything of that which is. Aristotle and St. Thomas occupy a privileged place for us only because, thanks to their supreme docility to the lessons of the real, we find in them the principles and the scale of values through which the total effort of this universal thought can be preserved without running the risk of eclecticism and confusion.⁷

⁷ Jacques Maritain, *Distinguish in Order to Unite or The Degrees of Knowledge*, trans. from the fourth French edition under the supervision of Gerald B. Phelan (New York: Charles Scribner's Sons, 1959), pp. xiii-xiv.

I hope to show that this fits in well with Duhem's own concerns and that he interacted with and influenced thinkers who were much more concerned with Thomas and Aristotle than he was himself. Several chapters will be necessary to establish these points and to make the distinctions that will answer Maiocchi's and Martin's objections.

The first chapter discusses the reasons which led Leo XIII to issue *Aeterni Patris*. Prior to 1879, the Church saw modern philosophy as a danger – whether it led to rationalism, which denied the supernatural, or to fideism, which slighted human reason – and condemned various philosophical propositions as untenable by Catholics. The encyclical went further than these negative interventions by mandating a return to scholastic philosophy. The chapter examines *Aeterni Patris* and its hopes for science. After a brief sketch of essential Thomist ideas, there follows an examination of various obstacles that militated against a return to scholastic ideas: opposition to *Aeterni Patris* among Catholics, as well as the scientific climate of France and Belgium. Although no one argued that the prime purpose of the encyclical was to address science, no philosophy could afford to remain silent on the question of science at the time.

The second chapter identifies some of the key individuals and institutions that had an interest in the bearing of science upon Thomism. Some of these have been mentioned only in passing by other scholars; but even when studies of the institutions do exist, they tend to approach the subject from a different perspective to what is necessary here. While there are now even English books that deal with the University of Louvain and a paper in English on the Brussels Scientific Society, there is no extensive treatment of the Society of Saint Thomas Aquinas in any language. Historical studies of the International Catholic Scientific Congresses, the Institut

catholique in Paris, and the *Revue thomiste* are available only in French. The chapter does not pretend to remedy these lacunae, only to provide sufficient information from which to make an informed assessment of Duhem's involvement with neo-Thomism. It was only when I finished writing this chapter that I came to appreciate how extensively Duhem's thought was debated and how personally involved he was with some of these institutions and individuals.

The third chapter examines criticisms of contemporary physical and chemical theories by Duhem and various neo-Thomists. It begins with an exposition of the salient points of Duhem's philosophy of physics so as to make his comments on the various neo-scholastic perspectives more intelligible. The goal of most neo-Thomists was to re-establish Aristotelian hylomorphism, the theory that all physical bodies are composed of matter and form. After a discussion of hylomorphism and some of its more evident historical problems, the chapter focuses on neo-Thomist arguments for hylomorphism based on the perceived deficiencies of mechanist and dynamicist theories in physics. Duhem's criticisms of the same theories follow. Both Duhem and the neo-scholastics preferred energetics among the actual approaches in physics, but for different reasons. Neo-scholastics appreciated the introduction of qualities such as temperature into modern physics as a means to bolster the case for hylomorphism. Duhem, on the other hand, promoted energetics because it seemed to provide the only hope of unifying the various branches of physics into one natural classification.

Sections of this chapter may resemble introductory histories of physics and chemistry. As such, they may be disappointing because they lack many of the nuances of such histories and because they fail to mention standard topics in the field such as the discovery of cathode rays or Hertz's work in electromagnetics. It is

important to remember, however, that this thesis is focusing on the debates as they took place and not as they should have taken place. The reader is directed to secondary literature when it is clear that the debate among neo-scholastics lacks *some important information*. The missing details of the history of physics or chemistry are of minor importance compared to the fact that they are missing.

The fourth chapter presents three case studies where physics was perceived to bear on metaphysical beliefs. First, the law of conservation of energy was seen as a threat to human freedom. As will become evident, the argument was really about mechanism and human freedom. Neo-scholastics were able to retain their Christian belief by appeals to hylomorphism; Duhem, by circumscribing the pretensions of physics. The second case study examines the second law of thermodynamics as an argument for the Christian dogma of creation of the universe in time. Few thought that the argument was conclusive, but it was often cited as a fitting reason from physics for the Christian dogma. A digression here shows Duhem's awareness of the influence that extra-scientific concerns can exert on the development of physics. Physics, he said, was not able to prove conclusively whether the universe is oscillating or not. If the physicist chooses to reject the eternal cycles it is because of prior beliefs in a linear progression of time. Yet it is one of Duhem's more daring claims that the development of modern physics was made possible by the Church's condemnation of the Great Year. Nietzsche's doctrine of eternal returns and other oscillatory schemes developed in Duhem's era put this particular case study into context. The third and last section of the chapter examines the effect of the law of inertia on the first of Thomas's five ways to proving the existence of God. Some neo-scholastics tried to rewrite the proof to make it convincing in light of Newtonian physics. In doing so, they implicitly condemned the medieval formulation as

nonsense. Duhem interrupted one such neo-scholastic public lecture to point out the dangers of misusing physics. Later, he was hounded by another Thomist, Garrigou-Lagrange, who thought that the law of inertia was a logical contradiction, to write an article on the status of inertia in physics so as to authorize a defense of the medieval formulation. Duhem's brief letter, explaining that the law of inertia is a mere hypothesis, has become his most often published work. The three case studies show that physics could not overcome metaphysical beliefs, even among those who believed that physics provided metaphysical explanations. Some separation was clearly possible.

The fifth chapter examines the connection between physics and metaphysics as it was understood by Duhem and various neo-scholastics. The different reactions to Duhem's first article on the philosophy of physics by two neo-Thomists, Vicaire and Lacome, immediately shows the need to distinguish among the school. It is argued that this debate provided a strong motivation for the next few papers which Duhem published on the philosophy of physics and which were eventually reworked into the *Aim and Structure of Physical Theory*. Duhem's intervention at the Brussels conference in 1894 provides the opportunity to show the similarity between his position and Gardeil's on the nature of physical theories. An examination of the correspondence from Bulliot to Duhem shows that even this ardent, albeit unsophisticated, neo-Thomist began to appreciate the wisdom of Duhem's instrumental understanding of modern physics. The gradual acceptance of Duhem's views among neo-scholastics is documented by references to the Fribourg Congress, to Louvain, and to the Dominicans. The last section of the chapter examines Maritain's philosophy of science and its similarity to and dependence on Duhem. Thus concludes the main argument of the thesis.

The sixth chapter addresses arguments which have been alleged, especially by Martin, against Duhem's association with neo-Thomism. An interest in Pascal was widespread at the time, even among neo-Thomists, who did not believe that he was a fideist. Duhem's friendship with Blondel did not amount to an acceptance of his philosophical views. The reader might also remember from the first chapter that Blondel's views were not as opposed to neo-Thomism as one might think. A letter from Duhem to Gardeil shows that he was just as fed up with some modernists as he was with some neo-scholastics. Finally, there is a section on Duhem's explicit views of Thomas's philosophy, positive at first and even as late as the publication of *Sozein ta phainomena* (1908), but then almost violently negative in the *Système du monde*. Two reasons may explain the ultimate harsh dismissal: (1) Duhem's own frustration with some neo-Thomists and (2) his historical view that modern science originated with Archbishop Tempier's condemnation in 1277 of many of Aristotle's and some of Thomas's propositions. Ironically, Duhem, who understood the link between physics and metaphysics to be analogical, missed Thomas's use of analogy in trying to reconcile disparate approaches to metaphysics. The last section should make clear that, in arguing for Duhem's compatibility with and influence on neo-Thomism, the thesis never claims that he himself was motivated or guided by Thomas's works.

It is only fair to warn the reader of a few motivations beyond mere historical curiosity which led me to undertake this study. First, I am interested in assessing the continuing relevance of natural philosophy of the kind found in Aristotle's *Physics*. My present suspicion is that discussions about the existence of the void or about the bearing of inertia on the principle of causality cannot engage the modern mind. Such discussions may usefully teach people to make distinctions and to be open to concerns other than those which modern physics can address; but I find it difficult to

see what knowledge natural philosophy can provide besides that which is available to common sense. I tend to agree with one of Nys's contemporaries at Louvain, Laminne, who pointed out that hylomorphism is neither confirmed nor refuted by modern physics and chemistry (page 190). Such a viewpoint, of course, does not lend itself to a favourable assessment of programs, such as Louvain's, to institutionalize a tight connection between the laboratory and the philosophical vocabulary of Aristotle.

A second related interest also does not augur well for Mercier and his associates: to assess in what sense and to what extent is a *philosophia perennis* possible. If it is possible at all as a treasury of timeless knowledge, it cannot be tied to mathematical physics. A true perennial philosophy in this sense would have both to predate physics and to avoid the shifting perspectives of the technical science.

A third consideration makes me particularly sympathetic to Duhem: the belief that physics does reveal something of the universe, beyond providing techniques to harness nature, for good or ill, to do our bidding. Duhem spoke of analogy as the link between physical theory and the world. His hope for a unified physical theory tending toward a natural classification may not have been borne out (so far), but Maritain's talk of physical theories providing oblique views of nature continues to be relevant and in line with Duhem's ideas about analogy. It was thus encouraging for me to have discovered this Duhemian streak in a particularly influential branch of neo-Thomism.

A few more introductory remarks might be useful. First, the chapters of the thesis assume a basic knowledge of Duhem's life. An appendix provides a brief introduction for those who need it, but can safely be omitted by those familiar with him. It is based heavily on Jaki's *Uneasy Genius* and does not pretend to be original.

Secondly, a word about what is not found here which one might naturally hope to find in a discussion of scholastic views of science – teleology. Admittedly the topic was discussed in debates about evolution and in more general discussions about philosophy, but it did not enter into discussions of physics and cosmology. In Louvain, Nys had restricted cosmology to the study of the formal and material causes of the inorganic realm. He thought that the efficient and the final causes would become evident once the contingency of the world had been proved.⁸ Many others must have thought likewise, for, apart from Duhem's comparison of minimization and maximization in energetics to Aristotle's notion of each thing seeking its natural place, teleology was not an issue.

Thirdly, a word about methodology gives me the opportunity to stress that many important letters from and to Duhem have not been taken into account by historians. The various works on Duhem introduced me to journals such as the *Annales de philosophie chrétienne*, the *Revue thomiste*, and the *Revue de philosophie* where the relevant debates took place. Histories of the neo-Thomist movement and perusal of neo-scholastic manuals acquainted me with the persons and institutions of importance to the study. After nearly three years of research in Toronto, I was skeptical about learning anything more from archival material. My skepticism was quickly overcome when I began to read the correspondence between Duhem and Gardeil, Mansion, Pautonnier, Bulliot, Peillaube, and Hedde. Stoffel is right to point out that the archives have yet to be exploited.

Fourthly, the reader will notice a great deal of French. Official bilingualism alone is not a sufficient argument to justify its inclusion. The French has been retained so as to shorten the thesis. With two exceptions, whenever English

⁸ Désiré Nys, *Cosmologie ou Étude philosophique du monde inorganique*, 2 vols, Cours de philosophie, no. 7 (Louvain: Institut de philosophie, 1916-18), I, p. 52.

published texts exist, I have quoted from the English. Thus whatever is now in the French would have required lengthy footnotes of the original, were I to translate it in the main text.

Fifthly, the reader might find references to 'secular priests' puzzling if not scandalous. The term here denotes that the priest does not belong to a religious Order such as the Jesuits or Dominicans, but that he is a diocesan priest. Likewise, a 'religious priest' does not necessarily mean that he is devout, only that he belongs to an Order. The French restrict the use of the title 'Father' to religious priests. Secular priests are addressed 'Monsieur l'Abbé'. Hence, in order to indicate that a person is a secular priest, I refer to him, for example, as the Abbé Merklen.

Sixthly, I do not generally distinguish between neo-Thomist and neo-scholastic, although the latter category is potentially more inclusive. At times, I even dispense with the 'neo' when there is no danger of confusion. Style was the main consideration in my particular choice of labels; so the reader is advised not to try to discern any distinctions where there are none.

Finally, a word about footnotes and the bibliography. I tend to use footnotes merely to give references for ideas discussed or passages quoted in the main text, rather than to carry on parallel conversations. The first citation of a given source provides full bibliographical details in the footnote (apart from what is clear in the text). All subsequent citations are by author and abridged title. All works referred to in this abridged manner can be found in the bibliography. The bibliography, however, does not contain all cited works. Thus a work that is cited only once may not appear in the bibliography if it is not immediately relevant to the topic of the thesis. The few abbreviations which are used are designed to be fairly suggestive, but a table of abbreviations is found on page vi. The use of the bibliography to fill

in the details for abridged references strongly suggests that it be by author and then by title rather than by themes. Any qualms of conscience that I may have to the effect that such a bibliography might not be as useful to potential Duhem scholars as thematic presentation of the material has been thoroughly overcome by the relatively recent publication of Jean-François Stoffel's excellent and almost exhaustive bibliography of primary and secondary Duhemian literature.⁹

⁹ Jean-François Stoffel, *Pierre Duhem et ses doctorands: Bibliographie de la littérature primaire et secondaire*, *Réminiscences*, no. 1 (Louvain-la-Neuve: Centre interfacultaire d'étude en histoire des sciences, 1996)

CHAPTER 1

**Towards a Renewed Harmony of Faith and Reason
in an Age of Science: The Encyclical Aeterni Patris**

Nor will the physical sciences, which are now in such great repute, and by the renown of so many inventions draw such universal admiration to themselves, suffer detriment but find very great assistance in the re-establishment of the ancient philosophy. *Aeterni Patris*¹

The relationship of philosophy to theology is a perennial question among Christians. On the one hand, there is within Christianity a distrust of philosophy, as evinced by Saint Paul's warning to the Colossians: 'See to it that no one makes a prey of you by philosophy and empty deceit.'² But the Apostle himself found that he could not dispense with philosophy, for he needed a rational basis from which to appeal to potential converts. The human mind, he insisted, is naturally capable of coming to know the existence of God, his basic attributes, and the fundamental precepts of the moral law.³ Thus philosophy could serve as a propaedeutic to belief. Furthermore, as Christians later came to appreciate, philosophy could also help the believer to understand the truths of Revelation and their interconnection.

But what is philosophy? The difficulty of the question is made evident by the variety of extant philosophical systems. Christian theologians have often turned to or developed different philosophies to explain and defend the Gospel. At times, the Church judged that some philosophical systems, or at least parts of them, presented grave dangers to Christian doctrine and took steps to warn the faithful not to be deceived. In the nineteenth century, the Church's Magisterium issued many such

¹ Leo XIII, *Aeterni Patris*, in *The Great Encyclical Letters of Pope Leo XIII* (New York: Benziger Brothers, 1903), pp. 34-57 (p. 55).

² Colossians 2.8.

³ See Romans 1.18-25.

condemnations. Most of these were directed against the works of Catholics who tried to defend the Church and to make the Gospel relevant to their contemporaries. It is instructive to look at some of these condemnations, for they indicate the limits which any philosophy acceptable to the Church must respect.

1. Dangerous philosophies: The Magisterium as via negativa

On the one hand, the Magisterium was concerned to uphold the dignity of human reason against fideism, which teaches that faith (*fides*) is the beginning of all knowledge of God. In 1835, 1840, and again in 1845, Louis Eugène Bautain (1796-1867), a priest and professor at the University of Strasbourg, was asked to sign several propositions which included the statement that ‘reason can prove with certitude the existence of God and the infinity of His perfections’. Bautain was enjoined to admit that this was true even in a fallen world: ‘although reason was rendered weak and obscure by original sin, yet there remained in it sufficient clarity and power to lead us with certitude to a knowledge of the existence of God.’⁴

Ecclesiastical authority also acted against the fideism of Augustin Bonnetty (1798-1879), a layman who founded the *Annales de philosophie chrétienne* in 1830 and remained its director until his death. Bonnetty emphasized tradition as the means by which man comes to know truths about God, about himself, and about civil society, to the point that he denied that man could know these things by reason.⁵ Traditionalism was popular in the first half of the nineteenth century among Catholics in France, who blamed the excessive claims of reason for the upheavals of

⁴ Henry Denzinger, *The Sources of Catholic Dogma*, trans. from the thirtieth edition by Roy J. Deferrari (Powers Lake, ND: Marian House, after 1957), paragraphs 1622-7. For a brief outline of Bautain’s life and work, see Louis Foucher, *La philosophie catholique en France au XIX^e siècle avant la renaissance thomiste et dans son rapport avec elle (1800-1880)* (Paris: Vrin, 1955), pp. 71-98.

⁵ For a brief outline of Bonnetty’s life and work, see Foucher, *La philosophie catholique*, pp. 65-8.

the Revolution. As late as the 1850s, many of the ultramontane bishops of France were favourable to traditionalism, which made Rome reluctant to act against it.⁶ Nevertheless, in 1855, Bonnetty was asked to sign four propositions to convince the Magisterium of his orthodoxy. In addition to affirming the power of reason to know important truths about God and man, he signed that 'the method which St. Thomas and St. Bonaventure and other scholastics after them used does not lead to rationalism, nor has it been the reason why philosophy in today's schools is falling into naturalism and pantheism'.⁷

This last proposition reveals the other philosophical extreme which the Church would not tolerate – rationalism. In 1846, Pius IX issued an encyclical in which he castigated those who rejected Christianity in the name of human reason:

Hence, by a preposterous and deceitful kind of argumentation, they never cease to invoke the power and excellence of human reason, to proclaim it against the most sacred faith of Christ, and, what is more, they boldly prate that it [faith] is repugnant to human reason. Certainly nothing could be more insane, nothing more impious, nothing more repugnant to reason itself can be imagined or thought of than this. For, even if faith is above reason, nevertheless, no true dissension or disagreement can ever be found between them, since both have their origin from one and the same font of immutable, eternal truth, the excellent and great God.⁸

The impossibility of faith and reason ever contradicting one another was eventually incorporated into the documents of the First Vatican Council in 1870. But before that, in 1854, Pius IX again took up the theme of rationalism in an allocution. 'Followers, or rather worshipers of human reason', he said, 'who set up reason as a teacher of certitude, and who promise themselves that all things will be fortunate under its leadership, have certainly forgotten how grave and terrible a wound was

⁶ Roger Aubert, *Le Pontificat de Pie IX*, Histoire de l'église depuis les origines jusqu'à nos jours, no. 21 (Paris: Bloud & Gay, 1952), p. 190.

⁷ Denzinger, paragraph 1652.

⁸ Denzinger, paragraph 1635.

inflicted on human nature from the fault of our first parent; for darkness has spread over the mind, and the will has been inclined to evil.⁹ Among those with rationalist tendencies, the Church rebuked some of her own priests: George Hermes in 1835; Anton Guenther, in 1857; and James Frohschammer in 1862.¹⁰

The German nationality of these theologians is no coincidence. Catholics in German-speaking lands took part in the general flowering of scholarship in their countries, especially in philosophical speculation and historical researches. Hermes had tried to adapt Kant's ideas to Catholic thought; Guenther was influenced by Hegel; and Frohschammer argued for academic freedom in theological studies and then adopted liberal Protestant positions. There is little doubt that German Catholics surpassed their co-religionists in other countries in scholarship, but their attempts to understand their faith in light of contemporary philosophical speculation were not always welcome in Rome.¹¹

The condemnations of both fideism and rationalism were not the only limits imposed upon Catholic theologians who needed a philosophical framework. In 1861, the Church judged that the ontologism professed by Casimir Ubaghs (1800-75) of Louvain could not be safely taught.¹² According to this doctrine, the human intellect can attain knowledge of existing things only because it has an immediate habitual knowledge of God, who is being itself. Although ontologism can be likened to the Platonist tradition within Christianity, it was suspect to the Magisterium because of its pantheist tendencies. Ubaghs was by no means the only ontologist. The system was widely taught in France; and in Italy, through the work of the priest Antonius de

⁹ Denzinger, paragraph 1643.

¹⁰ Denzinger, paragraphs 1619, 1635, and 1668.

¹¹ Aubert, *Le Pontificat de Pie IX*, p. 193.

¹² Denzinger, paragraphs 1659-65.

Rosmini-Serbatti (1797-1855), it became something of a national philosophy, at least outside of Jesuit circles. Although the philosophical works of another ontologist, Vincenzo Gioberti (1801-52), had been put on the *Index of Prohibited Books*, Rosmini remained unscathed under Pius IX, despite repeated attempts to condemn his works. Gioacchino Pecci had to wait to become Pope Leo XIII before he could issue the long desired condemnation himself in 1887.¹³

The condemnations discussed thus far have involved thinkers who were genuinely trying to promote the Faith. The Church also anathematized doctrines that were overtly hostile to her mission. The *Syllabus of Errors*, published in 1864, shows the siege mentality of the Vatican. Besides denunciations of philosophical systems such as pantheism, naturalism, and absolute rationalism, the *Syllabus* condemned various political positions and teachings about morality. The eightieth and final anathematized opinion was that ‘the Roman Pontiff can and should reconcile and adapt himself to progress, liberalism, and modern civilization’.¹⁴ It should come as no surprise that this proposition has exasperated the Church’s defenders and has provided great amusement to her detractors. But the statement loses much of its sensationalist value if one remembers that ‘progress, liberalism, and modern civilization’ meant the fall of the Papal States, the demise of orthodox Christianity, and revolutions of the kind that ravaged Europe in 1848.

The relationship between philosophy and theology was addressed by the First Vatican Council in 1870. The canons proposed nothing new but gave more authority to previous censures of pantheism, naturalism, fideism, and rationalism. In particular, the Council made it a dogma of faith that human reason is not powerless

¹³ Aubert, *Le Pontificat de Pie IX*, pp. 190-2.

¹⁴ Denzinger, paragraph 1780.

to know by its own light the one true God who is creator and Lord.¹⁵ This put an amusing twist into the debate about the possibility of what Catholics have traditionally called ‘natural theology’ – a theology based on reason alone.

Although the Magisterium was prepared to say what philosophies it found unacceptable, it was not yet ready to propose a remedy. There are several historical reasons for this reluctance. First, there was a general lack of interest in philosophy among many high-ranking clerics.¹⁶ Part of the blame for this must be attributed to the dry and eclectic manuals from which philosophy was taught in the seminaries. When, in 1846, John Henry Newman (1801-90) asked what philosophy the Jesuit professors in Rome had adopted, the response was ‘none’: ‘Odds and ends – whatever seems to them best. [...] They have no philosophy. *Facts are the great things, and nothing else.*’¹⁷ Roger Aubert, in his study of the Church under Pius IX, notes that complaints about the lack of scholarship in Rome were too uniform and numerous to be doubted, but he is careful to point out that there were exceptions. He cites the work of the Jesuit astronomer and physicist Angelo Secchi, researches in Christian archeology, and even a re-awakening in theological and philosophical studies.¹⁸ However, these exceptions could not make up for the neglect of studies in general in a city where the need to govern the universal Church imposed different priorities and provided more obvious outlets for ambition.

The second reason for the Church’s reluctance to legislate positively in matters

¹⁵ Denzinger, paragraph 1806.

¹⁶ Marvin R. O’Connell, *Critics on Trial: An Introduction to the Catholic Modernist Crisis* (Washington, DC: Catholic University of America Press, 1994), pp. 27-9.

¹⁷ Letter from Newman to J.D. Dalgairns, 22 November 1846, in *The Letters and Diaries of John Henry Newman*, 31 vols, ed. by C.S. Dessain (London: Nelson, 1961), XI, p. 279; see Marvin O’Connell, *Critics on Trial*, p. 28.

¹⁸ Aubert, *Le Pontificat de Pie IX*, pp. 184-5.

of philosophy is that her mission is to defend the truths of revelation. She believes that the charism of infallibility is primarily for the sake of her pastoral mission rather than to provide authoritative answers to philosophical speculation. Hence, the Church's interventions in philosophical disputes have tended to be negative.

Thirdly, the Magisterium is aware that there was a difference of philosophical outlook among many of Christianity's most authoritative expounders. The Church Fathers, for example, have tended to be neo-Platonist whereas Saint Thomas adopted concepts from Aristotle. Because a positive endorsement of one school is often an implicit repudiation of another, the Magisterium is necessarily wary about taking such steps, especially if the slighted schools are not mere historical curiosities. This was a real concern in the nineteenth century. Traditionalism, German idealism, Cartesianism, ontologism, Suarezianism, and eclecticism, despite the condemnations of some of their particular doctrines, were all well represented in the Church.

2. *The road back to Thomas*

The one school which had thus far escaped unscathed was the tiny band of Thomists. Although Thomas has had disciples in nearly every generation since his death in 1274, their numbers and influence have varied greatly over the centuries. It is common to speak of two Thomist revivals: one in the sixteenth century, and one in the nineteenth.

Historians of the second Thomist restoration emphasize the role of Canon Vincenzo Buzzetti who studied Thomas in Piacenza until 1798 and later taught the *Summa* at the diocesan seminary in Perugia.¹⁹ The brothers Domenico and Serafino

¹⁹ For a history of the nineteenth century Thomistic revival see Joseph Louis Perrier, *The Revival of Scholastic Philosophy in the Nineteenth Century* (New York: Columbia University Press, 1909); Roger Aubert, *Aspects divers du néo-thomisme sous le pontificat de Léon XIII* (Rome: Edizioni 5 Lune, 1961) and 'Le contexte historique et les motivations doctrinales de l'encyclique "Aeterni Patris"', in *Tommaso d'Aquino nel i centenario dell'enciclica 'Aeterni Patris'*, ed. by Benedetto D'Amore (Rome: Società

Sordi, both Jesuits, were in his class in 1810. Their enthusiasm for Thomas eventually spread to some very influential people. Serafino Sordi imparted his zeal for Thomism to Luigi Taparelli d'Azeglio who became the rector of the Gregorian University when it was restored to the Jesuits in 1824. Although Taparelli was unsuccessful in imposing Thomism on the professors, who preferred Descartes and Suarez, he was able to make inroads with some of the students. Among these was a bright teenager who served as a teaching assistant to Taparelli: Gioacchino Pecci, who would become Pope Leo XIII in 1878.²⁰ Prior to his election, Pecci would spend 32 years as the bishop of Perugia. There, he appointed his brother Giuseppe Pecci to teach Thomist philosophy at the seminary; and he started an academy of Saint Thomas.

Taparelli's influence spread in other ways. In 1829, he was made the Provincial of the Jesuits in Naples and appointed Domenico Sordi to teach philosophy to the order's seminarians. Although in 1833 Taparelli was exiled by the Bourbons and Sordi was forbidden to teach anything pertaining to the natural law and the rights of kings, the Naples sojourn bore fruit. Among Sordi's students were Carlo Maria Curci and Mattheo Liberatore (1810-92). In 1850, Curci was made the founding editor of the *Civiltà Cattolica* and Liberatore was appointed to its staff. Serafino Sordi and Taparelli too became involved with the paper. Thus Thomists were given the opportunity to publish a journal which was meant to influence the Italian educated classes.

Another Jesuit who contributed to the restoration of Thomism was the German

Internazionale Tommaso d'Aquino, 1979), pp. 15-48; Leonard Boyle, 'A Remembrance of Pope Leo XIII: The Encyclical Aeterni Patris', in *One Hundred Years of Thomism: Aeterni Patris and Afterwards: A Symposium*, ed. by Victor B. Brezick, (Houston: Center for Thomistic Studies, 1981), pp. 7-22; and Gerald McCool, *The Neo-Thomists* (Milwaukee: Marquette University Press, 1994).

²⁰ Boyle, pp. 15-7.

Joseph Kleutgen (1811-1883) who was dubbed 'Thomas Redivivus'. Kleutgen had written two influential works – the *Theologie der Vorzeit* and the *Philosophie der Vorzeit* (1860-62) – which argued for the superiority of scholastic philosophy and theology over anything that had happened since the Middle Ages. He called for a true renewal of philosophy which would surpass historical Thomism. Despite being German, Kleutgen was influential in Rome. He was instrumental in the condemnation of Guenther's works; and he was invited to work on *Dei Filius*, the Vatican Council's constitution on faith.²¹

Despite the success of the *Civiltà Cattolica* and Kleutgen's influence, official acceptance of Thomism was put off for some time. Strong opposition to the Thomist restoration came from the Jesuits at the Roman College, mainly on account of hylomorphism (see chapter 3.2).²² Pius IX, who was sympathetic to Thomism and even encouraged it in Naples, was reluctant to cause offense in Rome.²³ He was so careful in this regard, that shortly after the Council, he declined a request from Cardinal Pecci to declare Thomas the patron saint of Catholic universities.²⁴

3. Aeterni Patris: *the wisdom of the ages*

The official reticence changed quickly with the election of Pecci to the Papacy on 20 February 1878. A week after his election, Leo XIII took the first steps towards a Thomist restoration. He began by setting up an academy of philosophy at the Roman Seminary and insisting that the Cartesian manuals in use at the Seminary be replaced by manuals written by the Thomists Nunzio Signoriello and Tommaso

²¹ McCool, p. 31 and p. 26.

²² See R. Jacquin, 'Une polémique romaine sur l'hylémorphisme, il y a un siècle', *Revue des Sciences Religieuses*, 32 (1958), 372-7.

²³ Perrier, p. 160.

²⁴ Aubert, 'Contexte', p. 28.

Maria Zigliara (1833-1893). The Pope then turned his attention to the Gregorian (Roman) College. He installed Kleutgen as prefect of studies and indicated to the rector, Cardella, that he wanted Thomas to be the norm for teaching. However, the changes had little effect on the professors, who continued to expound Descartes, Suarez, or even Rosmini. Further steps had to be taken. The Jesuit Giovanni Maria Cornoldi (1822-1892), an uncompromising Thomist, was asked to take charge of an open course in Thomist philosophy at the Gregorian in 1878-79. And at the end of the school year, five professors from the College were forced into retirement.

Leo made further preparation for the scholastic reform by creating two Thomists cardinals at his first consistory in April 1879: his brother Giuseppe and the Dominican Zigliara. In the summer of 1878, Leo had told Cornoldi that it would take two years of preparation before he could make an effective push for scholastic philosophy.²⁵ But by the summer of 1879, perhaps emboldened by the arguments of three committed Thomists – his brother Giuseppe, Liberatore, and Msgr Salvatore Talamo – the Pope was ready to act.²⁶ On 4 August 1879, Leo published the encyclical letter *Aeterni Patris*, calling for a restoration of scholastic philosophy.

The encyclical began by blaming many of the evils of the nineteenth century on modern philosophy. To counter these effects, it was necessary to adopt a philosophy which would ‘respond most fitly to the true faith, and at the same time be most consonant with the dignity of human knowledge’.²⁷ The encyclical then dealt with the relationship of philosophy to theology, incorporating many of the traditional arguments. Faith was above reason, but reason could offer aid to faith. Philosophy

²⁵ Aubert, ‘Contexte’, p. 40.

²⁶ Aubert, ‘Contexte’, p. 43.

²⁷ Leo XIII, *Aeterni Patris*, p. 35.

was a handmaid of theology. It could prepare the way for Christian faith by proving that God exists and by making known some of his attributes. It could provide a unifying framework for theology and hone the mind to understand revealed truths more fully and accurately. This deeper knowledge of Christian mysteries was to be 'sought as well from analogy of the things that are naturally known as from the connection of those mysteries with one another and with the final end of man'.²⁸ Finally, philosophy could be used to defend the faith against the arguments of philosophers.

Aeterni Patris insisted that it was not proposing something drastically new. It pointed to the example of the early Church Fathers and the Scholastics who used philosophy in the ways that it was now advocating. The encyclical claimed that the Christians were much better philosophers than their non-Christian counterparts because 'faith frees and saves reason from error, and endows it with manifold knowledge',²⁹ and it maintained that this symbiosis of philosophy and theology found its ultimate expression in Saint Thomas Aquinas:

Clearly distinguishing, as is fitting, reason from faith, while happily associating the one with the other, he both preserved the rights and had regard for the dignity of each; so much so, indeed, that reason, borne on the wings of Thomas to its human height, can scarcely rise higher, while faith could scarcely expect more or stronger aids from reason than those which she has already obtained through Thomas.³⁰

The encyclical claimed that the founders of modern philosophy had severed the connection: 'hence it was natural that systems of philosophy multiplied beyond measure, and conclusions differing and clashing one with another arose about those

²⁸ Leo XIII, *Aeterni Patris*, p. 40.

²⁹ Leo XIII, *Aeterni Patris*, p. 43.

³⁰ Leo XIII, *Aeterni Patris*, p. 49.

matters even which are the most important to human knowledge.³¹ In order to overcome this baneful development, the Pope urged the restoration of scholastic philosophy in general, and the study of Saint Thomas Aquinas in particular.

Leo hoped that this re-attachment to tradition would soon have many beneficial effects. The encyclical first mentioned the political and social order which was especially in need of stabilization. Next it expressed hope for a reflowering of the arts. Finally it mentioned science:

Nor will the physical sciences, which are now in such great repute, and by the renown of so many inventions draw such universal admiration to themselves, suffer detriment but find very great assistance in the re-establishment of the ancient philosophy. For the investigation of facts and the contemplation of nature is not alone sufficient for the profitable exercise and advance; but when facts have been established it is necessary to rise and apply ourselves to the study of the nature of corporeal things, to inquire into the laws which govern them and the principles whence their order and varied unity and mutual attraction in diversity arise. To such investigation it is wonderful what force and light and aid the scholastic philosophy, if judiciously taught, would bring.³²

Leo was aware of the modern prejudice against the science of the Middle Ages. Hence, the encyclical tried to allay ridicule on this point by arguing that Thomas Aquinas and Albert the Great 'were never so wholly rapt in the study of philosophy as not to give large attention to the knowledge of natural things'. In fact, the Pope continued, philosophy demands that its practitioners be well versed in the study of physical things, because the natural progression is from the sensible to the suprasensible. Moreover, *Aeterni Patris* invoked the authority of contemporary scientists to assert that 'between certain and accepted conclusions of modern physics and the philosophic principles of the schools, there is no conflict worthy of the

³¹ Leo XIII, *Aeterni Patris*, p. 52.

³² Leo XIII, *Aeterni Patris*, p. 55.

name'.³³

Leo did not name the scientists, nor did he specify what sort of conflict there might be between scholastic science and modern philosophy. One possibility is that he was trying to put to rest the fear that scholastic philosophy was inextricably bound up with angels moving heavenly spheres and arrows being kept in flight by the fortuitous turbulence of their own making. Such schemes had been devised in the Middle Ages to explain the scholastic principle that 'everything that is moved is moved by another'. But the more probable reason for Leo's assertion about the harmony between modern physics and scholastic philosophy was to respond to the popular charge that the Church was against science.

There are more general aspects of the encyclical which need to be addressed before its bearing on science can be examined. Earlier Popes and Councils had cited the great intellectual service that Thomas had rendered to the Church; and, on occasion, Pontiffs had enjoined the study of Thomas on particular universities; but *Aeterni Patris* went much further in urging the whole Church to adopt a particular philosophy.³⁴ The unprecedented legislation was meant to address a real problem. There was a need to reform the teaching of philosophy in the seminaries if for no other reason than to provide a coherent basis for the teaching of theology. Modern systems of philosophy, the encyclical claimed, could not fulfil this function because they were undermined by fundamental errors. These errors were almost inevitable for two reasons. First, the systems were developed in isolation from theology. Secondly, they did not fit in to an established tradition and hence they did not have

³³ Leo XIII, *Aeterni Patris*, p. 56.

³⁴ Leo XIII, *Aeterni Patris*, pp. 50-1.

the approval that time alone could provide.³⁵ It was almost natural that the Church should look to scholastic philosophy for an answer. The approved thinkers of the Middle Ages philosophized under the rubric of *fides quaerens intellectum* – faith seeking knowledge. Moreover, they philosophized about the meaning of traditional texts such as the Scriptures, the Fathers of the Church, and earlier philosophers. The scholastics were ideally placed to distinguish perennially valid truths from ephemeral fads.

Aeterni Patris at times eulogizes the whole of scholastic philosophy while explicitly urging the study of Saint Thomas. This ambiguity led to some problems of interpretation. Were the Franciscans, for example, to continue to follow the teachings of their scholastic masters? Apparently yes. Shortly after publishing the encyclical, the Pope addressed a letter to the order ‘to tell them that not only could they but that they ought to continue to follow their Scotist tradition’.³⁶ Interpreted in this way, *Aeterni Patris* could lead to a revival of medieval philosophy, but the result would not be a unified system.

The encyclical contains another ambiguity in the directions it gives for the understanding of Thomas himself. It approves of the founders of religious Orders who made it a rule ‘to study and religiously adhere to the teachings of Saint Thomas, fearful lest any of them [their religious associates] should swerve even in the slightest degree from the footsteps of so great a man’.³⁷ *Aeterni Patris* speaks with nostalgia of a probably mythical time when at the most important universities ‘the minds of all, [...] , rested in wonderful harmony under the shield and authority of the Angelic

³⁵ Leo XIII, *Aeterni Patris*, pp. 52-3.

³⁶ Édouard Lecanuet, *La Vie de l'Église sous Léon XIII, L'Église de France sous la troisième République*, vol. 4 (Paris: Librairie Félix Alcan, 1930), p. 469.

³⁷ Leo XIII, *Aeterni Patris*, p. 49.

Doctor'.³⁸ And it calls upon teachers and students to go to the writings of Thomas himself lest they learn a corrupted version of his teaching. Yet the encyclical warns against a mere parroting of Thomas: 'For if anything is taken up with too great subtlety by the scholastic doctors, or too carelessly stated – if there be anything that ill agrees with the discoveries of a later age, or, in a word, improbable in whatever way, it does not enter Our mind to propose that for imitation to Our age.'³⁹ The sentence does not explicitly refer to Thomas, but some of his teachings clearly did not stand the test of time. He spoke of spontaneous generation and bodily humours and drew upon other aspects of medieval cosmology to illustrate theological points. Such teachings could not be credibly maintained in the nineteenth century.

Unfortunately, there were many people who thought that they were being faithful to the encyclical by merely repeating what Thomas had said and making no attempt to update his teaching. But there were more intelligent attempts to be faithful to *Aeterni Patris* than by merely repeating Thomas. The greater part of this thesis will be devoted to examining some of these efforts and to delineating the major themes in Thomist philosophy as it pertains to science. Yet it is important to have some basic ideas about Thomism at the outset, in order to understand the interests and concerns of those who claimed to be the Saint's disciples. Although there is often bitter debate between people who call themselves Thomists about what the Saint really meant, the following outline should sketch a fairly accurate picture of the salient points of Thomism.

³⁸ Leo XIII, *Aeterni Patris*, p. 50.

³⁹ Leo XIII, *Aeterni Patris*, p. 56.

4. Thomism: a brief sketch

Perhaps the most striking characteristic of Thomism is its confidence in human reason. Étienne Gilson puts it this way: 'To be true disciples of Thomas Aquinas, we would first have to put so much trust in the natural light of reason that nothing could make us doubt it, not even God.'⁴⁰ This confidence places no *a priori* limits to human knowledge. Thomists do not say that man can know *phenomena* but not *noumena*, that causality is only a mental construct, or that truth merely pertains to self-consistent ideas. Although Thomists, like their master, try to explain how man comes to know, the tradition considers Descartes's hyperbolic doubt or Kant's *Critique of Pure Reason* as illegitimate approaches to philosophy, which doom the intellect to know *nothing* but itself.

The Thomist confidence in man's ability to know is ultimately justified by a theological argument – man is made in the image of God – but it does not start there. Rather, it begins by taking seriously the common belief that man can come to know the natures of some things in the world around him. He can know human nature, for example, and the nature of oaks and acorns. This does not mean that he knows everything about man or acorns; but he knows enough to make judgments about causal relations. He can reward or punish human beings because he knows that they are responsible for their actions; and he can know that it is the nature of acorns to grow into oaks.

Causality is another principle of Thomism. In fact, many Thomists define philosophy as 'knowledge through ultimate causes' and distinguish it from science,

⁴⁰ Étienne Gilson, *The Spirit of Thomism* (New York: Harper and Row, 1964), p. 19.

which they define as 'knowledge through proximate causes'.⁴¹ A scientist, for example, knows that fire causes water to heat up. A philosopher would explain the same fact by appeals to more abstract concepts such as potency and act. But his analysis need not be only more general than that of the scientist; it could also invoke different notions of causality. The Thomist philosopher does not hesitate to make use of all four of Aristotle's causes – efficient, material, formal, and final. He finds the notion of final causality especially useful for theological speculation because it provides a basis for one of the classic arguments for the existence of God and it also makes intelligible the distinction between primary and secondary, or instrumental, causes, which is necessary to the study of moral and sacramental theology.

The Thomist's richer understanding of causality leads him to reject any monist or purely mechanical conception of the universe. This put him at odds with an influential world-view of the late nineteenth and early twentieth centuries. But the Thomist's insistence that true knowledge is knowledge through causes led some of them to reject Pierre Duhem's notion of physical theory, which denied that physical theories are causal explanations (see chapter 3.1).

Perhaps the most useful notion which Thomas borrowed from Aristotle is the distinction of potency and act. In 1914, the Vatican's Sacred Congregation for Studies issued a list of twenty-four theses which it deemed essential to a proper understanding of Saint Thomas. The very first reads: 'Potency and act so divide being, that whatever is, either is pure act [God], or is necessarily composed of potency and act as from first and intrinsic principles'.⁴² Act is perfection whereas

⁴¹ See, for example, *SéancesSSTA*, 19 April 1894, *AnnPhilChr*, 128 (1894), 292-6 (p. 296); a modern philosopher, Roger Scruton, has seized on causality as the defining characteristic of Thomism, *Modern Philosophy: An Introduction and Survey* (New York: Penguin, 1994), p. 8.

⁴² 'Potentia et actus ita dividunt ens, ut quidquid est, vel sit actus purus, vel ex potentia et actu tanquam primis atque intrinsecis principiis necessario coalescat.' *Acta Apostolicae Sedis*, 11 (3 August 1914), p. 383.

potency is capacity for perfection.

In material substances, potency and act are seen most clearly in matter and form respectively. These metaphysical concepts are extremely useful in accounting for change. Grape juice, for example, is potentially wine. Before fermentation, the substance is actually grape juice; afterwards, an aspect of grape juice – its matter – becomes an aspect of wine. Two forms – *grape-juiceness* and *wineness* – succeed one another in informing a constant substrate – prime matter. The technical name of this metaphysical doctrine is hylomorphism, from the Greek words *hyle* – wood or matter – and *morphe* – form or appearance. This way of looking at things appeals to common sense and is enshrined in many European languages. Grape juice is said to be ‘transformed’ into wine.

But even the linguistic instantiation of hylomorphism was not sufficient to hold out against the new philosophical conceptions of the seventeenth century, be they Cartesian notions of matter as extension or the Gassendian ontology of hard atoms in a vacuum. These modern alternatives lent themselves to the development of mathematical physics, but, because they lacked the concept of substantial form, they could not account for the unity of things as human beings encountered them in daily life. Nevertheless, the new ontology, especially atomism, was so ingrained by the mid-nineteenth century that even philosophers sympathetic to scholasticism, such as Tongiorgi at the Gregorian College, were scandalized by hylomorphism.⁴³

Epistemology and its associated anthropology provide further distinguishing features of Thomism. Thomas, like Aristotle, taught that knowledge comes from the exterior world through sense perception – *nihil in intellectu nisi prior in sensu*. But the act of knowing, according to Thomas, requires an intellectual power which must

⁴³ See Jacquin, ‘Une polémique romain’.

be immaterial. The intellect is a faculty of the soul, which is defined as the substantial form of the human body. The soul then is a spiritual form of a material entity. This basic Thomist anthropology has a few important bearings on the philosophy of science.

First, it requires Thomists to pay attention to experimental science because ultimately all knowledge comes from the senses. This is true whether *experiment* is taken to mean 'mere observation' or the 'intrusive twisting of nature to make it yield its secrets', for both approaches require the use of the senses. Secondly, in questions of biology and psychology, the soul's being the substantial form of a body makes it easy for the Thomist to accept that bodily conditions and psychological perceptions are closely linked. The Thomist thus avoids the difficulties inherent in Cartesian dualism. And his insistence on the immateriality of the soul offers him an escape from some of the more depressing claims of materialism – no life after death, no freedom, etc. Thirdly, the Thomist can invoke the soul's spiritual nature to argue that it can come to know spiritual things by analogy with the truths it learned directly from the senses. He does not accept the Kantian argument that the realm of metaphysics must remain out of bounds for human knowledge because it does not come under the direct control of experience.

This must suffice as a sketch of the basic tendencies of Thomist philosophy. It is necessarily vague because to descend to detail would be to adopt a particular philosophical position within Thomism and to risk excluding the work of actual Thomists. Already, the Transcendental Thomists would find the anti-Kantian tendencies mentioned in the outline to be non-essential to Thomist thought. But this brand of Thomism came into its own only after the First World War and, hence, it need not concern the present study. One of the most eminent Thomists of the early

days of the restoration, Cardinal Désiré Mercier, has given the following characterization of the philosophy of Saint Thomas:

It seems to me that one recognizes it by two characteristic traits. First is the union of reason and Christian faith; second is the union of observation and rational speculation, the combination of analysis and synthesis.⁴⁴

No one can seriously contradict this description, but it hardly distinguishes Thomas's thought from other Christian philosophers. Mercier's remark merely illustrates that *Aeterni Patris* could be given a very wide interpretation.

5. *Aeterni Patris: into a hostile world*

It is instructive to look at some of the ways in which the encyclical was implemented. Clément Besse, in his 'Deux centres du mouvement thomiste: Rome et Louvain' (1902), said that in Rome there was no shortage of professors who accepted every bit of the scholastic tradition and who were in a continual state of war against the modern world.⁴⁵ Perhaps the most notorious of these was Cornoldi. As early as 1874, he had founded the *Academia filosofico-medica di San Tommaso* in Bologna which began to publish the review *La Scienza Italiana*. Modern science and modern thought in general fared badly in the hands of Cornoldi. At the suggestion of Giuseppe Pecci, Cornoldi was called to Rome where he could gain a larger audience for his views which are neatly summarized in this oft-cited remark: 'The history of modern philosophy is nothing but the history of the intellectual aberrations of man abandoned to the caprices of his pride; so much so that this history could be called the pathology of human reason.'⁴⁶ Joseph Perrier, writing less than a decade after

⁴⁴ Désiré Mercier, 'Opening Discourse for the Course on St. Thomas' Philosophy', trans. by David A. Boileau, in David Boileau, *Cardinal Mercier: A Memoir* ([Brussels(?)]: Peeters, 1996), pp. 296-313 (p. 297).

⁴⁵ See Clément Besse, 'Deux centres du mouvement thomiste: Rome et Louvain', *Revue du Clergé Français*, XXIX (1902) pp. 238-54, 357-71, 473-500 (pp. 366-7).

⁴⁶ Cornoldi, quoted in Besse, 'Deux centres', p. 366.

Besse, agreed with his assessment of the Roman professors:

Roman Thomists have often remained in a complete ignorance of the spirit and contents of modern Philosophy. Without understanding modern thinkers, they have mercilessly condemned them. Non-Scholastic philosophical productions have been described as heretical; their authors, even the most inoffensive, as men who had wilfully opposed all rules of common sense and truth.⁴⁷

Perrier tried to excuse this attitude by pointing to the urgency of establishing a new philosophical basis in the center of the Catholic world. Yet this narrow-minded approach to philosophy was neither restricted to Rome nor to the years immediately after *Aeterni Patris*. Édouard Lécaneuet, in his history of the Church in France under Leo XIII, notes that, in many of the seminaries and theological faculties where Thomism was taught, the professors lacked a thorough knowledge both of Thomas and of modern philosophy, but made up for their deficiency by quoting set formulas from manuals and assuring their students that these were *ad mentem Sancti Thomae*.⁴⁸ This is consistent with Frederick Copleston's remark that 'in many ecclesiastical institutions Thomism, or what was considered such, came to be taught in a manner analogous to that in which Marxism-Leninism is taught in Communist dominated education'.⁴⁹

Part of the reason why Thomism was not taught more intelligently in France was that Catholic institutions had to prepare their students for degrees whose requirements were set by the secular universities, so their treatment of Thomism was cursory at best.⁵⁰ But some Catholics were opposed to the authoritative imposition

⁴⁷ Perrier, p. 169.

⁴⁸ Lécaneuet, p. 478.

⁴⁹ Frederick Copleston, *A History of Philosophy*, vol. 9, *Maine de Biran to Sartre* (New York: Image, 1977), p. 251.

⁵⁰ Lécaneuet, p. 477; see also François Picavet, 'Le mouvement néo-thomiste', *Revue philosophique de la France et de l'étranger*, 33 (1892), pp. 281-308 (p. 305).

of Thomism for more philosophical reasons. Five years before *Aeterni Patris*, Bishop Félix Dupanloup (1802-1878) objected to Msgr d'Hulst's identifying scholastic philosophy and Christian philosophy. The Bishop had nothing against Thomas; in fact he heaped many praises upon him. But he thought that it was dangerous to establish a particular philosophy dogmatically:

Croyez-moi, toutes les thèses absolues et exclusive ne sont ni vraies ni bonnes. Elles rapetissent toutes choses, la vérité et la science, la philosophie et la religion, nos grands hommes des temps modernes comme les Pères des premiers siècles. Elles troublent les esprits, entravent les études, amoindrissent notre cause, sacrifient les intérêts de la vraie science et ne servent que les passions d'une école ou d'un parti. Le christianisme est plus vaste qu'une philosophie et la philosophie plus vaste qu'un système.⁵¹

In 1902, Charles Denis, the editor of the *Annales de Philosophie Chrétienne*, echoed these concerns in the journal. His critique, however, was more specific because the intervening years had revealed some particular problems with the spread of neo-Thomism. Denis noted that the diocesan clergy knew hardly anything about Thomist doctrine. The restoration affected primarily the religious Orders, in particular the Dominicans and the Sulpicians.⁵² The neo-scholastics added to the usual tension between diocesan and religious clergy by ignoring the non-scholastic teachers of theology who were held in high esteem by their former students among the secular clergy. Furthermore, any dialogue between neo-Thomists and their contemporaries was hampered by technical vocabulary. The scholastics used words with their medieval meanings with little regard to their modern usage.⁵³ And they

⁵¹ Dupanloup, quoted in Lecanuet, pp. 464-5.

⁵² Charles Denis, 'Situation politique, sociale, et intellectuelle du clergé français', in *Tables des Annales de philosophie chrétienne d'avril 1884 à septembre 1902*, pp. 513-586 (p. 515).

⁵³ Charles Denis, 'Pourquoi, d'après M. Picavet, le néothomisme n'a-t-il pas triomphé?', *AnnPhilChr*, 150 (1905), 73-83 (p. 82).

looked upon Thomism as more important than Catholicism itself.⁵⁴

Denis further reproached the neo-Thomists with philosophical ignorance which they manifested by dismissing as Kantian every philosophy which did not suit them: 'Kantiste, moniste, hégélien, spinoziste, athée, c'est tout un.'⁵⁵ Denis was especially sensitive on this point because he was a partisan of Maurice Blondel's new approach to Christian apologetics. The point at issue was the starting point of the act of faith. The neo-Thomists emphasized the intellect and the objectivity of the world and Revelation. On their account, the existence of God could be demonstrated from the world as a cause from its effect. Tradition and Scripture could then establish the Divinity of Christ by pointing to his miracles.

Blondel's method, on the other hand, began from within human consciousness. For this reason, it came to be known as the method of immanence. Blondel's doctoral thesis *L'Action* (1893), which became the basis of the 'new apologetics', tried to show that man discovers within himself a longing that cannot be satisfied by any finite good. In response, he seeks God's Revelation which he finds in the Church and accepts by faith. No one thought that Blondel was anything but orthodox in intention, but the Dominican Benoît-Marie Schwalm, who published a treatise on the act of faith at about the same time based on Thomist principles, declared that Blondel's teaching was false and dangerous. There were misunderstandings on both sides and positions hardened. Blondel protested in vain that his was only a *method* of immanence and not a *philosophy* of immanence.⁵⁶ The level of tension between

⁵⁴ Denis, 'Situation', p. 515.

⁵⁵ Denis, 'Situation', p. 563.

⁵⁶ For a summary of this controversy, see Jean Caron, 'La discussion entre le P. Schwalm et Maurice Blondel à propos de la méthode d'immanence en apologetique (1895-1898)', in *Saint Thomas au XX^e siècle: Actes du colloque du Centenaire de la 'Revue Thomiste'*, ed. by Serge-Thomas Bonino (Paris: Saint-Paul, 1994), pp. 41-52.

Thomists and the new apologists can be surmised from a comment that Blondel's popularizer, Lucien Laberthonnière of the French Oratory, made to Gilson regarding Saint Thomas: 'Je le haïs; c'est un malefacteur.'⁵⁷

Blondel later came to appreciate the works of the saint. In 1911 or 1912, he made an entry into a private notebook regarding possible future editions of his apologetical works: 'I would like to extract from Saint Thomas *everything* which can be preserved of his philosophy. [...] That is a task of first importance for thought and religion.'⁵⁸ And in 1913, he was the first to put Thomism into the program for a license in philosophy at a secular university.⁵⁹ Unfortunately, this new direction caused an estrangement between Blondel and Laberthonnière who continued to loathe Thomas. But there was a split in Thomist ranks as well concerning the legitimacy of Blondel's method. Many continued to reject it; but some, such as the Jesuit Joseph Maréchal, accepted it and eventually developed it into Transcendental Thomism.

The Thomist animus against Blondel arose from a suspicion of any philosophy that begins with a criticism of reason. Reason criticizing reason without the prior knowledge of an external world of being, the argument went, leads necessarily to subjectivism and relativism. This was the traditional charge against Kant. The extant Thomist anti-Kantian tirades are numerous. The following is an extract from the foreword of Fr Albert Farges's *Cours de philosophie scolastique* (1905):

Bien loin de produire son objet, tout l'effort de la pensée doit être de se mouler de plus en plus exactement sur la réalité des sujets étudiés: tout le progrès des sciences en dépend. Kant décréta qu'au contraire, l'objet réel

⁵⁷ Gilson, *The Spirit of Thomism*, p. 11.

⁵⁸ Blondel, quoted in Claude Tresmontant, 'Blondel et le thomisme', appendix to his *Introduction à la métaphysique de Maurice Blondel* (Paris: Seuil, 1963), pp. 315-29 (p. 326).

⁵⁹ Tresmontant, 'Blondel et le thomisme', p. 325.

étant inaccessible, c'est le sujet pensant qui se crée lui-même un objet idéal, le moule sur les formes *a priori* de sa mentalité, et se forge ainsi une science toute subjective à son usage. Mais, on le devine aisément, cette prétendue autonomie et indépendance du sujet à l'égard de tout objet réel, n'est qu'un triste suicide, car une pensée incapable d'atteindre son objet n'est qu'une pensée vide, une connaissance sans objet connu!⁶⁰

Farges then pointed to the consequences of Kantian philosophy as he understood it.

If there is no objective knowledge of reality, the will becomes free to accept or reject the categorical imperative; hence moral philosophy is deprived of a rational basis.

And in theology, the denial of objective knowledge gives rise to fideism. Alluding to the neo-apologists, Farges continued:

Une nouvelle exegèse, assez bruyante, malgré le petit nombre de ses adhérents, est venue nous apprendre que la foi naturelle au Christ, – pas plus d'ailleurs que la foi naturelle de Kant au devoir, – ne pouvait se fonder sur aucune preuve intellectuelle, aucun motif raisonnable. Le fait surnaturel, tel que celui de la résurrection du Sauveur, par ex., ne serait plus constatable par l'histoire, et le témoignage des apôtres et des martyrs qui ont versé leur sang pour l'attester, serait incapable de le démontrer, attendu que 'la vérité est un produit naturel de l'esprit, et que le surnaturel, par définition, le dépasse'.⁶¹

The new apologetics, according to Farges, has discarded the traditional proofs based on reason in favour of new proofs based on sentiment: 'Une telle mutilation serait la ruine de la certitude religieuse, puisque la religion ne serait plus qu'une affaire de sentiment individuel, subjective et variable comme lui.'⁶²

Many of those who railed against Kant did not take the trouble to read his works, but the charge of subjectivism was also made by those who took his work seriously, such as the Jesuit Tilman Pesch and Cardinal Mercier. In a review of Pesch's book on Kant, Denis acknowledged the author's clear understanding of the

⁶⁰ Albert Farges and D. Barbedette, *Cours de philosophie scolastique d'après la pensée d'Aristote et de S. Thomas mise au courant de la science moderne*, 2 vols (Paris: Berche et Thanlin, 1905), I, p. x.

⁶¹ Farges, *Cours de philosophie scolastique*, I, pp. xi-xii.

⁶² Farges, *Cours de philosophie scolastique*, I, p. xii.

philosopher, but criticized Pesch for attributing all modern errors to Kantian thought. Pesch had set up an antithesis between the rock upon which the Church is founded and the rock from which it was attacked by secularists – modern science. And modern science, in his estimation, was the daughter of Kantian philosophy. Denis took him to task for making this connection: surely experimental induction owed nothing to Kant. Pesch, he said, was merely restating the charge of relativism in a new way.⁶³

Yet Pesch was not the only one to make the connection between modern science and Kant. Mercier, in a review of nineteenth century philosophy, attributed to Kant a large part of the success of positivism which appropriated the prestige of science to itself. 'According to Auguste Comte, we can only know observable realities; this is a *fact*. According to Kant, we can only know objects of experience, in their *exclusively phenomenal objectivity*; this is a *law* of human knowledge.' Both Kant and Comte insist on man's ignorance of metaphysics. Mercier concluded: 'When one thinks about the place occupied by the *Critique of Pure Reason* in the philosophy of our century [19th], is it not easy to understand the nearly general success of phenomenalistic positivism?'⁶⁴ Mercier also insisted on the baneful effects of Kant's subjectivism which, in his estimation, destroyed the possibility of moral philosophy. He repeated this charge in his courageous responses to officials of the German forces in occupied Belgium: 'Chez le peuple allemand, l'influence séculière, étendue, profonde, de Kant et de ses disciples, a faussé l'esprit publique, et l'exaspération du sentiment de la puissance nationale a brisé, à une heure de crise,

⁶³ Charles Denis, review of Tilman Pesch's *Kant et la science moderne* and *Le Kantisme et ses erreurs*, in *AnnPhilChr*, 137 (1899), pp. 613-4.

⁶⁴ Désiré Mercier, 'The Philosophical Assessment of the Nineteenth Century', trans. by Boileau, in Boileau, *Cardinal Mercier*, pp. 323-43 (p. 331).

les barrières de l'honnêteté'.⁶⁵

Farges's concerns about apologetics and Mercier's worries about moral philosophy are a reminder that science was not the neo-Thomists' primary concern. *Aeterni Patris* mentioned science as a potential beneficiary of a scholastic renewal only after political and social doctrine and the liberal arts. The precursors of the movement, such as Taparelli, the Sordis, and Liberatore, focused on questions of natural moral law and not on science. An early historian of neo-Thomism, François Picavet, stressed its utility as a social and religious philosophy.⁶⁶ And Denis wrote of Leo XIII's natural inclination towards Thomism as a means to surpass and complete Pius IX's conservative theological statements which focused on social questions: 'Entre les enseignements de l'encyclique *Quanta cura* et ceux de l'encyclique *Rerum novarum* il y a la différence de l'idée chrétienne qui s'immobilise et reste sur la défensive et l'idée chrétienne qui s'épanouit par esprit de conquête.'⁶⁷ Leo's encyclicals subsequent to *Aeterni Patris* do not concern themselves with questions of science but with social and theological issues.

These historical facts have suggested to Pierre Thibault that Leo's preference for Thomas was based on a desire to put political power into the hands of the clergy.⁶⁸ Aubert thinks that there are some valid points in Thibault's thesis although it has great historical weaknesses. Henry Donneaud is more straightforward in dismissing Thibault's work as driven by a virulent bias that is devoid of any

⁶⁵ Désiré Mercier, quoted in Louis de Raeymaeker, *Le Cardinal Mercier et l'Institut supérieur de philosophie de Louvain* (Louvain: University of Louvain Publications, 1952), p. 32.

⁶⁶ See François Picavet, 'Le mouvement néo-thomiste', pp. 306-8.

⁶⁷ Denis, 'Pourquoi, d'après M. Picavet', p. 76.

⁶⁸ Pierre Thibault, *Savoir et pouvoir: philosophie thomiste et politique cléricale au XIX^e siècle* (Québec City: Laval, 1972).

objectivity.⁶⁹ The intention here is not to settle the argument but only to point out that none of the disputants has earmarked science as the central focus of the neo-Thomist revival.

Yet several circumstances forced the neo-Thomists to deal with science. First of all, scientism was the more-or-less official philosophy of the Third Republic governments of France. 'Scientism', as Casper Hakfoort has shown, can mean many things, especially if the term is used to describe the relationship of science to other human endeavours over a span of several centuries or more.⁷⁰ But Hakfoort found scientism to be a useful term to define the world view of William Ostwald (1853-1932). This view was characterized by three features: 'the striving towards a unified science of nature; its use as the basis for an all embracing philosophy; and the effort to realize this philosophy in practice, as a secular religion to replace Christianity.'⁷¹ The powerful elements in French politics did not have a unified science of nature, but the various modern sciences provided a convenient basis from which to challenge Christian beliefs. Among the prominent politicians of the Third Republic were men such as the chemist Marcelin Berthelot, the physiologist Paul Bert, the mining engineer Charles de Freycinet, and the doctors Émile Combes and Georges Clemenceau.⁷² Some of these were also prominent in their opposition to Catholicism and more generally to any claims of the supernatural order. Berthelot, for example, proclaimed that,

⁶⁹ Aubert, 'Contexte', p. 49; Henry Donneaud, 'Le renouveau thomiste sous Léon XIII: critique historiographique', in *Marie-Dominique Chenu: Moyen-âge et modernité*, Les Cahiers du Centre d'études du Saulchoir, no. 5 (Paris: Cerf, 1997), pp. 85-119 (p. 91).

⁷⁰ Casper Hakfoort, 'The Historiography of Scientism: A Critical Review', *History of Science*, 33 (1995), pp. 375-95.

⁷¹ Caspar Hakfoort, 'Science Deified: Wilhelm Ostwald's Energeticist World-View and the History of Scientism', *Annals of Science*, 49 (1992), pp. 525-44 (p. 528).

⁷² Harry W. Paul, 'The Debate Over the Bankruptcy of Science in 1895', *French Historical Studies*, 5 (1968), pp. 299-327 (p. 300).

le monde est aujourd'hui sans mystère [...]. En tout cas, l'univers matériel est revendiqué par la science [...]. La notion du miracle et du surnaturel s'est évanouie comme un vain mirage, un préjugé suranné.⁷³

As Henry Guerlac puts it, 'for the anti-clerical Third Republic, the cult of reason and science provided [...] the central *mystique*, and served as a useful political blunderbuss'.⁷⁴

The extent to which the republican ideology depended on science can be surmised from the reaction to Ferdinand Brunetière's 1895 article, 'Après une visite au Vatican', in which he exposed some of the myths of science and spoke at least of its partial failures if not "banqueroutes" totales.⁷⁵ The Union of Republican Youth countered with a dinner in honour of Berthelot to toast science and the French Revolution. It was important to them to uphold the myth of science as the only saviour of mankind. This was the main theme Ernst Renan's *L'Avenir de la Science* which had been written in 1848 but only published in 1890. Much had changed in science in the intervening years but that did not reduce the value of the book as propaganda. Harry Paul writes that at the dinner, 'the heroes of the "scientific" camp recited embellished versions of the scientific catechism'. He then describes Berthelot's intervention in greater detail:

[He] repeated in a more elementary form the opinions expressed in his article on the derivation of morality from science and made even 'le sentiment du beau' in art and literature a function of science. The republicans certainly heard what they wanted to hear: their immediate ancestors, Berthelot declared, were Voltaire, Diderot, d'Alembert, and Condorcet. The originality of the French Revolution was that it proclaimed France's independence of dogmatism and religious ideas and

⁷³ Marcelin Berthelot, *Les origines de l'alchimie* (Paris: Steinheil, 1885), p. v: see Paul, 'The Debate', p. 310.

⁷⁴ Henry E. Guerlac, 'Science and French National Strength', in *Modern France*, ed. by Edward Mead Earle (Princeton: Princeton University Press, 1951), pp. 81-105 (p. 89): see Paul, 'The Debate', p. 300.

⁷⁵ Ferdinand Brunetière, 'Après une visite au Vatican', *Revue des deux mondes*, 127 (1895), 97-118 (p.103).

made it possible for human society to be founded on science and reason.⁷⁶

Not everyone at the dinner would have agreed with everything that Berthelot said. Msgr d'Hulst, the rector of the Institut catholique, also attended the festivities.⁷⁷ His presence shows that Catholics were eager not to be perceived as detractors of science. In spite of the propaganda, they wanted to show that there was no necessary antagonism between science and faith.

The regime perpetuated the scientific myth until the First World War made national unity a top priority. In 1904, the government passed laws which prevented religious Orders from teaching and which led to the confiscation of much of their property and forced some of them into exile. In 1905, diplomatic relations between Paris and the Vatican were ruptured and the Concordat between Church and State, which dated from the time of Napoleon, was terminated. Although intelligent people were converting to Catholicism – Brunetière, Jacques and Raïssa Maritain, Charles Péguy – and Georges Sorel reminded readers of the *Revue de métaphysique et de morale* that science done by Catholics was up to scratch in fields ranging from biblical criticism to physics and mathematics, the government chose not to listen.⁷⁸ Nor did it need to listen, because the populace had largely abandoned its Catholic heritage and was willing to give its support to the anti-clericals at the polls.⁷⁹ A history of the Church in France during the Third Republic would have to deal with issues such as the Dreyfus affair, the monarchist movement, and the Action Française, and would have to delve more deeply into questions of religious practice,

⁷⁶ Paul, 'The Debate', p. 320.

⁷⁷ Martin, *Pierre Duhem*, p. 31.

⁷⁸ Georges Sorel, 'La crise de la pensée catholique', *Revue de métaphysique et de morale*, 10 (1902), 523-51 (p. 524).

⁷⁹ Harry W. Paul, *The Second Ralliement: The Rapprochement Between Church and State in France in the Twentieth Century* (Washington, DC: Catholic University of America Press, 1967), pp. 17-8.

the modernist crisis, the educational laws, the suppression of the religious Orders, and the tensions and eventual rupture between Paris and the Vatican. However, the present brief sketch of the scientific climate in France must suffice to show that Catholics could ill afford to ignore science in their development of an updated Thomism.

In Belgium, Catholics were forced to address science for much the same reasons. It is true that Belgium, unlike France, was a monarchy, and that Catholics in Belgium had sufficient political power to have their own schools and even a University in Louvain, but, as in France, their enemies tried to appropriate the prestige of science for themselves and to portray Catholics as ignorant and afraid of science.⁸⁰ In this way, Belgium no less than France was a divided society. And Catholics of both countries had the same interest in addressing science in their philosophy.

In fact, Christians in most European countries had to contend with the myth that science and faith were fundamentally irreconcilable. The idea had some very able popularizers. In Germany and France in the 1850s, Carl Vogt (1817-95), Jacob Moleschott (1822-93), and Ludwig Büchner (1824-99) gave much publicity to their materialist conception of the world with catchy phrases such as 'Thoughts come out of the brain as gall from the liver, or urine from the kidneys'.⁸¹ The appearance of Darwin's *Origin of Species* in 1859 gave new ammunition to those who wanted a world free from orthodox Christian ideas, such as Clémence Royer (1830-1902) in France, Thomas Henry Huxley (1825-95) in England, and Ernst Haeckel (1834-1919)

⁸⁰ On Belgium as a divided country, see David Boileau, *Cardinal Mercier*, pp. 4-6. On the portrayal of Catholics as threatened by science see Desiré Mercier, 'Report on the Higher Studies of Philosophy Presented to the Congress of Malines on September 8, 1891', trans. by Boileau in his *Cardinal Mercier*, pp. 344-57, especially pp. 344-5.

⁸¹ Owen Chadwick, *The Secularization of the European Mind in the Nineteenth Century* (Cambridge: Cambridge University Press, 1975), pp. 165-75.

in Germany. John William Draper published his *History of the Conflict between Religion and Science* in 1874. The Anglican historian Owen Chadwick notes that it was basically an anti-Catholic tract. Faith and science, according to Draper, must be at war, because faith is static while science progresses. The hundreds of inventions that had transformed life in the nineteenth century revealed the potential of science. All that the Pope could do in the face of such progress was to issue the *Syllabus of Errors*. Therefore the Church was wrong. This was not a logical argument but many people were eager to believe it. The book was quickly translated into eight European languages.⁸²

But it is important not to lose perspective. In speaking of the mutual animosity of science and faith, one must distinguish between two levels of discourse – the scholarly and the popular. In 1891, Mercier said ‘that sectarians are merely an exception in the intellectual world’. It is rather ‘amongst the vulgarizers of the second and third order than amongst intellectuals truly deserving of this title that the sectarians are regrouped’.⁸³ For a historian, this has the practical consequence that writing about the extremists on either side is not going to reveal the intellectual subtleties inherent in the complex relationship between science and faith. Yet the antics of the extremists must be kept in mind, for their influence on the popular imagination can be significant.

The success of Draper’s book shows that the scientific popularizers had an audience. Further proof of their success comes from the publication in 1903 of *Das Christentum und die Vertreter der modernen Naturwissenschaften* by the Jesuit Karl

⁸² Chadwick, *The Secularization*, pp. 161-2.

⁸³ Mercier, ‘Report on the Higher Studies of Philosophy’, p. 346.

Kneller.⁸⁴ The book is an attempt to show that among the best known scientists of the nineteenth century many were not materialists and some were believing Christians. Sometimes, as in the case of Hermann von Helmholtz (1821-94), the evidence for personal religious belief is scanty; but Kneller was able to cite a letter which Helmholtz wrote to Haeckel in which he pointed out that a prudent investigator into the intricate processes of nature should know that his knowledge 'gives him no more right, not a scintilla more, than any other man to pronounce dogmatically on the nature of the soul'.⁸⁵ A second German edition of Kneller's book and its English translation appeared in 1911, showing that there was a continuing need to answer the charges of scientific propaganda. Any renewed Catholic philosophy would have to take account of this situation.

The neo-Thomists had further reasons for turning their attention to science. Even among the more serious philosophers, the spirit of reductionism was rife. Émile Boutroux, at the Third International Congress of Philosophy held in Heidelberg in 1909, reviewed the philosophical currents in France since 1867. He noted the importance of the sciences, especially evolutionary biology, in giving a new impetus to philosophical activity, but the main effect was to shatter philosophy into various parts, each of which pretended to furnish a universal explanation of reality. According to Boutroux, there was no indication of a forthcoming synthesis.⁸⁶

The philosophical pretensions of the sciences were in part made possible by a particularly acute crisis in philosophy. Léo Freuler cites philosophers who lamented

⁸⁴ The book has been recently reprinted: Karl A. Kneller, *Christianity and the Leaders of Modern Science: A Contribution to the History of Culture during the Nineteenth Century, with an Introductory Essay* by Stanley L. Jaki (Fraser, MI: Real View Books, 1995).

⁸⁵ Helmholtz, quoted in Kneller, p. 39.

⁸⁶ See Émile Boutroux, 'La philosophie en France depuis 1867', *Bericht über den III. Internationalen Kongress für Philosophie zu Heidelberg*, ed. by Th. Elsenhaus (Heidelberg: Carl Winter's Universitätsbuchhandlung, 1909), pp. 125-58, see especially pp. 125-6, and p. 154.

the state of their discipline by the 1870s.⁶⁷ Scientists provide further evidence for the low esteem of philosophy. James Clerk Maxwell, for example, portrayed metaphysics as a den of thieves full of dry bones. Stanley Jaki notes that part of the reason for this harsh dismissal was the identification of German idealism with the whole of philosophy.⁶⁸ A letter from Helmholtz to Haeckel written in 1857 supports this interpretation:

To my mind, too, you are not right in designating the majority of prudent scientists as enemies of Philosophy. Indifferent the greater part undoubtedly are, a state of things for which the blame rests on the extravagant speculations of Hegel and Schelling, two writers who have, I grant you, been taken to represent all philosophy...⁶⁹

Boutroux echoed this analysis in his speech to the inaugural session of the Congress of philosophy in 1900:

Le conflit qui s'était produit entre la philosophie et les sciences à l'occasion des hardies constructions dialectiques des Schelling et des Hegel avait déterminé un divorce entre ces deux ordres de connaissance.

Duhem too thought that a separation of philosophy from the sciences – a trend which he thought had been going on for over a century – had made philosophy degenerate into ‘a verbiage whose sound revealed its hollowness’. Philosophy needed to be nourished with the teaching of the particular sciences ‘so that it might absorb and assimilate them to itself’ and could once again merit its traditional title of *Scientia scientiarum*.⁹⁰ The necessary reform of philosophy did not

⁶⁷ Léo Freuler, ‘Les tendances majeures de la philosophie autour de 1900’, in *Les savants et l'épistémologie vers la fin du XIXe siècle*, ed. by Marco Panza and Jean-Claude Pont (Paris: Blanchard, 1995), pp. 1-15 (p. 1).

⁶⁸ James Clerk Maxwell, ‘Address to the Mathematical and Physical Section of the British Association’ (1870), in *Scientific Papers of James Clerk Maxwell*, ed. by W.D. Niven, 2 vols (Cambridge: Cambridge University Press, 1890), II, p. 216: see Stanley Jaki, ‘The Physicist and the Metaphysician’, *The New Scholasticism*, 63 (1989), 183-205 (p. 183).

⁶⁹ Helmholtz, quoted in Kneller, p. 39.

⁹⁰ Pierre Duhem, ‘The Value of Physical Theory’, Appendix to *The Aim and Structure of Physical Theory*, trans. by Philip Wiener (Princeton: Princeton University Press, 1954), pp. 312-35 (pp. 312-3).

take place, in Duhem's estimation, until the late nineteenth century. The first decades of the twentieth century saw published in quick succession, works in the philosophy of science by Boutroux, Henri Bergson, Duhem, Édouard LeRoy, Abel Rey, Henri Poincaré, Gaston Milhaud, and Émile Meyerson in France, Wilhelm Ostwald in Germany, and Ernst Mach in Austria, to name only some of the better known authors. This trend provided a further impetus for neo-Thomists to examine the philosophical meaning of science.

The fact that there were great developments in science – some would even say revolutions – between the thirteenth and late nineteenth centuries, and the inherent Thomist interest in science, indicate that Leo's project to steer the Church towards a *philosophia perennis* was not going to be simple. Neither the pious parroting of Thomas nor the criticism of the enterprise should come as a surprise. The critics may have had more philosophical sophistication than the parrots but they did not have the monopoly on wisdom. Within the Church, there were many intelligent people who were grateful for *Aeterni Patris*. They knew that adapting Thomas to answer nineteenth century questions would require much thought, but in the meantime the basis would provide a consistent framework for explaining the Catholic Faith. No longer would students have to be presented with diverse and contradictory systems of philosophy which, as d'Hulst put it, left the slower ones wondering what philosophy was about and the brighter ones cynical about the existence of truth.⁹¹

Outside of Catholic circles, scholastic philosophy never caught on and went largely unnoticed. In North America, it gained a hearing through the lectures of two of its most eloquent spokesmen, Étienne Gilson and Jacques Maritain, in the 1920s and 1930s. In 1925, John Zyburka sent a questionnaire to various English-speaking

⁹¹ *SéancesSSTA*, Annual Meeting (1885), *AnnPhilChr*, 110 (1885), 489-510 (p. 490).

philosophers asking them for their opinion of scholasticism. Most had only the vaguest notions of its teachings. Zybura's resulting book includes a review of the fortunes of scholasticism in France, Belgium, Italy, and Germany. In each of these countries, there were intelligent attempts at renewing Thomas's thought which were recognized by non-Catholic thinkers, yet neo-Thomism remained, for the most part, a Catholic enterprise.⁹²

There is much more to neo-Thomism than its ability to understand the sciences. But the importance of science to the enterprise must not be underestimated. Although Gilson ignored science throughout most of his career, he changed his mind in later life. In 1962, he wrote that 'the future of a Christian philosophy [which for Gilson meant scholasticism] will therefore depend on the existence or absence of theologians equipped with a scientific training, no doubt limited but genuine'.⁹³ Gilson's contribution to this endeavour was *From Aristotle to Darwin and Back Again*. Maritain came to philosophy from science, so it is not surprising that he grappled with the philosophy of science much earlier, beginning with 'La science moderne et la raison' (1910). His *Distinguer pour unir* (1932) and his 'Dieu et science' (1962) are both the fruit of much thinking on the subject. (These works by Maritain will be examined in chapter 5.7) But as important as Maritain is both to neo-Thomism and to the present thesis, there are others, whose names are now largely forgotten, who devoted themselves to the philosophy of science, long before Maritain became well-known. It is time to identify these contemporaries of Pierre Duhem.

⁹² John S. Zybura, *Present Day Thinkers and the New Scholasticism* (St. Louis, MO: Herder, 1927)

⁹³ Étienne Gilson, *The Philosopher and Theology*, tr. Cécile Gilson (New York: Random House, 1962), p. 221. On Gilson and science and for the above quotation see Stanley Jaki, 'Gilson and Science', in *Patterns or Principles and Other Essays* (Bryn Mawr, PA: Intercollegiate Studies Institute, 1995), pp. 179-199 (p. 193).

CHAPTER 2

Thomism and Science: The Culture in France and Belgium in Duhem's Era

Nous avons discuté les sciences avec M. Lenderent le chimiste. C'est naturel puisqu'il s'agissait de théologie. – *The Abbé Victor Bernies to Duhem on 6 February 1902, regarding his theology examination.*¹

Among the many vices of neo-Thomists which Charles Denis cited was their inability to come to terms with science: 'Là où mentalité thomiste se perpétue, avec elle se perpétue conflit philosophico-scientifique sur toute la ligne.'² Denis was engaged in polemics, but a more objective observer could provide plenty of evidence to substantiate the charge. Clément Besse found the Thomists in Rome especially reluctant to treat seriously the claims or concerns of modern science. Zigliara and Liberatore, for example, managed to refute the theory of evolution by giving to 'species' its meaning in Aristotelian logic instead of confronting its sense in biology. Gianantonio Zanon thought that he had attained the essence of electricity when he defined it as 'a quality of matter, and specifically tension of matter, which has been demonstrated by electrical discharge'. And Cardinal Mazella thought that he could dismiss geology in speaking of the days of creation – twenty-four hour periods by his reckoning – because God could have created fossils *in statu perfecto*.³ In 1887, at the third annual meeting of the Société de Saint Thomas d'Aquin, Msgr d'Hulst complained of narrow-minded scholastics who were making it easy to dismiss the neo-Thomist movement:

Où, disent-ils, la philosophie du moyen-âge est inséparable de sa physique,

¹ Letter from Bernies to Duhem, 6 February 1902, in ArchAcSci, *fonds* Duhem.

² Denis, 'Pourquoi, d'après M. Picavet', p. 81.

³ Besse, 'Deux centres', pp. 365-6.

donc il faut garder l'une et l'autre. Vous riez, Messieurs? j'ai connu de ces hommes vénérables qui hochaient la tête en parlant du mouvement de notre planète et qui ne voulaient rien lâcher des vieux systèmes, ni les sphères tournant, ni l'incorruptibilité des corps célestes, ni les métaux engendrés par l'influence du soleil dans les entrailles de la terre.⁴

As numerous as these medieval relics may have been, they are of no further interest to this study: it is enough to be aware of them. The task at hand is to identify the main groups of Thomists in France and Belgium who were interested in understanding modern science and incorporating it into their philosophical framework.

The following institutions in Belgium and France will introduce the major figures in the neo-Thomist movement: universities – Institut supérieur de philosophie in Louvain and the Institut catholique in Paris; societies – the Société scientifique de Bruxelles and the Société de Saint Thomas d'Aquin; journals – the *Revue de philosophie* and the *Revue thomiste*, (as well as the *Revue néo-scholastique* and the *Annales de philosophie chrétienne* which will be mentioned briefly in conjunction with the institutions of which they were an organ); and conferences – International Catholic Scientific Congresses. Not all of these organizations made Thomism their focus of interest; nor were they all interested in modern science to the same extent, as a closer look at each will reveal.

The labels used by historians of the Thomist restoration are of limited value in this study. Besse, for example, contrasted the 'paleo-Thomism' of Rome with the 'neo-Thomism' of Louvain, and praised the new at the expense of the old.⁵ The contrast is useful to illustrate different approaches to philosophy, but the new developed its own set of problems which Besse did not foresee. Francesco Beretta

⁴ *SéancesSSTA*, annual meeting, 22 June 1887, *AnnPhilChr*, 114 (1887), 499-516 (p. 511).

⁵ Besse, 'Deux centres', p. 496.

also cited Louvain's philosophical sophistication. He describes Louvain's program as 'neo-scholastic' to distinguish it from the more consciously apologetic outlook of the *Revue thomiste* which he labels 'neo-Thomist'; and he finds it significant that Louvain's journal chose as its motto *Nova et vetera* (the new and the old) whereas the *Revue thomiste* opted for *Vetera novis augere* (to augment the old by the new).⁶ Yet, once again, the new did not have the monopoly on wisdom. Ambrose Gardeil and Bernard Lacombe, at the *Revue thomiste*, knew a lot less about modern physics than did Desiré Nys in Louvain, but their conception of the relationship between science and philosophy has withstood the test of time much better than has Nys's. Labels such as Besse's and Beretta's, although they have their use, cannot replace a more detailed analysis of the institutions and the individuals within them.

1. *Société scientifique de Bruxelles*

The Brussels Scientific Society was definitely not Thomist at the time of its foundation in 1875. The Society was formed from three separate groups of Catholics who each sought to show that the Church had nothing to fear from science.⁷ 'Le groupe agricole' was composed of three men who were working to improve Belgian agriculture through modern chemistry. One of these, Joseph Proost, had gone to Paris to visit the laboratories of eminent scientists. The climate of unbelief in these places convinced him of the necessity to found an international league of religious scientists to combat materialism on the level of science and to reform the educational system at the high-school level so as to inspire Catholics to take up the

⁶ Francesco Beretta, 'La *Revue Thomiste* et les sciences expérimentales de 1893 à 1905: programme et limites d'un projet néo-thomiste', in *Saint Thomas au XX^e siècle*, ed. by Serge-Thomas Bonino (Paris: Saint Paul, 1994), pp. 19-40 (p. 40).

⁷ The foundation of the Society is recounted by Paul Mansion on the occasion of the celebration of the Society's twenty fifth anniversary in April 1901; the article, which is untitled will henceforth be cited as Mansion, 'Histoire', *RevQuestSci*, 50 (1901), 32-61.

study of science.

The Cercles Cauchy were the second base from which the Society arose. Charles Lagasse-de Loch, in his biographical sketch of Paul Mansion (1844-1919), described how several of the brightest students from the faculties of engineering and science at the University of Ghent used to get together over lunch at the hotel *Étoile*.⁸ Beginning in 1863, they took over the main table to discuss and expose atheistic propaganda based on absurd scientific claims. As the students began to be graduated and to disperse, Lagasse had the idea of continuing these talks by instituting the Cercles Leibnitz in 1870. He had chosen Leibnitz because he believed that the eminent philosopher had never found the slightest opposition between reason and faith. But Mansion, who was 'the godfather and principal promoter' of the work, insisted that the name be changed from the Protestant Leibnitz to the Catholic mathematician Cauchy.⁹ The Cercles Cauchy soon spread to other Belgian cities: Antwerp, Nivelles, Mons, Louvain, and two in Brussels. Philippe Gilbert, a professor of mathematics at the Catholic University of Louvain, was the patron of the Cercle Cauchy in that town. And the Jesuit priest Ignace Carbonnelle founded the Cercles in Brussels.

The third group somewhat overlapped the second. It consisted of Gilbert and several other professors at the Catholic University and of Carbonnelle. All three groups thought that it was necessary to educate the public by popularizing the results of science and by exposing false philosophical claims made in its name. But this third group went further in maintaining that it was also necessary for many Catholics to become scientists.

⁸ Charles Lagasse de Loch, 'Paul Mansion', *RevQuestSci*, 77 (1920), 7-26 (p. 12).

⁹ Lagasse de Loch, 'Paul Mansion', p. 15.

The meetings of the Cercles Cauchy served as the catalyst that brought the three groups together. Proost and Lagasse-de Locht were the first to propose that a single association be formed to promote the extension and diffusion of science, and eventually convinced Carbonnelle and Gilbert to agree to the idea. After some preliminary meetings, the basic statutes of the Brussels Scientific Society were adopted on 17 June 1875. The new Society chose as its motto the Vatican Council's teaching on faith and reason: 'Nulla umquam inter fidem et rationem vera dissensio esse potest' (There can never be any true contradiction between reason and faith). And it warned its members that it would not tolerate in its midst any attacks, even if courteous, against Catholicism or against any philosophy that it deemed 'spiritualiste et religieuse', which is to say that the Society would not countenance any materialist philosophies that denied the existence of a spiritual soul or of a personal transcendent God.

The founders of the Society thought that it would be necessary to recruit at least 250 members if their project were to be a viable enterprise. In fact, by the time of the first meeting in November 1875, there were 453, among whom were 50 lawyers, 50 medical doctors, 60 engineers, and 70 professors, mainly from the sciences.¹⁰ Carbonnelle did much of the recruiting himself. He managed to secure the support of the faculties of the nascent Catholic Universities (later Institutes) in France. But Gilbert also had numerous contacts among scientists in both Belgium and France, and hence it is likely that he too secured many members. A list of all members from 1875 to 1904 contains 1618 names: 1120 from Belgium, 261 from France, 84 from Spain, 22 from Italy, and a few from 27 other countries as far away

¹⁰ Mansion, 'Histoire', p. 35.

as Canada, Madagascar, and China.¹¹ Although the Society aspired to be an international organization, it clearly retained a Belgian and French character which was reflected in its choice of presidents from Belgium and France in alternating years.¹² There was a fairly high rate of turnover among members. At Easter 1898, for example, Mansion reported that in the previous year there were 35 new members but death and resignations had reduced the ranks by 20 leaving a total of 420 – far short of the approximately 1600 who had been members at some point in the first quarter century.¹³

Many of the members contributed nothing but their annual dues and perhaps the prestige of their names. This was the case with the large numbers of ecclesiastical persons and institutions such as Cardinal Goosens of Malines or the *École libre de Sainte-Geneviève* in Paris; but a significant number of eminent scientists were also content to be passive, such as Louis Pasteur (1822-95) and, later on, Paul Sabatier (1854-1941), the Nobel laureate in chemistry, as well as less well-known members of the *Académie des Sciences* in Paris such as Joseph Boussinesq (1842-1929), Émile Picard (1856-1941), and Charles Sainte-Claire Deville (1814-76). But both some priests and some eminent scientists were active in the Society.

Among the priests, there were many with scientific credentials. This was especially true of the Jesuits who needed science teachers for their colleges.

¹¹ *Annales de la Société Scientifique de Bruxelles: Table Analytique des vingt-cinq premiers volumes*, p. 21.

¹² *Annales de la Société Scientifique de Bruxelles: Table Analytique des vingt-cinq premiers volumes*, p. 15. However, there was some dispute as to the status of the custom. Lagasse invoked it to push for Domet de Vorge's presidency in 1890; Mansion replied that 'la tradition invoquée n'existe pas en réalité'. See handwritten minute book of the *Séances du Conseil*, 15 April 1890, in the Archives of the *Société Scientifique de Bruxelles*, Namur, Belgium.

¹³ *Bulletin de la Société scientifique de Bruxelles: session tenue à Bruxelles, le 19, 20, et 21 avril 1898*, p. 80.

Carbonnelle, for example, had a doctorate in mathematics.¹⁴ As the first secretary general of the Society, he set up its offices in the Jesuit College in Louvain, and was able to recruit collaborators for the Society's journals from his confreres. Among these was Joseph Delsaulx (1828-1891) who had a doctorate in mathematical and physical sciences and contributed to the understanding of Brownian motion.¹⁵ Victor-Joseph Van Tricht (1842-1897) did not have a doctorate but was a successful science teacher who published a physics text-book for use in high schools.¹⁶ Guillaume Hahn (1841-1904) studied biology under Huxley at University College in London in the 1870s and was later named professor at the state university in Namur.¹⁷ Other Jesuits who took an active part in the Society were the physicists Julien Thirion¹⁸ (1852-1918) and his former student Victor Schaffers¹⁹ (1866-1933), and the mathematics teacher Henri Bosmans²⁰ (1852-1928). The list of Jesuits could be extended still further, but there were other priest members who had considerable scientific expertise. Into this category fit the Eudist priest Ad. Leray, (whose works Duhem deemed worthy to analyze), the American biologist J.A. Zahn, and Paul de Broglie, a graduate of the École Polytechnique and the uncle of Louis de Broglie. After World War I, Georges Lemaître (1894-1966) became the best-known of the Society's priest-scientists. His studies in general relativity led him to postulate a primordial state of the universe, the 'primitive atom', which has since been developed

¹⁴ Georges Lemoine, 'Le R.P. Carbonnelle', *RevQuestSci*, 25 (1889), supplement pp. I-VIII.

¹⁵ Paul Mansion, 'Le R.P. Delsaulx', *RevQuestSci*, 29 (1891), pp. 585-8.

¹⁶ Maurice Lefebvre, 'Le R.P. Van Tricht', *RevQuestSci*, 43 (1898), 67-106.

¹⁷ J. Thirion, 'Le R.P. Guillaume Hahn', *RevQuestSci*, 55 (1904), 133-9.

¹⁸ V. Schaffers, 'Le R.P. Thirion', *RevQuestSci*, 77 (1920), 27-52.

¹⁹ H. Dopp, 'Le Père Victor Schaffers, S.J.', *RevQuestSci*, 103 (1933), 79-83.

²⁰ P. Peeters, 'Le R.P. Henri Bosmans, S.J.', *RevQuestSci*, 93 (1928), 201-14.

into the Big-Bang theory.²¹

Some prominent scientists also contributed more than their prestige to the Society. Between the years 1875 and 1904, 26 members of the Society were also members of the French Academy of Science, a body whose total membership – resident, non-resident, and correspondent – could not exceed about 180 at the time. Among the better-known Academicians who contributed at least an article for one of the Society's journals were the mathematicians Charles Hermite (1822-1901) and Camille Jordan (1838-1922). And several Academicians were regular contributors: the geologist Albert de Lapparent (1839-1908), the chemist Georges Lemoine (1841-1922), and the physicists Philippe Gilbert and Pierre Duhem. The Society could also count on the collaboration of Belgian scientists such as the mathematician Paul Mansion, the astronomer Ernest Pasquier, and the chemist Louis Henry (1834-1913), as well as French scientists with professorial positions such as Eugène Vicaire and Aimé Witz (1848-1926). And it also printed the works of retired scientists such as Charles de Kirwan who sometimes wrote under the pseudonym Jean d'Estienne.

The names cited so far reflect this thesis's focus on physical science. But it should be kept in mind that there were five sections in the Society: mathematical sciences (including rational mechanics and aspects of astronomy), physical sciences (including chemistry and parts of astronomy), natural sciences, medical sciences, and economic sciences. All of these fields had their share of expert Jesuits as well as lay scientists.

The Society had three meetings per year: a four-day conference immediately after Easter and two shorter sessions, in October and January, whose main purpose was to prepare the agenda for the Easter gathering. In keeping with its stated

²¹ Jean-Pierre Luminet, 'Qui est Georges Lemaître?', *RevQuestSci* 166 (1995), 213-36.

intention of promoting science, the Society gave grants and medals in recognition of excellence; and each year, one of the sections proposed a prize question. The Society published the technical works of its members in the *Annales de la Société scientifique de Bruxelles* right from its inception. Then, beginning in 1877, it began to publish the *Revue des questions scientifiques*, a quarterly journal of about 250 pages per issue, as part of its efforts to popularize the results of science. The *Revue* is best described as a journal of *haute vulgarisation*. It featured full-length articles on scientific topics such as X-rays, mechanical proofs for the rotation of the earth, and explosive chemicals. Book reviews, often written by authorities such as Duhem and Gilbert, kept subscribers informed about recent publications from around the world by Maxwell, Boltzmann, Lorentz, Hertz, Poincaré, and many others. Finally, short articles summarized new scientific discoveries and technical developments. But, in each of these categories, besides the technical articles, the *Revue* also published material pertaining to the history and philosophy of science. Some of these articles were the works of non-scientists such as the philosopher Edmond Domet de Vorges, who was an important figure in the early days of neo-Thomism, and Georges Lechalas. But scientists too contributed to these broader reflections. The *Revue* was the venue for nearly all of Duhem's early work in the history and philosophy of science.

When the Brussels Society was formed, the first order of business was to respond to the charges that there was a contradiction between science and faith and that Catholicism in particular was the great enemy of science. Thus, the inaugural issue contains the first instalments of Carbonnelle's, 'L'aveuglement scientifique', in which he argues that Lucretius and Epicurus were not the great scientists which John Tyndall had made them out to be. In the same issue, another Jesuit, Charles de

Smedt, argued against Draper in 'L'Église et la Science'. Gilbert's extensive articles on the Galileo affair were also part of this effort to defend the Church against popular detractors. De Smedt's and Gilbert's articles were written to correct the many historical errors that Draper and various champions of Galileo relied upon to substantiate their claims; their message was that science had not negated the teachings of the Church and that the Church was not paranoid of science. Carbonnelle's articles, on the other hand, go further by claiming that science and human reason aid faith by proving the existence of the Creator and various dogmas of the faith such as creation of the universe in time and its eventual end.²² (The differences in Catholic attitudes to rational theology will be discussed at greater length in chapter 4.3.A.)

Carbonnelle's work deserves further scrutiny primarily because of his importance in the foundation of the Society in 1875 and on account of his being its secretary general until his death in 1889. Ignace Carbonnelle was born in 1829 in Tournai, Belgium, and studied at the city's Collège Notre-Dame before going off to Paris in 1853 to study higher mathematics. In the same year, he successfully defended his doctoral thesis before a state-appointed jury in Ghent. He then went on to study theology in Louvain. Ordained a priest in 1857, he was assigned to rather diverse tasks: teaching rhetoric in Louvain; teaching at the Jesuit college in Calcutta where he became the editor of an *English journal*; teaching astronomy in Louvain; and being one of the editors in Paris of the *Études religieuses*. In 1871, he returned for good to Louvain, where he eventually set up the offices of the Brussels Society. His wide background and many contacts were an immense help to the

²² See, for example, Ignace Carbonnelle, Chapters 4 and 5 of *Les Confins de la Science et de la Philosophie*, 2 vols, 2nd edition (Paris: Victor Palmé, [N.D.]), 1, pp. 227-373.

Society.²³

Carbonnelle faced a difficult task as a secretary. Despite his numerous connections, he sometimes could not find contributors to write on subjects of contemporary interest, so he took upon himself the task of researching and writing about diverse topics. He also had to contend with disgruntled members of the Society who cancelled their membership on account of articles questioning the universal flood or because the journal did not embrace a literal Thomism.²⁴ To some, especially to those whose manuscripts he felt compelled to reject, he was a dangerous modernist.²⁵

The thankless task of refusing articles was necessary to keep a serious scientific society from degenerating into something like François Moigno's (1804-1884) pious concordism which today draws nothing but patronizing smiles.²⁶ Modern mathematics itself, this priest had argued, shows that the flood had taken place 4,205 years ago. There were 8 people who got off the ark; the rate of population increase for the whole earth is an average of 0.5% per annum; the present population of the world is 1.3 billion. The solution to the simple exponential equation that governs proportional growth proves the Biblical chronology.²⁷ In 1879, Moigno published his five volume *Splendeurs de la Foi*, a work of simplistic apologetics which did not

²³ This paragraph follows closely George Lemoine, 'Lc R.P. Carbonnelle'.

²⁴ Ignace Carbonnelle, 'L'encyclique et la science', *RevQuestSci*, 6 (1879), 353-411 (p. 409).

²⁵ See, for example, Ignace Carbonnelle, 'Une accusation d'hérésie', in *RevQuestSci*, 19 (1886), 168-88. The 'heresy' in question is Jean d'Estienne's denial of the universality of the flood, which had been published in the *RevQuestSci* in 1885.

²⁶ On Moigno, see M. Lagrée, 'L'abbé Moigno, vulgarisateur scientifique (1804-84)', *Christianisme et science*, Études réunies par l'Association Française d'Histoire Religieuse Contemporaine (Paris: Vrin, 1989), pp. 167-182: see Francesco Beretta, *Monseigneur d'Hulst et la science chrétienne: portrait d'un intellectuel*, Textes Dossiers Documents, no. 16 (Paris: Beauchesne, 1996), p. 90.

²⁷ Georges Minois, *L'église et la science: histoire d'un malentendu*, 2 vols (Paris: Fayard, 1991), II, p. 240.

confine itself to the physical sciences but was an attempt to show the harmony between all human knowledge and a very literal reading of Scripture. As naive as Moigno's efforts appear today, he enjoyed the support of the French Cardinal Pitra. Moigno cited this patronage in letters of complaint against the teaching of Albert de Lapparent at the Institut catholique in Paris. And the Cardinal opposed the efforts to organize International Catholic Scientific Congresses. As it turned out, neither Moigno nor the Cardinal got his way, but they represented one vision of 'Catholic science', a vision which Carbonnelle was not prepared to allow into the Brussels Society.

Carbonnelle printed the encyclical *Aeterni Patris*, both in Latin and in French, in the *Revue des questions scientifiques*. In a brief commentary, he noted that from a philosophical point of view it was a magnificent document worthy of total acceptance. He was particularly happy to note that the encyclical, in speaking of science, directed the scientist to go beyond the investigation of facts and the mere observation of nature. Once the facts have been established, the encyclical stated, 'it is necessary to rise and apply ourselves to the study of the nature of corporeal things, to inquire into the laws which govern them and the principles whence their order and varied unity and mutual attraction in diversity arise'.²⁸ Carbonnelle understood this to be a direct answer to positivist pretensions:

C'est qu'en dépit des principes positivistes, les phénomènes matériels se rattachent les uns aux autres par les liens de la causalité, qui permettent au savant de les subordonner entre eux, d'en découvrir les lois et de remonter, d'anneau en anneau, toute la chaîne des causes, jusqu'à ce qu'arrivé au terme de ses observations, de ses inductions et de ses raisonnements, il attache enfin son dernier anneau aux causes substantielles qui appartiennent au philosophe.²⁹

²⁸ Leo XIII, *Aeterni Patris*, p. 55.

²⁹ Carbonnelle, 'L'encyclique et la science', p. 397.

From a contemporary Thomist point of view, this was impeccable reasoning. But Carbonnelle's Thomist credentials did not go beyond a belief in causality. He thought that Thomas's works were an excellent preparation for the philosophical study of science but that 'sans doute, quoi qu'en disent certains admirateurs inconsidérés, ce n'est pas là qu'on peut s'initier aux sciences proprement dites'.³⁰ Unfortunately, Carbonnelle lamented, many have made just such a mistake. One exasperating neo-Thomist 'déclare vingt fois sans sourciller que la théorie des atomes et des molécules, théorie exclusivement scientifique et toute moderne, admise universellement dans ses traits généraux par les physiciens, les chimistes et les mathématiciens, est tout à fait contraire aux doctrines de saint Thomas, lequel naturellement n'en a jamais parlé'.³¹ Carbonnelle then complained that this kind of neo-Thomist tends to know nothing about the basis of atomic theory and constantly confuses nineteenth century atomism with the 'ignorant reveries' of Epicurus.

Carbonnelle resented the association of modern atomism with the teachings of Epicurus for two opposite reasons. First, it made it easy for hostile commentators such as Tyndall to vilify the medievals for turning their backs on the wisdom of classical antiquity. Secondly, it made neo-Thomists suspicious of Carbonnelle's Boscovichean cosmology. Carbonnelle argued for this vision of the world in his major work, the two-volume *Confins de la science et de la philosophie* which was a collection of his *Revue des questions scientifiques* articles on 'L'aveuglement scientifique'. According to Carbonnelle, Boscovich had correctly guessed the basic structure of the material world which a century of experimentation and refinement went on to confirm. The essence of contemporary physics, Carbonnelle thought,

³⁰ Carbonnelle, 'L'encyclique et la science', p. 398.

³¹ Carbonnelle, 'L'encyclique et la science', p. 409.

could be summarized as: 'Tous les phénomènes matériels se réduisent en dernière analyse à des mouvements mécaniques dont les mobiles sont des atomes de deux classes seulement, appelés pondérables ou impondérables suivant la loi qui régit leurs actions.'³² He then speculated that 'cette nouvelle physique [...] porte dans ses flancs l'explication de tous les phénomènes inorganiques et [...] joue déjà un rôle considerable dans l'explication des phénomènes vitaux. Tout physicien, tout physiologiste, tout philosophe est désormais obligé de l'étudier.'³³

Confins is by no means restricted to questions of Boscovichean cosmology. In the book, Carbonnelle ventured into the history of science by analyzing Epicurus and other ancient atomists. He tried to prove that the world was created in time by *a priori* arguments designed to refute the Kantian cosmological antinomies. He argued against Darwin in biology. And he confronted the perennial questions of human freedom, prayer, and Providence, in the context of nineteenth century science. The *Confins* give a good indication of the breadth and vision of the Society until Carbonnelle's early death in 1889.

After Carbonnelle's death, another Jesuit, Charles Georges, acted as interim secretary for a year before Mansion was elected secretary general in 1890, a post which he retained well into the twentieth century. Mansion consciously changed the direction of the Society. Speaking at the society's silver jubilee in 1901, he said that 'on peut faire comprendre l'évolution philosophique de la Revue, pendant le premier quart de siècle de son existence, en rapprochant et en comparant deux séries d'articles qui ont paru les uns avant, les autres après 1889'.³⁴ The first series became

³² Carbonnelle, *Confins*, p. 99.

³³ Carbonnelle, *Confins*, p. 103.

³⁴ As reported in an unsigned article, 'Le mouvement néo-thomiste', *Revue néo-scolastique*, 8 (1901), 401-3 (p. 402).

Carbonnelle's *Confins*. Mansion praised this work enthusiastically: 'Que d'articles, que de livres apologétiques même s'en sont inspirées, directement ou indirectement, et ont mis sous une forme plus assimilable les arguments profonds ou subtils du savant auteur!' Yet Mansion's praise was not unconditional. He continued:

Mais, chose remarquable, presque tous ceux qui ont utilisé, démarqué ou pillé les *Confins* du P. Carbonnelle l'ont fait en se dégageant du système cosmologique de Boscowich. Ils ont vu, ou du moins ils ont senti instinctivement que les parties les plus solides de son argumentation étaient indépendantes de son dynamisme.³⁵

The second series of articles which Mansion cited was composed of Duhem's early papers on the philosophy of physics. Mansion characterized the shift of perspective as a movement from dynamism to an enlarged Thomism. The argument is summarized in a letter Mansion wrote to Duhem on 14 February 1901:

Aujourd'hui, c'est à la Société qui l'on sait le mieux que les mathématiques ne donnent qu'une représentation symbolique du monde et c'est à M. Duhem qu'on le doit; c'est ainsi que nous autres catholiques, occupés de science de la nature, nous avons été fidèles à la direction imprimée par Léon XIII à la philosophie: la quantité n'est plus seule dans le monde; les qualités y sont entrées grâce à vous.

The letter was an invitation to Duhem to address the Society by illustrating Mansion's general argument with observations from mathematical physics. Although the invitation was rather belated, Duhem *did not let his friend down and took part in the twenty-fifth anniversary celebrations.*

Duhem had been a member of the Society since 1891. Direct evidence for his reasons for becoming a member has yet to be discovered. Jaki suggests that Duhem may have been pushed in this direction by his friendship with Père Bourgeat and Charles-Eugène Barrois, who were both members of the Society.³⁶ But there are

³⁵ Mansion, 'Histoire', p. 49.

³⁶ Stanley Jaki, *Uneasy Genius: The Life and Work of Pierre Duhem* (The Hague: Martinus Nijhoff, 1984), p. 93.

enough clues to suggest a further reason. In his 'Physics of a Believer' (1905), Duhem recounted a series of philosophical conversions. He had entered the École Normale as a mechanist but he left for Lille convinced of the wisdom of Newton's *hypothesim non fingo*. Yet he maintained his faith in the validity of the hypothetico-deductive method. Such a vision of science was hardly original. But in Lille, Duhem came to what he believed was a novel view – his holism. This was something to write about. But where? He was *persona non grata* in Parisian scientific circles on account of Berthelot's opposition.³⁷ The *Revue thomiste* and the *Revue de philosophie* had yet to be founded. There was the *Annales de philosophie chrétienne*, but it was not a specifically scientific journal and perhaps Duhem had seen enough of it to develop a strong dislike for some of its main contributors, as he was later to do. The *Revue des questions scientifiques*, on the other hand, was interested specifically in science, and was both beyond Berthelot's control and geographically close to Lille.³⁸ It was the perfect venue for Duhem's articles on the philosophy of physics, which began to appear in 1892, within a year of his joining.

Duhem became a member of the Society after it had declared its 'entière et explicite [adhésion] à la doctrine de saint Thomas d'Aquin, telle quelle est recommandée dans plusieurs documents pontificaux et spécialement dans l'encyclique *Aeterni Patris*' and confirmed the encyclical's claim that 'between certain and accepted conclusions of modern physics and the philosophical principles of the schools, there is no contradiction worthy of the name'.³⁹ This letter of allegiance was sent to Leo XIII on 15 October 1890. Moreover, the Society elected Domet de

³⁷ On Berthelot's opposition, see Hélène Duhem, *Un savant français: Pierre Duhem*, (Paris: Plon, 1936), p. 53 and pp. 146-7; see also Jaki, *Uneasy Genius*, *passim*, but especially, p. 53 and p. 94.

³⁸ Jean-François Stoffel has suggested this to me in an informal conversation.

³⁹ *Annales de la Société Scientifique de Bruxelles: Table Analytique des Vingt-Cinq Premiers Volumes* (1904), p. 39.

Vorges as its president for the year 1890-1 as further proof of its sincere Thomism.

Domet de Vorges was not a scientist but he was at the time the vice-president of the Parisian Société de Saint Thomas d'Aquin. The minute book of the Society's governing council meeting on 14 April 1890 gives the reason for its overt adoption of Thomism:

M. Mansion fait savoir que d'après une dépêche de son Excellence le Cardinal Rampollo à son excellence le Nonce, le Saint Père demande que la Société Scientifique, à l'occasion du renouvellement de son bureau, fasse une déclaration d'adhésion entière et explicite à la doctrine de S. Thomas telle qu'elle est recommandée dans plusieurs documents pontificaux et spécialement dans l'encyclique *Aeterni Patris*.⁴⁰

Mansion gives a more detailed reason for the Vatican's demand in a letter to Duhem, dated 17 February 1892. Referring to Carbone's cosmology, he wrote: 'A sa mort, cet ultradynamisme ne nous a pas causé peu d'embarras, en haut lieu, à Rome, où l'on recommande les idées aristotélicienne et thomistes.'

The Society's official adoption of Thomism can hardly be used to argue for the conversion of all its members in their manner of understanding science, but the sincerity of Mansion's neo-scholasticism cannot be doubted. Much of the evidence for this assertion can be found among the thirty-eight extant letters he wrote to Duhem. Unfortunately, there is no trace of Duhem's letters to Mansion, but Mansion's letters give every indication that the two were in complete agreement on the meaning of physical theory. Right from the beginning of their correspondence, Mansion hoped to get Duhem to write as many articles as possible for the *Revue des questions scientifiques*. The death of Gilbert in 1891 had left the journal high and dry in the physical sciences, for he had always been able to get one of his numerous

⁴⁰ Séance du lundi 14 avril 1890, photocopy of minute book supplied by Dominique Lambert, from the Archives of the Société scientifique de Bruxelles, Namur, Belgium.

contacts to contribute.⁴¹ Gilbert also used to review important new books on physics; Mansion now hoped that Duhem could take over this important work.⁴²

Duhem did not disappoint. He helped the journal both with his numerous articles and frequent book reviews. In 1900, Duhem became a vice-president of the Society. Furthermore, his views on physics influenced the editorial policy of the Society's journals. In 1906, both Mansion and Thirion, the editor in charge of physical science, were embarrassed by an article by Emmanuel Ariès on electricity which they had agreed to publish before seeing that it was not according to their and Duhem's liking. Mansion wrote to Duhem to apologize.⁴³ Ariès put the Society on the spot several years later in 1912 by submitting a paper on false chemical equilibria written specifically against Duhem's teaching on the subject. Mansion wrote to Duhem to ask what to do about it because it was difficult to reject a paper by a member, but eventually published it.⁴⁴

Among the many things Mansion had in common with Duhem was an interest in the history of science. It is not surprising then that Duhem should have written to him for advice when another Belgian, Georges Sarton, first approached Duhem to be a collaborator on a new journal he was about to found. Mansion warned Duhem not to have anything to do with Sarton, who had been one of his former students. The letter is filled with interesting details – mostly pejorative – about Sarton's ability and character, but the relevant point here is Mansion's judgment of Sarton's motivation in starting the journal: 'Vous avez bien deviné: la nouvelle Revue, scientifique agnostique au début sera certainement anticatholique et il est très

⁴¹ Letter from Mansion to Duhem, 11 February 1892, in ArchAcSci, *fonds* Duhem.

⁴² Letter from Mansion to Duhem, 29 April 1892, in ArchAcSci, *fonds* Duhem.

⁴³ Letter from Mansion to Duhem, 17 November 1906, in ArchAcSci, *fonds* Duhem.

⁴⁴ Letter from Mansion to Duhem, 10 October 1912, in ArchAcSci, *fonds* Duhem.

probable que M. Sarton en la fondant a surtout en vue de combattre la *Revue des questions scientifiques*. [...] Inutile de vous dire que je vous engage vivement à ne pas l'aider dans son entreprise.⁴⁵ Duhem took his friend's advice and immediately sent Sarton a note declining to be officially associated with the journal but promising to keep it in mind should he have an appropriate paper to send it.⁴⁶ As it turned out, Sarton's journal *Isis*, published in English from North America, was hardly competition for the Society's *Revue*. But this development need not invalidate Mansion's surmise which had been written before the outbreak of WWI drastically changed many people's plans.

The question naturally arises as to the influence of the *Revue des questions scientifiques*. Unlike the more technical *Annales de la Société scientifique de Bruxelles*, the *Revue* was not sent automatically to each member but only to those who were willing to pay for the subscription. (Non-members could also obtain either journal.)⁴⁷ Hence, it is difficult to know exactly how many copies were printed and distributed. Mansion obviously thought that the *Revue* was a serious threat to positivist propaganda. Others also believed that the journal was influential. The chemist Georges Lemoine, who was the Society's president for the year 1888-89 and a member of the French Académie des Sciences as of 1899, wrote of both the *Annales* and the *Revue* on the occasion of Carbonnelle's death: 'Ces publications pénètrent aujourd'hui partout: elles sont mêmes lues par des hommes dont les doctrines philosophiques sont en désaccord avec les nôtres.'⁴⁸ More recently, Jaki has

⁴⁵ Letter from Mansion to Duhem, 9 April 1912, in ArchAcSci, *fonds* Duhem.

⁴⁶ Note from Sarton to Duhem, 14 April 1912, in ArchAcSci, *fonds* Duhem.

⁴⁷ *Annales de la Société Scientifique de Bruxelles: Tables Analytiques des Vingt-Cinq Premiers Volumes* (1904), pp. 52-5.

⁴⁸ Lemoine, 'Le R.P. Carbonnelle', p. IV.

suggested that Poincaré may have been ‘one of those who read the *Revue des questions scientifiques* without ever referring to it’.⁴⁹ The tacit agreement among the intellectual elite, he maintains, was ‘*Catholica non leguntur*’. Jaki is almost certainly correct when he says that Poincaré plagiarized Duhem’s *Revue* article on the impossibility of a crucial experiment in a very prestigious forum – the World Congress of Philosophy in 1900. The more difficult point to establish is that Poincaré actually read the journal and not just off-prints which Duhem might have sent him. In any case, the Society’s publications seem to have made their way into the library of the Académie des Sciences.⁵⁰ And the Royal Society’s *Index of Scientific Publications* duly cited articles in both the *Annales* and the *Revue*.

Gilbert and Carbonnelle kept the Society growing in the early years. Duhem gave it prestige in the 1890s. But the society struggled over the next decade. In 1906, Mansion admitted to Duhem that ‘en réalité nous avons trop peu de collaborateurs actifs et parfois nous devons publier des articles moins solides ou moins bien écrits que nous le voudrions’.⁵¹ The first World War put an end to the Society’s activities altogether. But the Society revived in the 1920s. There were articles by Georges Lemaître and the brothers Maurice (1875-1960) and Louis (1892-1987) de Broglie in the *Revue*. The renowned mathematician Charles Jean de la Vallée-Poussin (1866-1962) was the Society’s secretary general in these exciting years for physics. He had been a student under Jordan and Poincaré in Paris and Schwarz

⁴⁹ Jaki, in Pierre Duhem, *Prémices Philosophiques: Présentées avec une introduction en anglais par Stanley Jaki* (Leiden: Brill, 1987), introduction, p. xi.

⁵⁰ Letter from Adrien Pautonnier to Duhem, 3 January 1898, in the ArchAcSci, *fonds Duhem*. ‘Votre brochure a fait beaucoup de bruit dans les milieux scientifiques -- et on a cherché (Picard je crois) à son occasion les Annales Scientifiques de Bruxelles dans le Bibliothèque de l’Institut. Je crois qu’on a demandé un abonnement.’ Pautonnier was probably referring to Duhem’s article on Berthelot which in fact appeared in the *RevQuestSci* and not the *Annales*.

⁵¹ Letter from Mansion to Duhem, 17 November 1906, in ArchAcSci, *fonds Duhem*.

and Fuchs in Berlin. He in turn taught mathematics to Lemaître. His best known achievement was the proof of Legendre's conjecture about the distribution of prime numbers. He was a member of the Pontifical Academy of Sciences and the first president of the Union Internationale des Mathématiciens. When he was made a Baron in 1928 on the occasion of his 35th anniversary as professor of mathematics at the Catholic University of Louvain, the committee of honour included Niels Bohr, Jacques Hadamard, Tullio Levi-Civita, and Edmund Whittaker.⁵² During these years, every important book in physics was reviewed in the *Revue*. Many of the society's active members continued to be scientifically competent Jesuits, such as H. Dopp, as well as the more controversial Pierre Teilhard de Chardin (1881-1955) and Joseph Maréchal.

The Society continues to exist to this day, although with a drastically reduced membership. Neither the Society nor the Jesuits nor the Catholic University of Louvain has escaped Belgium's linguistic fragmentation, nor have the archives of any of these institutions.

2. *Institut supérieur de philosophie: Louvain*

Besse held up Louvain's neo-Thomism as a bright contrast to Roman paleo-Thomism.⁵³ If Besse's article in places reads like a promotional pamphlet for the *Institut supérieur de philosophie*, it is probably because Besse had submitted it to the Institute's founder and director, Désiré Mercier, for approval and revision prior to its

⁵² See *Dictionary of Scientific Biography*, ed. by C.C. Gillispie (New York: Scribner's, 1970-80), vol. 13, pp. 561-2; on the celebration of the banquet, see commemorative booklet in the ArchAcSci, *fonds Vallé-Poussin*.

⁵³ The term 'paleo-Thomism' was probably due to Mercier, see Donneaud, 'Le Renouveau thomiste', p. 89. Nevertheless Besse adopted it in his concluding remarks in 'Deux Centres', p. 496.

publication.⁵⁴ Yet there is plenty of evidence to support Besse's portrait of the Institute as the most vibrant center for the study of scholastic philosophy rejuvenated by modern science.

The Institute was a relatively recent addition to the University of Louvain, which proudly traces its foundation to Pope Martin V's charter of 1426, and which boasts Erasmus (1466?-1536) and Vesalius (1514-64) among its alumni. Yet the University has seen such drastic changes over its history that one can legitimately question whether the late nineteenth-century institution had anything to do with the medieval foundation. In 1797, the University was suppressed by French armies; and it was re-opened only in 1816, not as a Catholic institution, but as a State University. After the 1830 revolution which separated Belgium from Holland, the bishops took advantage of the new constitution to found a Catholic University. In 1834, they opened a temporary university in Malines, because the State University was still in Louvain; but by 1835 the bishops moved the Catholic institution to the medieval site.⁵⁵

It is not surprising that Pope Leo XIII should have looked to the University of Louvain to play an important role in the restoration of scholastic philosophy. It was the only complete Catholic University in the world; it had closer ties to the francophone intellectual world than did the Roman Colleges; and Gioacchino Pecci had been the papal legate to Belgium from 1843 to 1846.⁵⁶ During his tenure, he had been embroiled in questions of higher education; and he had maintained direct

⁵⁴ Donneaud, 'Le renouveau thomiste', p. 89. Mercier in turn charged one of his students, the Abbé A. Felzer, to make the revisions.

⁵⁵ For a brief history of the University of Louvain see Paulin Ladeuze, 'L'Université de Louvain', *RevQuestSci*, 92 (1927), 5-16.

⁵⁶ Entry 'Leo XIII', in *New Catholic Encyclopedia* (New York: McGraw-Hill, 1967), VIII, 647-8.

contacts with the University of Louvain over the decades after his return to Italy.⁵⁷ On Christmas day in 1880, Leo sent a letter to Cardinal Deschamps, the Belgian primate, to ask that a special chair of Thomist philosophy be set up in Louvain. The Belgian bishops did not respond enthusiastically to the project, not because they were opposed to scholastic philosophy, but because they were in the midst of a bitter struggle with the government over religious education in the primary schools which taxed their resources and made them reluctant to appear as agents of a foreign power.⁵⁸ They hoped that they could satisfy the Pope by incorporating Thomist philosophy into existing courses instead of establishing a new chair. But this compromise did not satisfy the Vatican. In August 1881, Leo decided to fill the chair at his own expense with the appointment of an Italian Dominican, Hyacinthe Rossi, who was ordained titular bishop of Thrace to give more visibility to the project. This move spurred the Belgian bishops into action. Rossi had the threefold inconvenience of being a foreigner, a religious, and a bishop, which would have made it very difficult for the local bishops to exercise control over him. The Belgian hierarchy was able to secure his recall with promises to comply with the papal directive themselves.⁵⁹

The bishops first looked to Msgr Aloïs Van Weddingen to fill the mandated chair. Van Weddingen had been graduated from Louvain's theological faculty with a doctorate in 1869, and he had gone on to publish a study of Albert the Great which included a commentary on *Aeterni Patris*. Unfortunately, Van Weddingen was prevented from accepting the appointment on account of his being court chaplain to

⁵⁷ Roger Aubert, 'Désiré Mercier and the Origins of the Institute of Philosophy', tran. by Boileau, in Boileau, *Cardinal Mercier*, pp. xiii-xxv (p. xiv).

⁵⁸ Aubert, 'Désiré Mercier', p. xiv.

⁵⁹ De Raeymacker, *Le Cardinal Mercier*, p. 43.

King Leopold II. Nevertheless, he contributed a brief sketch of the ideal candidate, which Louis de Raeymaeker summarized as follows:

Il lui faudra qu'il ait étudié la philosophie du moyen âge dans les sources et non dans les manuels; il devra aussi connaître la philosophie de Kant. Il devra suivre le développement des sciences, de la psycho physique, de la microscopie cellulaire.⁶⁰

At the end of July 1882, Van Weddingen suggested that the post be offered to Fr Désiré Mercier. The Belgian bishops concurred and the Vatican also agreed. In August, Mercier went to Rome where he met with the principal agents of the Thomist movement – Zigliara, Liberatore, and Cornoldi – as well as with Leo XIII.⁶¹ Armed with a papal doctorate in philosophy, Mercier returned to Louvain, where he was attached to the faculty of theology. On 27 October 1882, Mercier gave the inaugural lecture on the 'Haute Philosophie selon Saint Thomas'.

Désiré Mercier was born in November 1851 into a poor tanner's family in Braine l'Alleud, a Walloon town in Brabant. Upon the death of Mercier's father in 1858, his pious mother was left with seven children and very little resources. Désiré's older sisters made great sacrifices to enable him to study for the priesthood (and his brother to study medicine) before three of them entered religious life themselves. The family's hopes in Désiré were well-founded for he was both pious and intelligent.

Soon upon entering the minor seminary in Malines in 1868, he was disappointed by the intellectual poverty of the philosophical manuals then in use – a strange mixture of Cartesian rationalism, Mennaisian epistemology, and Ubagh's ontologism. This could hardly provide a coherent framework for understanding reality. Mercier soon turned to Tongiorgi's *Praelectiones Philosophicae*, a manual of

⁶⁰ De Raeymaeker, *Le Cardinal Mercier*, p. 45.

⁶¹ De Raeymaeker, *Le Cardinal Mercier*, p. 47.

scholastic philosophy, for a more coherent grounding.⁶² Upon his entry into the major seminary in 1870, Mercier continued to seek understanding from scholastic authors. He read the French translation of Kleutgen's *Philosophie der Vorzeit*. And he began to read Thomas's *Summa Theologiae*.⁶³ But Mercier was not content to reiterate the philosophy of the Middle Ages. While still at the minor seminary, he came to believe that modern scholastics would have to formulate an answer to Kant's critical philosophy if they were to be taken seriously by their contemporaries; and he also understood the need to address the claims of science. One of his earliest lectures was a critique of Comte's positivism which had derived much of its authority from the success of science.⁶⁴

Mercier was ordained to the priesthood in 1874. At the end of his studies in Louvain, he was assigned to the minor seminary in Malines where he taught psychology, epistemology, and theodicy (rational theology) and assumed responsibility for the spiritual formation of the students. In 1882, he was relieved of his duties in Malines so that he could devote himself to teaching Thomist philosophy at Louvain. Although he was only thirty years old, he already possessed much of what Van Weddingen had thought necessary for the position, but he was determined to deepen his own knowledge of the areas which he considered crucial. He became something of an authority on Kant, despite his hatred of the German philosopher's thought. And he tried to learn as much as possible about the state of the sciences. To this end, he spent some time at Jean Martin Charcot's (1825-1893) psychiatry clinic in Paris; and in Louvain he followed courses in physiology, chemistry, and mathematics.

⁶² Boileau, *Cardinal Mercier*, p. 11.

⁶³ Boileau, *Cardinal Mercier*, p. 14.

⁶⁴ Boileau, *Cardinal Mercier*, p. 17.

For chemistry, he relied on Louis Henry, and for mathematical enlightenment he turned to Paul Mansion, who were both active in the Société Scientifique de Bruxelles.⁶⁵

Mercier insisted that it was necessary for the modern scholastic to have a knowledge of science. In his very first lecture, he challenged his audience: 'Do we not [...] profess that it [true science] is the obligatory point of departure of all serious metaphysics, and have we not so often heard the sovereign Pontiff himself encourage us to study the natural sciences and to accept with respect every useful discovery, no matter where it comes from?'⁶⁶ In his textbook on logic, Mercier put his view of the relationship between science and philosophy more succinctly: 'Philosophy is science in an advanced state.'⁶⁷ This position is consistent with Mercier's belief that philosophy is first of all something to be discovered rather than taught.⁶⁸ But it is hardly compatible with a belief in a *philosophia perennis* that contains unchanging principles.

Mercier's course at the university was popular. It was a free public course, taught in French rather than Latin, which was obligatory for all students of theology as well as for all doctoral candidates in philosophy and science. In the academic year 1887-8, over nine percent of Louvain's approximately 1750 students took the course. Mercier did not teach metaphysics himself, probably because it was already

⁶⁵ De Raeymaeker, *Le Cardinal Mercier*, p. 55.

⁶⁶ Mercier, 'Opening Discourse', p. 307.

⁶⁷ Mercier, quoted in Georges van Riet, 'Cardinal Désiré Mercier (1851-1926) and the Institute of Philosophy of Louvain', in *Tradition and Renewal: The Centennial of Louvain's Institute of Philosophy*, vol. 3, ed. by David A. Boileau and John A. Dick, Louvain Philosophical Studies, no. 7 (Louvain: Leuven University Press), pp. 1-39 (p. 17). 'La philosophie est la science au stade le plus avancé: sa méthode est donc celle de la science.' Désiré Mercier, *Logique*, 5th ed. (Louvain: Institut supérieur de philosophie, 1909). The sentence is gone by the third edition of *A Manual of Scholastic Philosophy* (pp. 202-3), but the supporting arguments all remain.

⁶⁸ Van Riet, 'Cardinal Mercier', p. 3.

being taught from a Thomist viewpoint by his former mentor Dupont. Instead, he concentrated on criteriology – the study of the certainty and of the limits of human knowledge. And he addressed popular questions of the day such as the possibility of human freedom in light of mechanical determinism.

Before setting out to meet the Pope in 1882, Mercier was told that his appointment was meant to be the beginning of a philosophical movement. In particular, the Rector had mentioned that apart from teaching a course, Mercier was to organize study circles in Thomist philosophy and to publish learned articles on important scientific and social questions of the day.⁶⁹ By 1888, there were enough alumni of Mercier's course to start the Société philosophique de Louvain.⁷⁰ This group made possible the development of two further institutions: the Institut supérieur de philosophie in 1889 and the *Revue Néo-Scolastique* in 1894, which have both survived to the present day.⁷¹

The Institute was officially founded on 8 November 1889 with a papal brief addressed to Cardinal Goossens, but it had been in the works for over two years. In 1887, Mercier had asked the Pope to create the Institute as a separate entity from the faculty of philosophy and letters, which he found too concerned with history and philology. The Pope quickly warmed to the idea, but Mercier had to face much local opposition. Besides the expected administrative resentment at having an autonomous institute at the university, he had to deal with two divergent intellectual outlooks which were both hostile to his vision of neo-Thomism. One school thought that seeking wisdom from the Middle Ages was misguided; the other, that Mercier was a

⁶⁹ Boileau, *Cardinal Mercier*, p. 38.

⁷⁰ De Raeymaeker, *Le Cardinal Mercier*, p. 59.

⁷¹ De Raeymaeker, *Le Cardinal Mercier*, p. 61. The *Revue Néo-Scolastique* has since changed its name to *Revue philosophique de Louvain*.

dangerous innovator by opening Thomism to modern fads. This latter school proved far more troublesome to Mercier because it was able to secure powerful allies in Rome. In 1895, Mercier's project was nearly destroyed by a Vatican decree that stipulated that courses in the Institute had to be taught in Latin rather than French. It took three years to reverse this decision, but eventually Mercier got his way. Although he was at times in danger of being relieved of his post of President, he retained it from the foundation of the Institute until his appointment as Archbishop of Malines in 1906 which made him the highest ranking churchman in Belgium. Created Cardinal in 1907, Mercier is known to most people for his courageous moral leadership in World War I, but it is his founding of the Institute that is of present interest.

Mercier's vision of the importance of science to philosophy can be seen right from the start in the choice of courses and professors. In 1890-91, the first academic year at the Institute, Mansion gave conferences in the fundamental principles of mathematics; and Gilbert, in modern physics; Henry taught the principles and theories of modern chemistry; Charles de la Vallée Poussin, crystallography; and Ernst Pasquier, hypotheses of cosmogony. For students who needed a more basic introduction to mathematics and experimental physics, there were courses by N. Sibenaler and A. Van Biervliet. Henry de Dorlodot taught cosmology; and Saint George Mivart, the Catholic evolutionist who criticized Darwin's theories, taught an introductory course in the philosophy of nature.⁷² Most of these men were prominent members of the Brussels Scientific Society; and, in fact, all of them were members at some point in their lives.

In 1893, Mercier was able to give the Institute more stability and also to assure

⁷² Courses and professors are listed by de Raeymaeker, *Le Cardinal Mercier*, p. 74.

a continuation of his ideas by securing professorial chairs for four of his brightest students. Maurice de Wulf specialized in the history of medieval philosophy. Simon Deplouge made sociological questions his focus of interest. Armand Thiéry, who had often visited Wundt's laboratory in Leipzig, was the resident expert in experimental psychology. And Desiré Nys specialized in cosmology. *Of these four, Nys is most relevant to understanding Duhem's relation to neo-Thomism.*

Desiré Nys was born in 1859 in Saint Léger, in the southwest corner of Belgium. After basic seminary training, he went to the University of Louvain to obtain a bachelor's degree in theology as well as the grade of candidate in the natural sciences. Wulf, in a eulogy of his former colleague, remarked that in the 1880s, it was highly unusual to see a student of theology taking courses in chemistry and physics. Nys was probably even more of a rarity as a student in Ostwald's laboratory. Although hostile to Christianity, Ostwald was the natural teacher for someone looking for an alternative to mechanical theories about matter. His energetics held the promise of incorporating qualities into physics instead of just quantities. This was important to neo-Thomists who were hoping to introduce Aristotelian hylomorphism into modern physics and chemistry. Nys did not adopt uncritically the whole of Ostwald's philosophy, which included the negation of matter and the elevation of energy into an all-encompassing religious doctrine. But he adopted enough of it that at least one historian could lump Ostwald along with the neo-Thomists and Duhem into the same school.⁷³

Nys had a large influence on the neo-Thomist understanding of physical science. He was *one of the first to receive a doctorate in Thomist philosophy from*

⁷³ Jaki, *Uneasy Genius* (p. 360), cites J. Sageret, *La vague mystique. Henri Poincaré -- Energétisme (W. Ostwald) -- Néo-Thomisme (P. Duhem) -- Bergsonisme, Pragmatisme -- Emile Boutroux* (Paris: Flammarion, 1920), a work which, in Jaki's estimation, is driven by positivistic prejudice.

the University of Louvain in 1888 with a thesis entitled *Le problème cosmologique*, which was an extended argument for hylomorphism. For many years, he taught chemistry and cosmology at the Institute. He directed or co-directed several doctoral theses among which were: *La récurrence des éléments* (1899) by A. Conzemius; *La valeur de l'expérience scientifique et les bases de la cosmologie* (1899-1900) by J. Lemaire; *La philosophie de Mr. Ostwald et essai critique* (1909), by Th. Quidbach; and *Mach et Duhem: Etude épistémologique comparée* (1910), by Constantin Michalski. This abridged list shows that his work is relevant to an evaluation of Duhem's position *vis-à-vis* neo-Thomism. The Institute's fascination with Duhem's work in the philosophy of science was manifest more officially when it awarded him an honorary doctorate in 1908, although the importance of this gesture must not be overemphasized. Duhem was one of several members of the Brussels Scientific Society to be given the honour in that year.⁷⁴

The strong connection between science and philosophy at the Institute can best be seen from its course offerings.⁷⁵ Students in their first year, working towards their baccalaureate, had to take (1) logic, (2) ontology, (3) history of medieval philosophy, (4) physics, (5) psychophysiology (experimental psychology as exemplified in the work of Gustav Theodor Fechner (1801-87) and Wilhelm Wundt (1832-1920)), and (6) chemistry, and could choose from special courses such as (a) trigonometry, analytical geometry, and differential calculus, (b) general biology, botany, and zoology, with practical exercises, (c) general anatomy and physiology, (d) political economy, and (e) method of historical criticism. Students in their second year, studying towards their licentiate, were expected to take courses in

⁷⁴ *RevQuestSci*, 66 (1909), p. 8.

⁷⁵ Boileau, *Cardinal Mercier*, pp. 105-6.

(1) cosmology, (2) psychology, (3) psychophysiology, (4) moral philosophy, (5) history of medieval philosophy, (6) history of ancient and modern philosophy, and (7) anatomy and physiology, and to choose from (a) integral calculus, (b) analytical mechanics, (c) embryology, histology, and physiology of the nervous system, (d) mineralogy and crystallography, (e) history of social theories, and (f) method of historical criticism. The doctoral programme required a third year of lecture courses in (1) psychology, (2) psychophysiology, (3) natural and social law, (4) theodicy, and (5) history of ancient and of modern philosophy. In addition, the student was expected to do laboratory work in (a) chemistry and (b) psychophysiology, as well as to take part in seminars in (a) social philosophy and (b) the history of medieval philosophy.

The aim of these curricula, despite their appearance, was not to educate scientists and engineers but philosophers. Physics, chemistry, analytical mechanics, and mathematics were studied for the sake of cosmology; biology, physiology, botany, and psychophysiology were to inform a philosophical psychology which was necessary for a study of moral philosophy; and political economy and social theories were deemed necessary to an intelligent discussion of social ethics. This is not to denigrate the way in which the sciences were taught at the Institute. Mercier believed that the sciences must be cultivated for their own sake if they are to be understood properly, and worked towards this goal at the Institute.⁷⁶ Thiéry's psychological laboratory was especially impressive. It was well-equipped with instruments ranging from olfactometers and reaction meters to X-rays. Binet, writing in the *Année psychologique* in 1896, noted that nothing in France approached

⁷⁶ Mercier, 'Report on Higher Studies', p. 349.

Louvain's program in the overall quality of instruction in the subject.⁷⁷

The Institute spread its teachings abroad at first through articles in the *Revue néo-scholastique de philosophie*, which featured articles by professors. Nys, for example, published articles on time and space, the physics of quality, hylomorphism, and energetics. But the *Revue* also opened its pages to its advanced students. The very first volume in 1894, for example, printed an article, 'Le positivisme et l'évolution intellectuelle', by J. Halleux, who went on to defend a doctoral thesis *Les principes du positivisme contemporain* in 1895. By 1904, after nine years of publishing, the journal had 350 subscribers.⁷⁸ This was about the same number as the *Revue thomiste* and the *Revue de philosophie*, but it made a greater impact on the world of philosophy. Louis de Raeymaeker, a one-time president of the Institute who wrote its history in the 1950's, might be a bit partisan, but he could enlist the support of the *Revue de métaphysique et de morale* and *Kantstudien* for his assertion that in 1900, 'l'Institut de Louvain s'impose aussi à l'attention de la pensée non-scholastique, ce qu'aucun autre centre de philosophie n'avait réussi à faire jusqu'alors'.⁷⁹

The Institute also assured the wide dissemination of its teaching through its two-volume *Manual of modern scholastic philosophy*, which included sections on cosmology, psychology, epistemology, ontology, natural theology, logic, ethics, and the history of philosophy. The work was the joint effort of Mercier and his four core professors. The popularity of the text may be gauged from the fact that, by 1926, the

⁷⁷ Besse cites Binet and gives a list of the principal instruments used in Louvain in 'Deux centres', pp. 491-2. Unfortunately, Besse's citation lacks so much detail, as to make it unverifiable to anyone who does not want to read about 300 pages of the 1896 volume of the *Année Psychologique*.

⁷⁸ De Raeymaeker, *Le Cardinal Mercier*, p. 100.

⁷⁹ De Raeymaeker, *Le Cardinal Mercier*, p. 159. See Besse, 'Deux centres', p. 487, for a list of non-scholastic publications which paid tribute to the Institute.

third English edition of the text appeared. It was subsequently reprinted several times and as late as the 1950s. It is also difficult to keep tabs on the many editions of Nys's *Cosmologie*, whose second and third French editions appeared in 1906 and 1916 respectively. (The first seems to have been his 1888 thesis.) The work was being republished in a slightly modified English form as late as the 1940s.

Some of the Institute's renown is due to its professors' lecturing abroad. Maurice de Wulf, for example, spent 1915-1918 at Cornell, Harvard, and the University of Toronto before returning to Belgium at the end of the war. And Léon Noël taught the philosophy of Saint Thomas at Oxford from 1914-1918. But the graduates of the Institute also helped to spread its doctrines. By 1898-99, the total number of students at the University of Louvain was 1905. Of these, 1737 were Belgians. However, of the 168 foreign students, 20 were American, despite the fact that the Catholic University of America had already been founded. When the University of Louvain opened its doors after the war, over 3,000 students registered. Of these, 73 were registered at the Institut. The number of Institute students continued to increase until it hit a high of 245 in 1927-28 of which 62 were foreigners.⁸⁰

Some of the North American graduates went on to occupy important positions in Catholic Colleges in Canada and the United States. For example, Gerald P. Phelan, who received his doctorate in 1925, was one of the founders of the Pontifical Institute of Medieval Studies in Toronto and its president from 1935-46. Later, he went to teach at the University of Notre Dame in Indiana. Fulton Sheen, who graduated with the same degree at the same time, went on to disseminate Thomist doctrines through his immensely popular radio and television lectures in the United

⁸⁰ De Raeymaeker, *Le Cardinal Mercier*, p. 194.

States.⁸¹ Thomas was finally getting a wide hearing, or at least Thomas as he was understood in Louvain.

3. *Institut catholique de Paris*

The Catholic Institute in Paris predates Louvain's Institute by fourteen years, but it makes sense to examine it after Louvain because, in its teaching of Thomas, it looked to Belgium for its model. The Parisian Institute began its existence as one of the five Catholic Universities which the Bishops of France founded in 1875 immediately after the government made it possible to establish independent institutes of higher learning. The bishops wanted to create universities, which meant that their institutions would have to have at least three of the five canonical faculties: theology, letters, sciences, law, and medicine. Not wanting to compete with their own seminaries, they quickly agreed to drop theology. They wanted to keep medicine on account of the materialist doctrines prevalent at the state universities, but the government's requirement that every faculty of medicine have an associated hospital made this venture prohibitively expensive, at least in Paris. Hence the University started out with the faculties of law, letters, and science.⁸²

Despite its three faculties, the Parisian University lost its right to use the title in March 1880, soon after the virulently anti-clerical republicans won the elections in 1879.⁸³ The anti-clericalism of the government was a constant source of pressure for the Institute in Paris. At times, there was a real danger that the state might force the Institute to shut down, just as it was suppressing all schools taught by religious

⁸¹ De Raeymaeker, *Le Cardinal Mercier*, p. 197.

⁸² Claude Bressolette, 'La fondation de la faculté de philosophie à l'Institut catholique de Paris 1875-1895-1912', in *Le statut contemporain de la philosophie: première centenaire de la Faculté de philosophie* (Paris: Beauchesne, 1996), pp. 259-99 (p. 263).

⁸³ Beretta, *Monseigneur d'Hulst*, p. 75.

Orders and even closing down monasteries, convents, and chapels of religious houses in the years immediately prior to the complete rupture of its relations with the Vatican in 1905. In these years, the Institute required all its professors who were members of religious Orders to be secularized; and it demanded that Jean Bulliot of the Marists retire, after he was arrested for three times breaking the seals which the government had placed on the doors of his order's chapel.⁸⁴

Pressure from the state shaped the Institute in less dramatic ways. Its requirements for granting degrees strongly influenced the students in their choice of courses. The state's scientific agenda was a major incentive for the Institute to develop a strong science program. More negatively, its general opposition to the Church did much to limit the student population. Whereas Louvain's University had over 2,000 students in the first decade of the twentieth century, the Parisian Institute had only 300 lay students in addition to the 127 clerical students registered at its associated seminaries.⁸⁵ The faculty of law had by far the largest number of students. But it is the faculty of science and the development of the faculty of philosophy that will be of interest in this brief sketch of the early history of the Institut catholique.

The foundation of the Institute was largely the work of Monseigneur Maurice d'Hulst (1841-1896) who was the vicar apostolic of the Archdiocese of Paris in the summer of 1875 when the bishops met to decide upon the foundation of Catholic Universities. Internal strife among Catholics made it impossible for d'Hulst, who was suspected of liberalism, to be appointed rector at the outset. He was, however, made secretary of the Governing Commission and thus had to do most of the work in insuring that courses in law, letters, and the sciences be in place in time for opening

⁸⁴ Various newspaper clippings found in the ArchICP, *fonds* Bulliot.

⁸⁵ Bressolette, 'La fondation', pp. 282-4.

day in the fall.⁸⁶ He was finally elected rector in January 1881 and relieved of most of his administrative duties at the diocese so that he could devote himself to the Institute and to teaching. He retained this position until his premature death in 1896.

A few weeks into his new position, d'Hulst was denounced to Rome on the charge of having affirmed that '*le Cartésianisme est la seule vraie philosophie*'. Although this caused d'Hulst some temporary embarrassment, it gave him a chance to defend his Thomist credentials and eventually to secure the personal favour of Leo XIII. In a long letter to Cardinal Zigliari, written in March 1881, in anticipation of his trip to Rome, d'Hulst said that for more than fifteen years his philosophical outlook was '*tout à fait détachée du Cartésianisme et complètement acquise à la doctrine de saint Thomas*'.⁸⁷ D'Hulst was able to point to his being censured by Bishop Dupanloup for being too severe with Descartes and his school; and he said that, in his lectures on the proofs for the existence of God, he always eulogized Thomas's five ways and disparaged Anselm's ontological argument. Perhaps Zigliara did not believe him at first, for Baudrillart reports that d'Hulst was severely reprimanded *during a private audience with the Pope for being too Cartesian*. But d'Hulst was made a papal chamberlain in December of the same year. Later on, d'Hulst's reputation in Rome made it possible to get Vatican approval for another one of his ventures – the International Catholic Scientific Congresses.

Yet d'Hulst continued to make people feel uneasy. In an effort to show that it was possible for Christians to hold their own in various intellectual endeavours, he favoured much freedom in research and teaching. He was against the strict

⁸⁶ Beretta, *Monseigneur d'Hulst*, pp. 43-5.

⁸⁷ See letter from d'Hulst to Zigliara, 29 March 1881, in Beretta, *Monseigneur d'Hulst*, pp. 181-7 (p. 182).

concordism of 'Catholic science' which still had powerful supporters, especially among the traditionalists. D'Hulst, for example, had to defend his faculty such as Albert de Lapparent from charges by François Moigno that the geologist did not take the flood into account in his teachings and publications.⁸⁸ Such complaints soon ceased to be matter for serious debate, but d'Hulst's support for his professor of biblical exegesis, the modernist Abbé Alfred Loisy (1857-1940), who eventually left the Church, remains controversial. Everyone agrees, however, on the prodigious amount of work that d'Hulst accomplished and on the hope he placed in science and philosophy as means of bringing about a new respect for the Gospel.

In debating over which faculties to include in the Catholic universities, the bishops knew that science would have to stay: '*Les Sciences demandent un matériel coûteux, mais la tendance du jour ne permet pas de les exclure.*'⁸⁹ D'Hulst remained a committed partisan of this policy throughout his life. In 1881, in an address entitled '*La fausse science et la nécessité de la combattre par l'enseignement supérieur catholique*', he said: '*Ce qu'il faut c'est de produire, sous les yeux des sceptiques, la chose même qu'ils déclarent impossible, c'est de faire la science vraiment scientifique et vraiment chrétienne.*'⁹⁰ In the 1890s, he took up this theme again. To protect students against the prevailing scientism of the day, it was not enough to expose the false conclusions of the adversary who pretended to argue from the authority of science. Nor should the Institutes try to save money by sending students to state universities for most subjects and then try to preserve their Catholic faith through a few courses of philosophy.⁹¹ Much more was necessary if the Church

⁸⁸ The evidence is in the ArchICP, *fonds de Lapparent*.

⁸⁹ Bressolette, '*La fondation*', p. 263.

⁹⁰ Beretta, *Monseigneur d'Hulst*, p. 82.

⁹¹ Beretta, *Monseigneur d'Hulst*, p. 80.

were to regain its influence in society:

Il faut pour atteindre ce but tout un ensemble de ressources et d'instruments de travail, des livres, des collections, des laboratoires, des hommes spéciaux qui produisent, qui prennent leur place dans l'ardente concurrence des recherches contemporaines; il faut qu'en lisant leurs écrits, en prenant connaissance de leur découvertes, on ne dise pas seulement: ces savants étaient des chrétiens, mais qu'on dise encore: le milieu où ils ont vécu, où ils ont travaillé, était un milieu chrétien.⁹²

In short, d'Hulst wanted to establish a scientific culture in a Catholic setting.

Alfred Baudrillart, the third rector of the Institut, in his biography of d'Hulst, describes in detail the efforts of his predecessor to assemble a serious faculty of science. D'Hulst turned for help to the Abbé de Foville, an alumnus of the École polytechnique. De Foville suggested, among others, the chemist Georges Lemoine (1841-1922), the geologist Albert de Lapparent (1839-1908), and the mathematician Camille Jordan (1838-1922), and eventually helped to convince Lemoine and de Lapparent to sign on. D'Hulst was aided in seeking a professor of mathematics by Charles Hermite (1822-1901), by then a respected member of the Académie des Sciences, but even so he could not attract men of renown. The chair of physics proved the most difficult to fill despite the collaboration of much talent and good will: the brothers Charles (1814-1876) and Henri (1818-1881) Sainte-Claire Deville, Lemoine, and Victor Puiseux (1820-1883). These Academicians (or in the case of Lemoine, future Academicians) put together a list which included Duhem's teacher at the Collège Stanislas, Jules Moutier, and three future members of the Institut de France: Émile Amagat (1841-1915), Alfred Cornu (1841-1902), and Édouard Branly (1844-1940).

Branly, who eventually got the job, was highly recommended by Henri Sainte-Claire Deville: 'Branly est parmi nos élèves un de ceux que j'aime le plus.

⁹² D'Hulst, quoted in Boretta, *Monseigneur d'Hulst*, p. 82.

Excellente thèse, excellent professeur, travailleur infatigable, consciencieux et bon, enfin très aimé de ses camarades.⁹³ The problem was how to woo him away from his present position as chief of Desain's laboratory at the Sorbonne. Branly at first accepted d'Hulst's offer, but changed his mind when his father pointed out the uncertain future of the new institution. D'Hulst wrote to Lemoine in discouragement: 'il [Branly] est agrégé de l'Université; il sait qu'après être venu à nous il sera mal vu, et que, si nous cessions d'être, il se trouverait sans position, ou du moins n'obtiendrait qu'un poste de disgrâce dans quelque lycée de province. A cela, je n'ai rien à dire...'⁹⁴ Lemoine eventually persuaded Branly to change his mind yet again and come to the Institute. Hence, the new faculty could boast three future Academicians among its founding staff.

The future was by no means easy for the new core faculty. Branly, who brought much fame to the Institute by his invention of an iron-filing detector for Hertzian waves, found it necessary to become a medical doctor and to open a part-time practice in order to make ends meet. The historian Harry Paul notes that Branly thought that the Institute did not reward him sufficiently and in particular blamed Baudrillart for the ingratitude: 'J'ai dit à Alfred [Baudrillart]: le jour où je publierai mes mémoires, vous n'aurez plus qu'à vous cacher dans les cabinets.'⁹⁵ Lemoine and de Lapparent were also faced with difficult personal choices.⁹⁶ Both were employees of the state when they were offered a professorship at the Institute.

⁹³ Sainte-Claire Deville, in Alfred Baudrillart, *Vie de Mgr d'Hulst*, 2 vols (Paris: Ancienne Librairie Poussielgue, 1912-14), 1, p. 348.

⁹⁴ D'Hulst, quoted in Baudrillart, *Vie de Mgr d'Hulst*, 1, 349.

⁹⁵ Branly, quoted in Harry Paul, *From Knowledge to Power: The Rise of the Science Empire in France, 1860-1939* (Cambridge: Cambridge University Press, 1985), p. 229.

⁹⁶ For the cases of de Lapparent and Lemoine, see Harry W. Paul, 'The Crucifix and the Crucible: Catholic Scientists in the Third Republic', *Catholic Historical Review*, 58 (1972), 195-219 (pp. 212-4).

Both asked for and received permission to take on the new assignment. Lemoine continued to receive his salary; and de Lapparent went on a *congé illimité* without pay. The anti-clerical government elected in 1879 would not tolerate these arrangements. In 1881, Lemoine quit his post at the Institute, whose future was bleak, while de Lapparent, who was in a much better position to take a risk, remained. However neither Lemoine nor de Lapparent made other concessions to the state. Both were active members of the Brussels Scientific Society and played prominent roles in the International Catholic Scientific Congresses.

Branly did not enter directly into debates on the philosophy of science. He was, however, the only science professor to be cross-appointed to the Faculty of Scholastic Philosophy.⁹⁷ Lemoine was mainly interested in the chemistry of dissociation at high temperatures. This branch of chemistry was often cited in neo-scholastic attempts to distinguish true substances from mere mixtures. De Lapparent contributed most to the discussion of the philosophy of science and the relation between faith and science. His major works in these fields are *Science et Philosophie* and *Science et Apologétique*. Yet his greatest contribution to the philosophy of science may be an article on crystallography as a means of arguing towards the reality of molecules, for it may have prompted Duhem to write the *Théorie physique* as a refutation.⁹⁸ On 1 May 1902, Mansion wrote to Duhem:

Le R.P. Thirion m'apprend que vous n'avez plus l'intention de répondre aux deux articles de M. de Lapparent. Je comprends parfaitement que vous éprouviez un sentiment de découragement en voyant qu'il faudrait écrire un volume pour répondre au savant géologue sur tous les points qu'il effleure. Mais il me semble qu'il y a mieux à faire qu'une réfutation directe. Ne pouvez-vous profiter de l'occasion pour donner de nouveau une exposition de vos idées?

⁹⁷ *Annuaire de l'Institut catholique* (1898-9).

⁹⁸ Letter from Mansion to Duhem, 1 May 1902, in ArchAcSci, *fonds* Duhem. I would like to express my gratitude to Jean-François Stoffel for bringing this to my attention.

Duhem began the public lectures which eventually became *La théorie physique* in 1903.

Albert de Lapparent was born in Bourges in 1839. His grandfather was a member of the first graduating class of the *École polytechnique* in 1794; his father was a polytechnicien of 1828; and Albert too became a polytechnicien in 1858, the first-ranked in his class on both entry and graduation.⁹⁹ A protégé of the geologist Léonce Élie de Beaumont (1798-1874), de Lapparent was assigned to make detailed geographical surveys. In 1867, he was one of three French geologists assigned to study the feasibility of an undersea tunnel from Pas-de-Calais to England. After much intense work, the commission judged that the project was possible.¹⁰⁰

De Lapparent was interested in research but even more zealous to teach; hence he immediately accepted the position offered to him at the Institute.¹⁰¹ He also devoted himself to writing textbooks of geology which were greeted with enthusiasm, both in France and abroad; his *Traité de Géologie* went through five editions by 1909 and sold over 14,000 copies.¹⁰² The geologist Charles Barrois (1851-1927) noted that the popularity of de Lapparent's textbooks lay in their systematic presentation of a subject that had hitherto been fragmented into narrow fields of specialization. They had the further virtue of being equally solid in all their parts, which testified to de Lapparent's knowledge of subjects as diverse as mathematics, physics, chemistry, mineralogy, biology, and paleontology.¹⁰³ De Lapparent was

⁹⁹ Charles Barrois, 'Albert de Lapparent', *RevQuestSci*, 66 (1909), pp. 9-44 (p. 10).

¹⁰⁰ Entry 'de Lapparent' in *Dictionary of Scientific Biography*, ed. by C.C. Gillispie (New York: Scribner's, 1970-80), vol. 8, pp. 30-1.

¹⁰¹ Barrois, 'Albert de Lapparent', p. 17.

¹⁰² Barrois, 'Albert de Lapparent', p. 22.

¹⁰³ Barrois, 'Albert de Lapparent', pp. 20-1.

respected by his peers. He was elected to the Académie des Sciences in 1897; and in 1907, he was made perpetual secretary of the physical sciences. Among the many foreign honours granted to him was a degree from Cambridge.¹⁰⁴

De Lapparent did not restrict his teaching to pure science. He was involved in many Catholic efforts to defend the faith against the claims of science. He was a member of the Brussels Scientific Society from its foundation and served as its president three times between 1881 and 1899. He was prominent in the International Catholic Scientific Congresses, and presided at the fifth and last Congress which took place in Munich in 1900. *Science et Philosophie* (1913) is a collection of articles and talks which de Lapparent had given on diverse occasions. The recurring theme of these essays is that science shows order in nature which leads to the idea of an ordering cause – God. The collection contains two articles on *bathybius* which for nearly a decade was the darling of evolutionists.¹⁰⁵ The account is interesting both in itself and because it reveals what Catholics had to endure from the propaganda of the materialist evolutionists.

In 1868, Huxley was probing the depths of the North Atlantic. He noticed that all the samples he brought aboard contained considerable amounts of a gelatinous substance which seemed to have been a form of life and which he classified as *bathybius* – deep dwelling life. This protoplasm had neither organs nor any definite form, except for some small grains of stone which were given the names *coccolithes* and *rhabdolithes*. In 1870, Haeckel made a detailed study of *bathybius*. He noted some small random trembling movement and, after performing various chemical

¹⁰⁴ Barrois, 'Albert de Lapparent', pp. 40-1.

¹⁰⁵ De Lapparent, 'Vie et matière -- le bathybius' and 'Encore le bathybius', in *Science et Philosophie* (Paris: Bloud et Cie., 1913), pp. 153-63, and pp. 165-85. The two articles appeared earlier in the *RevQuestSci* in 1878 and 1880 respectively.

tests, declared that *bathybius* was definitely an organic form. Another German scientist, Carl Wilhelm Gumbel (1823-98), without having seen the substance, also declared it was organic and insisted that it could be found in every sea and at all depths. In Canada, John William Dawson (1820-99) and William Boyd Carpenter (1841-1918) appealed to *bathybius* as a contemporary example of their controversial ancient protozoa which they had classified as *ezoon Canadense*. By 1876, Karl Alfred Zittel (1839-1904) had classified *bathybius* as the head of the class of moneres, the first of the family of protozoa.

It is not surprising then that the British research vessel *Challenger* was on the lookout for *bathybius* as it dredged its way across the Atlantic and Pacific Oceans. But *bathybius* could not be teased out of the depths. It did not, however, elude the scientists forever. John Murray finally discovered that when sea water was mixed with alcohol it gave rise to a gelatinous substance that eventually turned out to be *bathybius*. The deep dwelling life was really a form of mineral precipitate. This was an embarrassment to Huxley and Haeckel and their associates, but de Lapparent sadly noted that the incident did not teach them humility: 'il suffit de lire les derniers *crits de MM. Huxley et Haeckel pour voir avec quel dedain, avec quelle hauteur les adversaires du transformisme sont traites par eux.*'¹⁰⁶ Much to de Lapparent's surprise, they managed to keep the whole affair from the public and even from professional zoologists. That is why he published the expose in the *Revue des questions scientifiques* in 1878.

In the spring of 1905, de Lapparent was asked to give six lectures at the Institute on science and the faith. The six editions of his *Science et Apologetique* testify to the popularity of these lectures. Yet not all were convinced of their

¹⁰⁶ De Lapparent, 'Bathybius', p. 161.

soundness. Duhem's correspondent, the Jesuit Jean de Séguier (1862-1935)

lamented:

Je vous avoue que les conférences récemment publiées de M. de Lapparent m'ont singulièrement agacé par la simplicité de leur réalisme. Je n'aurais jamais cru qu'un membre de l'Institut pût [dire] de pareilles choses en l'an de grâce 1905.¹⁰⁷

The historian Roberto Maiocchi places de Lapparent among the 'tomisti ortodossi', without giving a reason for the classification.¹⁰⁸ De Lapparent would not object. In 1868, long before the publication of *Aeterni Patris*, he was already citing Thomas's definition of science – *cognitio rerum per causas*.¹⁰⁹ And like other neo-Thomists, he believed that one could come to know the essence of molecules. There is no reason to believe that he did not accept the official philosophy of the Institute, but there is also no evidence that Thomism was foremost on his mind.

The real devotees of Thomism at the Institute were in the faculty of philosophy which grew out of the faculty of letters. The slow and often painful development of the faculty as a whole is an interesting story described in some detail by Claude Bressolette. The great difficulty was to ensure a scholastic orientation to philosophy at the Institute at a time when the secular universities were interested only in modern philosophy. Were the Church to insist that students devote themselves to scholastic philosophy without studying modern philosophy, two problems would arise. First, her ministers would not be able to obtain government teaching licences. And, secondly, the Church would isolate herself from the rest of French society. Eventually the problem was resolved by the rule that no ecclesiastical student could

¹⁰⁷ Letter from Séguier to Duhem, 3 November 1905, in ArchAcSci, *fonds Duhem*.

¹⁰⁸ Roberto Maiocchi, *Chimica e filosofia*, p. 143.

¹⁰⁹ De Lapparent, 'La philosophie des sciences', in *Science et philosophie* (Paris: Bloud & Cie, 1913), pp. 1-27 (p. 21).

present himself for a state licentiate until after having successfully obtained a licentiate in scholastic philosophy.¹¹⁰ Yet, until the Church imposed this double burden on the students, very few of them were willing to take courses in scholastic philosophy. This caused much tension between the professors of modern and scholastic philosophy at the Institute and delayed the final constitution of the faculty until 1912.

The first description of a chair in scholastic philosophy comes from a general meeting of French bishops in January 1879: 'il faudrait une chaire de philosophie scholastique. Les élèves de cette école devraient en outre fréquenter la Faculté des sciences et y prendre des grades combinés avec les études philosophiques.'¹¹¹ It took nearly a decade before the first concrete steps were taken. In 1887, d'Hulst managed to secure the nomination of Jean Bulliot as an assistant professor for the chair of scholastic philosophy, but he had to wait a full year for the choice to be ratified.

Jean Bulliot was born in 1851 in Autun and ordained to the priesthood in 1878. By then, he had received a doctorate in scholastic philosophy from the Roman universities. He also had the benefit of learning scholastic philosophy from the Marist Donatien Derennes (1837-1895) who was one of the early pioneers of neo-Thomism in France. Bulliot taught at the major seminary at Agen from 1879-83; then at the scholasticate of the Marists, whom he had joined; and finally at the major seminary in Moulins from 1886 until his appointment to the Institute in Paris in 1888.¹¹² D'Hulst praised his new professor 'dont les rares aptitudes philosophiques s'étaient révélées à nous et dans sa collaboration aux travaux de le Société de Saint-

¹¹⁰ Bressolette, 'La fondation', p. 292.

¹¹¹ Bishops' report, quoted in Bressolette, 'La fondation', p. 267.

¹¹² Dossier on Bulliot at the ArchICP.

Thomas d'Aquin et dans les discussions du Congrès scientifique. Nous avons constaté chez lui une connaissance approfondie des principes de Saint Thomas jointe à une instruction scientifique peu commune et à une remarquable netteté d'exposition."¹¹³ The Dominican priest Ambroise Gardeil also had a high regard for Bulliot's scientific knowledge although he was dubious of his philosophical acumen: 'Le P. Bulliot a dépassé la région des élémentaires depuis longtemps et c'est aux cours des meilleurs professeurs de mathématiques et de physique, de la Sorbonne et du Collège de France, qu'il est allé prendre ses informations scientifiques. Son tort, peut-être, est non pas d'ignorer les théories physiques, mais de les connaître si bien qu'il leur prête une valeur philosophique."¹¹⁴ Others found him deficient in both science and philosophy. Duhem, for example, lost patience while listening to Bulliot mix philosophy and science at the Brussels Congress in 1894 and got up to blast theologians who spoke of science while knowing nothing about it (see chapter 5.2). Duhem's personal correspondence on the subject was equally passionate. After describing to his friend the Abbé Adrien Pautonnier how a true philosopher should analyze science, he lamented: 'Au lieu de cela, nous avons Bulliot et Domet de Vorges qui se croient capables de nous détailler l'essence du mouvement, alors qu'ils ne seraient pas f... [*sic*] (comme disait Mesureur) de traiter un problème de mécanique de License."¹¹⁵

Despite the show of frustration, Duhem became friends with Bulliot.

Immediately after the Congress, the two exchanged a few letters about scholastic philosophy and science which will be analyzed in chapter 5.3. Duhem collaborated

¹¹³ D'Hulst, quoted in Bressollette, 'La fondation', p. 268.

¹¹⁴ Ambroise Gardeil, 'La philosophie au congrès de Bruxelles', *RevThom*, 2 (1894), 569-85, 752-9 (p. 580).

¹¹⁵ Letter from Duhem to Pautonnier, 25 April 1896, in Archives of the Archdiocese of Paris, *fonds Pautonnier*.

with Bulliot on the *Revue de philosophie*. And later, when Duhem was writing the *Système du monde* in the isolation of Bordeaux, Bulliot sought out manuscripts for him in Paris and helped him to deal with publishers.

Perhaps one of the things that endeared Bulliot to Duhem and to many others was his passion for whatever he was doing. As Pautonnier put it to Duhem:

C'est un bien brave homme, mais n'ayant pas de suite dans les idées. Actuellement il est à la physiognomie et aux sciences psychiques. Il dispense ses efforts sur trop de sujets pour rien faire de sérieux sur un point donné. D'ailleurs il est droit, et assez ouvert d'esprit. C'est bien fâcheux qu'il n'ait pas reçu une meilleure formation.¹¹⁶

Bulliot was certainly willing to write articles on many different subjects, although he never had the stamina to publish a book. Among his papers are 'L'unité des forces physiques au point de vue philosophique et scientifique' (1888) and 'De principales théories de la combinaison chimique' (1891) which will be examined in chapter 3.3. Bulliot remained at the Institute until 1912, with the exception of a forced retirement of three years on account of his being thrown in jail for violating the government's anti-clerical laws in 1903. He died in 1915, at the age of sixty-four.

Throughout his life, Bulliot had a passionate hatred for Descartes, as may be gathered from an obituary which appeared in the *Revue de philosophie*:

La nationalité française du philosophe n'était pas de nature à le faire revenir des sentences sévères qu'il portait contre lui; il voyait en lui l'ancêtre de toutes les aberrations philosophiques modernes, y compris l'idéalisme allemand, 'le père du mensonge', comme il le nommait.¹¹⁷

Charles Denis was probably not exaggerating when he accused Bulliot of failing to distinguish between modern philosophers.¹¹⁸ Baudrillart knew that he could not

¹¹⁶ Letter from Pautonnier to Duhem, 1 April 1895, in Archives of the Archdiocese of Paris, *fonds Pautonnier*.

¹¹⁷ Anonymous, 'Le R.P. Bulliot', *RevPhil*, 26(1919), 123-6.

¹¹⁸ Denis, 'Situation', p. 567.

avoid mentioning something of Bulliot's strong views at a sermon he preached by his grave:

Il paraissait, il était quelquefois un peu passionné, un peu tenace, un peu, comment dirai-je? rigoureux, dans ses rapports avec autrui quand une question lui tenait au coeur.¹¹⁹

But, Baudrillart went on to say, all esteemed him and recognized his charity, which is much the same judgment that Gardeil had passed on him over twenty years earlier:

'O Père Bulliot que vous eussiez été méchant, si vous n'étiez pas si saint.'¹²⁰

The first dean of philosophy at the Institute was Bulliot's brother in religion, Émile Peillaube. Born in 1864, in the region of Agen, he was ordained a priest in 1890 and entered the Society of Mary in 1892. Like Bulliot, Peillaube also learned scholastic philosophy from Derennes. He was sent to Paris to study and took courses at the Institute, the Sorbonne, the Collège de France, and the Salpêtrière, on account of his specializing in psychology.¹²¹ In 1895, he defended a doctoral thesis on the formation of concepts. And in 1899, he was made a professor at the Institute.¹²² As soon as he was appointed, he started planning a new publication, the *Revue de philosophie*. Peillaube remained the editor of this journal until his death in 1930.

There were many other professors at the Institute who were interested in neo-Thomism. Some of these will be introduced in the section on the Société de Saint Thomas d'Aquin; others, as the need arises. But something must be said here about the final organization of the Institut. In 1899, the rector Msgr Pierre-Louis Péchenard complained of the prevailing subjectivist and positivist current of thought in society at large, which he hoped to overcome by strengthening the scholastic

¹¹⁹ In dossier on Bulliot in the Archives of the Society of Mary.

¹²⁰ Gardeil, 'La philosophie au congrès', p. 575.

¹²¹ *Annales de Marie*, 7 (1934), p. 333.

¹²² Bressolette, 'La fondation', p. 273.

philosophy program being at the Institute. He noted that in the past year, 'à l'enseignement philosophique proprement dit, nous avons ajouté des leçons de sciences, mathématiques, physiques et psychophysiologiques. Mais ces efforts n'aboutiront à rien s'ils ne sont renforcés et régularisés.'¹²³ The rector also cited favourably the example of the Institute in Louvain.

It was perhaps inevitable that Louvain should be invoked as a model. Soon after Peillaube was named rector in 1912, he proposed that an 'Institut philosophique' be founded, along the lines of the Belgian Institute. Bressolette, making use of Peillaube's words, puts it this way:

'[L'Institut philosophique] serait d'abord une École normale supérieure où se formeraient tous les professeurs de philosophie. Il serait ensuite un foyer de recherche philosophique et scientifique.' Il comprendrait un ensemble de chaires de philosophie et de sciences: 'Les chaires de sciences serviraient de base aux chaires de philosophie', mais 'il ne faudrait étudier les sciences qu'autant qu'elles sont utilisables par la philosophie'. Dans cette perspective, les chaires de philosophie 'ont besoin comme annexes de laboratoires' qui donnent à un enseignement 'beaucoup de relief scientifique' et sont des lieux d'expérimentation et de démonstration. Deux paraissent très désirables: l'un de cosmologie, l'autre de psychologie; mais à côté des manipulations, il y aurait des conférences. En effet, 'il est capital que les laboratoires avec leurs conférences, dépendent des professeurs de cosmologie et de psychologie, chargés l'un de la métaphysique de la matière, l'autre de la métaphysique de l'âme. La partie scientifique doit être subordonnée à la métaphysique: si la métaphysique est servante par rapport à la théologie, elle est reine par rapport aux sciences'.¹²⁴

Peillaube also recommended that two chairs be created: one in natural law and sociology to counteract the influence of Émile Durkheim, 'un sociologue athée'; and another in the history of science.

In May 1911, Bulliot wrote to Duhem to ask him for support in reforming the faculty of philosophy: 'Quelque chose me dit que si vous me prêtez votre aide, nous

¹²³ Péchenard, quoted in Bressolette, 'La fondation', p. 275.

¹²⁴ Bressolette, 'La fondation', p. 294.

réussions.’ In response, Duhem wrote a long letter to plead for the necessity of setting up a chair in the philosophy of science and another in the history of science. Although strictly speaking no chair in the history of science was created, François Borrières was hired in 1912 to teach a course in ‘Sciences mathématiques et science physiques’, which was designed to address at least some of the needs that Duhem had specified.¹²⁵

There is no evidence that Duhem was asked to teach the history of science, but his name was circulated for a different position. In a letter to his daughter dated 21 July 1912, he wrote that he had chatted with Duval-Arnould ‘de l’Institut catholique, où il vient d’être nommé professeur d’économie politique et où, à la rentrée, va fonctionner la fameuse Faculté de philosophie que l’on voulait fonder en me nommant doyen’.¹²⁶ Although he was not in fact made dean, Duhem was still asked for advice by Peillaube, who visited him at Arcachon in January 1913. Reporting to his daughter on the visit, Duhem wrote: ‘Nous avons eu une conversation très intéressante sur son Institut de philosophie; il m’a demandé beaucoup de conseils pour l’organisation de l’enseignement scientifique indispensable, que les séminaristes se refusent à peu près à suivre, pendant que les jeunes filles le suivent avec succès.’¹²⁷

Although the Institut de philosophie which Peillaube had hoped to establish was never created, the program at the Institute in Paris resembled the Louvain

¹²⁵ Private communication from Jean-Baptiste Lebigue, archivist at the Institut catholique de Paris, 2 November 1998.

¹²⁶ See letter from Duhem to his daughter, 21 July 1912, in *Lettres de Pierre Duhem à sa fille Hélène*, ed. by Stanley Jaki (Paris: Beauchesne, 1994), p. 75.

¹²⁷ Letter from Duhem to his daughter, 4 January 1913, in *Lettres*, pp. 93-4.

model in its linking of science and philosophy.¹²⁸ A way of teaching philosophy had been instituted at two influential centers of Catholic thought. The continuing popularity of Louvain's textbooks well beyond the Second World War witnesses to the endurance of this model. Yet, some Thomists started to have doubts about the system much earlier. Baudrillart went to Rome in 1917, where he met the Abbé Gény, whom he found 'simple et ouvert'. Gény thought that the Institute's program was too dispersed. Besides personal criticisms of Peillaube and Bulliot (who was by then dead), he mentioned that 'la psychologie expérimentale a fait son temps et n'abouti à rien. Même à Louvain, cela ne marchait plus.'¹²⁹ But institutionalization would keep it around for some time. A course in experimental psychology was part of the curriculum in philosophy at the Institut catholique as late as 1968.¹³⁰

As important as the organization and teaching at the Insitute were to the development of neo-Thomism, the debates about the meaning of physical science took place in two closely related forums. The first is the Société de Saint Thomas d'Aquin; the second, the *Revue de philosophie*.

4. Société de Saint-Thomas d'Aquin

In the spring of 1884, the Jesuit Père Jovene, a professor at the Institute, talked with some friends about starting a Thomist philosophical society. Although he left Paris a few months later, the idea he had sown took root. The Society of Saint Thomas Aquinas was officialy founded in the fall of 1884. At the Society's first annual dinner, d'Hulst and Domet de Vorges each gave credit to the other for its

¹²⁸ See Pierre Colin, 'La faculté de philosophie dans ses publications: 1900-1985', in *Le statut contemporaine de la philosophie: première centenaire de la Faculté de philosophie* (Paris: Beauchesne, 1996), pp. 301-32 (p. 317).

¹²⁹ Gény, quoted by Baudrillart, in entry for 8 May 1917, in *Le Camets du Cardinal Baudrillart*, ed. by Paul Christophe (Paris: Cerf, 1994).

¹³⁰ Personal communication from Jean-Baptiste Lebigue, 2 November 1998.

foundation. Both, in fact, played a prominent role in the Society. D'Hulst was its first president; and Domet de Vorges, its first vice president.¹³¹

The Society's two stated goals were (1) 'rechercher et établir les vérités philosophiques, en s'inspirant des Pères et Docteurs de l'Église, particulièrement de saint Thomas d'Aquin', and (2) 'exposer et réfuter les erreurs modernes, en s'appuyant à la fois sur la philosophie chrétienne et sur les sciences naturelles et expérimentales'. The Society called upon not only philosophers and theologians but also scientists and especially doctors to help it show that 'L'Église n'a rien à craindre de la vraie science, ni la vraie science de l'Église'.¹³² Although Thomist, the Society welcomed members who were not, so that there could be a lively exchange of ideas and the members could be sure not to distort modern teachings. By January 1885, the Society had twenty resident members as well as corresponding members in the provinces.¹³³

There was no official link between the Institute and the Society, but, as d'Hulst put it, 'les points de contact sont nombreux'. The Institute offered space for the monthly meetings; many of its professors, including Bulliot and Peillaube, were also members of the Society; d'Hulst was the rector of one and president of the other; and many of the benefactors of the Institute were among the members of the Society.¹³⁴

One prominent member who was also a professor at the Institute was the Sulpician Albert Farges. Born in 1848 in the region of Limousin, he was educated

¹³¹ The history of the Society's foundation is recounted by d'Hulst and Domet de Vorges, in separate speeches published as *SéancesSSTA*, Annual Meeting in November 1885, *AnnPhilChr*, 110 (1885), 489-510.

¹³² 'Société de Saint-Thomas d'Aquin', *AnnPhilChr*, 109 (1884/5), 188-91 (p. 189).

¹³³ *SéancesSSTA*, Annual Meeting in November 1885, *AnnPhilChr*, 110 (1885), p. 492 and p. 496.

¹³⁴ *SéancesSSTA*, Annual Meeting in November 1885, *AnnPhilChr*, 110 (1885), pp. 492-3.

by the Jesuits in Bordeaux before entering the seminary of Saint Sulpice in Paris.¹³⁵ Ordained a priest in 1872, he went on to obtain doctorates in philosophy and theology. Farges was then sent to teach at the major seminaries in Bourges and Nantes before being called to Paris. In the capital, he taught philosophy both at the Sulpician seminary in Issy and at the Institute. From 1898-1905, he was superior of the seminary at the Institut catholique d'Angers. He went into official retirement in 1905, but continued to write and to perform other pastoral duties until his death in 1926.

Farges was a prolific writer on diverse subjects. In a series entitled *Études philosophiques pour vulgariser les théories d'Aristote et de S. Thomas et leur accord avec les sciences*, he published no fewer than eight books by 1895, including: *Matière et Forme en présence des sciences modernes*, *La Vie et l'Évolution des espèces* (1888), *Le Cerveau, l'Âme et les Facultés* (1891), and *L'idée de Dieu d'après la Raison et la Science* (1894). The last-named book included letters of approval from Pope Leo XIII and Cardinal Zigliara and received a laudatory review in the *Revue des questions scientifiques*.¹³⁶ A later Thomist, however, lamented that 'il est regrettable que ce volumineux essai de vulgarisation pèche, en son concordisme bien intentionné, par une interprétation trop matérielle de la doctrine de S. Thomas et par une déficience grave de sens historique'.¹³⁷ Farges, for example, relied on the heat death of the universe predicted by the second law of thermodynamics to argue for creation in time. And he appealed to geology, and in particular to erosion, as being consonant with the Biblical promise 'Every valley shall be exalted, and every mountain and hill

¹³⁵ This account follows Jean-Paul Besse, 'Un théologien et spirituel thomiste méconnu: Monseigneur Albert Farges (1848-1926)', in *Acti del IX Congresso tomistico internazionale, Tome 2, Storia del Tomismo* (Rome: Pontifical Academy of Saint Thomas, 1992), pp. 290-301.

¹³⁶ Jean d'Estienne, *RevQuestSci*, 36 (1894), 299-312.

¹³⁷ Obituary, *Bulletin thomiste*, 2 [1927(?)], p. 32.

shall be made low'.¹³⁸ If these works are read today, it is only as historical curiosities; but Farges's books were popular in their day and he kept emending them to keep up with changes in science. In 1921, he published the thirty-first edition of his *Philosophia scholastica ad mentem S. Thomae Aquinatis exposita et recentioribus scientiarum inventis aptata*; and in 1933, the seventeenth edition of his *Cours de philosophie scolastique, d'après la pensée d'Aristote et de S. Thomas mise au courant de la science moderne et dirigée contre le Kantisme et le modernisme* was published posthumously. Farges also wrote on other subjects, such as on the history of his native region, on mystical phenomena, and on the philosophy of Henri Bergson.

At the Society's meetings, Farges contributed papers on the moved and the mover (May and June 1886) and on the psychological proofs for the existence of God (March 1893). Farges took up the renewal of Thomas's *prima via* again at the International Catholic Scientific Congress in Brussels where he spoke at the session which Duhem interrupted. The details of his efforts will be analyzed in chapter 4.3.A. If Farges's arguments could not convince, he could count on the force of his personality. Gardeil described him as: 'Solide, court, petit, avec une poitrine d'athlète, tête forte et bien posée sur deux robustes épaules, M. Farges a le type du philosophe dogmatissant'.¹³⁹ In Farges's estimation, Thomas had provided the definitive answers to everything.

Edmond Charles Eugène le Comte Domet de Vorges (1829-1910) was the vice-president of the Society at the time of its foundation and then became its president in 1892. He always took an active part in the discussion periods following the reading of papers; and he contributed many papers himself. He was active in many

¹³⁸ Farges, *L'idée de Dieu d'après la raison et la science. Existence de Dieu, Nature de Dieu, Rapports de Dieu et du monde* (Paris: [n.p.], 1894), pp. 93-4.

¹³⁹ Gardeil, 'La philosophie au congrès', p. 574.

other Catholic and Thomist causes, such as the Brussels Scientific Society and the International Catholic Scientific Congresses. No doubt, he had his admirers in these circles. Always smiling, he was immediately recognized by the red rose affixed to his lapel and his charming manners.¹⁴⁰ But he also had his detractors. Duhem had pretty harsh things to say about him in his private correspondence. His letter to Blondel is perhaps the most severe: 'quant à la Société de St Thomas d'Aquin ... elle renferme sans doute aussi de braves gens, mais elle renferme aussi des êtres bouffis de vanité – M. le Comte Domet de Vorges, par exemple.'¹⁴¹ Niall Martin quotes this letter at length to argue that Duhem was against scholasticism, but although Duhem went on to say harsher things about 'the Catholic world', it is clear that he was distinguishing and that he was aware that even the Society of Saint Thomas should not be condemned as a whole on account of its president.¹⁴²

Domet de Vorges was born in Paris in 1829. He wanted to be a philosopher but was told: 'La philosophie ce n'est pas une position.'¹⁴³ Instead, he entered the diplomatic service, where he first served as a secretary to the embassies in Denmark, Portugal, and Brazil. He then became a plenipotentiary and was sent to Port au Prince, Lima, and Alexandria, where he opposed the British bombing in 1882 and insisted on being the last French citizen to board the rescue vessel.¹⁴⁴ With the advent of the anti-clerical government, Domet de Vorges found himself without a job. He decided to take an early retirement and to dedicate himself to philosophy

¹⁴⁰ Albert Farges, 'Domet de Vorges', *RevPhil*, 18 (1911), 303-9.

¹⁴¹ Letter from Duhem to Blondel, 12 January 1896, in Blondel Archives, Institut supérieur de philosophie, Louvain-la-Neuve, Belgium.

¹⁴² Martin, *Pierre Duhem*, p. 54.

¹⁴³ Robert Jacquin, 'Deux promoteurs inattendus de la philosophie de Saint Thomas d'Aquin', *Divinitas*, 18 (1974), 357-68 (p. 358).

¹⁴⁴ Farges, 'Domet de Vorges', pp. 303-9.

and to Catholic social projects.

He was by no means new to philosophy and even to the philosophy of Saint Thomas. In 1853, under the inspiration of Victor Cousin, the Académie des sciences morales et politiques announced a prize essay on the thought of Thomas to be completed by 1856. The candidates were to establish the authentic works of Thomas and their order of composition; they were to explain his metaphysical and moral teachings and determine what he borrowed from the tradition and what he added; they were to examine how his teaching was understood in the succeeding centuries; and finally they were asked to make a judgment whether any of his writings remain valid. Domet de Vorges was twenty-four years old when the contest was announced and approached it with the zeal of youth. Although he did not win, his 560-page essay received an honourable mention. And he had learned a lot about philosophy in the meantime.

Domet de Vorges returned to philosophy even before his retirement. In 1875, he published *La métaphysique en présence des sciences*, in which he tried to re-establish the link between science and philosophy. His hostile reaction to Duhem's understanding of physical theory, which will be taken up in chapter 5.1, betrays his naively simple view of the relationship of metaphysics to physics. Domet de Vorges's long list of publications ranges over a variety of topics, displaying an eclecticism reminiscent of his philosophy. Although Domet de Vorges was president of the Society of Saint Thomas, he was by no means a pure Thomist. As Farges put it: 'M. de Vorges se trouve classé parmi les Thomistes sincères, un peu teintés d'eclecticisme, avec quelques faiblesses avouées pour Suarez et Leibnitz.'¹⁴⁵

Another prominent member of the Society was Joseph Gardair (1846-1911).

¹⁴⁵ Farges, 'Domet de Vorges', pp. 303-9.

Like Domet de Vorges, he was not a philosopher by profession but sold all kinds of oil – sesame seed, olive, and lubricating – to support his family of twelve children. However, he gave all his free time to philosophy, adopting as his motto: ‘primum vivere, deinde philosophari.’¹⁴⁶ Domet de Vorges described Gardair as a pure Thomist who had been studying the Angelic Doctor for nine years by the time the Society was founded.¹⁴⁷ Although Gardair concerned himself with questions of science – he published ‘La matière et la vie’ and a critique of Hirn’s *La notion de la force dans la science moderne* – his primary contribution to neo-Thomism was to make it known at a state university.¹⁴⁸ In 1890, he received permission from the Sorbonne to give a ‘cours libre’ on the thought of Saint Thomas for the next five years. Domet de Vorges called this license ‘le plus notable de cette décade et le plus inattendu, vu les idées qui règnent en France’; and sure enough it was not renewed in 1895. But in the intervening five years, Gardair gave lectures to about 150 auditors on the powers of the soul. In contrast, his occasional lectures at the Institut catholique attracted only about 30 students. In 1896, Gardair read a paper on Thomas’s five ways before the Academie des sciences morales et politiques. Upon becoming a widower, he thought of joining the Dominicans, but instead retired to Arcachon to teach his beloved Saint Thomas.¹⁴⁹

An early member of the Society with a famous family name was the Abbé Paul de Broglie (1833-1895). He was the uncle of the physicists Maurice and Louis de Broglie. Paul was himself interested in science from an early age and so opted for

¹⁴⁶ Jacquin, ‘Deux promoteurs’, p. 363.

¹⁴⁷ *SéancesSSTA*, Annual Meeting in November 1885, *AnnPhilChr*, 110 (1885), p. 494.

¹⁴⁸ On Gardair at the Sorbonne, see, A. Ackermann, ‘La philosophie de Saint Thomas à la Sorbonne’, *AnnPhilChr*, 121 (1890/91), 388-93.

¹⁴⁹ Jacquin, ‘Deux promoteurs’, pp. 363-8.

the *École polytechnique*. Upon graduation, he spent thirteen years in the navy. During that sojourn he discerned a religious vocation and also discovered Thomas's *Summa theologiae* which he 'read and reread' while sailing around the world.¹⁵⁰ He joined the Sulpicians and was ordained a priest during the siege of Paris in October 1870. In 1876, he went on to teach Christian apologetics at the Institut catholique. At first, this apologetic was aimed specifically at the sciences. In 1881, he published an article in the *Revue des questions scientifiques* on 'Dynamisme et atomisme', in which he argued for hylomorphism. He later presented a modified version of this paper at one of the first meetings of the Society in February 1885. He also published a lengthy article, 'De la nature des sons et des couleurs', in the *Annales de philosophie chrétienne*. Besides these articles specifically dealing with science, de Broglie also published more epistemological works and was interested in the history of religions. The last paper he presented to the Society was on the argument for God's existence based on the almost unanimous consent of mankind to the proposition. He was still actively teaching at the Institute and writing papers when he was shot to death by a crazy woman penitent in 1895.¹⁵¹

Besides priests and amateur philosophers, the Society counted several scientists among its members. From the start, it managed to attract two medical doctors into its ranks, Drs Goix and Ferrand, who were both members of the Brussels Scientific Society and had published in scientific journals. Dr Ferrand, especially, took an active role in the meetings. In the physical sciences, the Society attracted the Academician Adhémar Barré le comte de Saint-Venant (1797-1886), although death would remove him from the ranks in the second year of his membership. Listed as a

¹⁵⁰ Farges, 'Domet de Vorges', p. 304.

¹⁵¹ *Catholicism: hier, aujourd'hui, demain. Encyclopédie en sept volumes* (Paris: Lctouzey et Ane, 1948-), II, cols 280-1.

corresponding member, de Saint-Venant nevertheless made significant contributions to the debates. His main field of research was fluid mechanics, a science which, the French insist, he and Navier founded.¹⁵² De Saint-Venant was associated with another prominent Catholic scientist, Joseph Boussinesq, whom he recommended for membership to the Académie des Sciences in 1876.¹⁵³ Prior to Boussinesq's election, de Saint-Venant presented a paper to the Academy by his protégé which tried to explain how particular mathematical states might allow freedom of the will to intervene in a mechanistic universe (see chapter 4.1.C). Boussinesq was finally admitted into the Academy a few months after de Saint-Venant's death, just in time to read his eulogy.

Eugène Vicaire (1839-1901), a much younger scientist than de Saint-Venant, was also a member of the Society.¹⁵⁴ Born near Lyon, Vicaire entered the École polytechnique in Paris at the age of seventeen, and like de Lapparent, was ranked first both on entry and graduation. This propitious beginning led to many promotions within the civil service, mainly in developing the nation's network of railroads. Vicaire took an interest in both pure and applied science. He published articles in mathematics, solar physics, and celestial mechanics as well as papers on industrial ovens, refining metals, ventilating mines, and railroad brakes. Vicaire also managed to find time to teach a course in mechanics at the Institut catholique and a course in celestial mechanics at the Collège de France (1883-85). He was a member of the Brussels Scientific Society, the Société mathématique de France, and the Société philomathique de Paris, and served a term as the president of each of these

¹⁵² Bruno Belhoste, 'De Saint-Venant', *Annales des Ponts et Chaussées* (1997), p. 82.

¹⁵³ See the dossier on de Saint-Venant, in ArchAcSci.

¹⁵⁴ This account closely follows Maurice d'Ocagne, 'Eugène Vicaire', *RevQuestSci*, 49 (1901), 420-431.

societies. A devout layman, Vicaire was the father of nine children, among whom were a priest, a Carmelite nun, and a seminarian who died before ordination.

Vicaire's prominence in Catholic circles and his undisputed scientific credentials lent authority to his forays into the philosophy of science. He wrote essays on the reality of space and the necessity of absolute movement for the *Annales de la Société scientifique*. But he is best known to historians of science for a lengthy article he published in the *Revue des questions scientifiques*: 'De la valeur objective des hypothèses physiques'. The paper had the subtitle 'A propos d'un article de M.P. Duhem', whose ideas, according to Vicaire, 'sont destructives de toute science'.¹⁵⁵ In particular, Vicaire saw in Duhem's denial that physical theory is a causal explanation a slighting of the power of the human intellect and hence the beginning of the descent to full blown scepticism. Mansion wrote a letter to Duhem before Vicaire's paper was printed. He found the article muddled but thought that Vicaire was as fair as possible 'étant donné qu'il admet que les théories physiques sont de vraies explications'. He also urged Duhem not to be too harsh in replying to the article because it had been vetted by Vicaire's son at the seminary, who had died in the meantime, for possible transgressions against charity.¹⁵⁶ But, in a subsequent letter, Mansion urged Duhem to reply; and it is clear from their correspondence that Duhem's 'Physique et métaphysique' was a reply to Vicaire, although it was written in an impersonal manner.¹⁵⁷ Whereas Vicaire found little support for his views from Mansion, he could take consolation in Domet de Vorges's approval at the Society of

¹⁵⁵ Eugène Vicaire, 'De la valeur objective de hypothèses physiques: à propos d'un article de M.P. Duhem', *RevQuestSci*, 33 (1893), 451-510 (p. 453).

¹⁵⁶ See letter from Mansion to Duhem, 20 March 1893, in ArchAcSc, *fonds* Duhem.

¹⁵⁷ Mansion wrote to encourage Duhem on 19 May 1893. In a letter of 10 December 1893, Mansion asked Duhem whether he had seen that the *AnnPhilChr* had published his reply to Vicaire just after the *AnnPhilChr* republished 'Physique et métaphysique'.

Saint Thomas.

The Society discussed many subjects that will be taken up in the present study: 'Constitution of Bodies' or 'Atomism and Dynamism' (1885); 'The Mover and the Moved' (1886); Boussinesq's solution to the problem of free will (1886); 'Free will and determinism' (passim); 'The unity of physical forces' (1889); 'Force and mass' (1891); 'Proof for the first mover' (1892); 'Value of physical theories' (1893); 'On the criterion to distinguish philosophy from the other sciences' (1894); and 'On the real existence of extension' (1895). These papers accounted for only a small percentage of the total. The members debated the traditional philosophical questions such as universals, the categories, the formation of concepts, and morality. They were also interested in biology and discussed the definition of life, heredity, and animal magnetism. They tried to be true both to Thomas and to modern psychology in distinguishing the powers of the soul. And they debated the definition of scholastic philosophy.

It is at first easy for the historian to follow the debates at the monthly meetings because the Society more or less took over the *Annales de philosophie chrétienne*. Soon after Bonnetty's death in 1879, the *Annales* came under the direction of the Abbé Joseph Guieu who was among the original members of the Society.¹⁵⁸ Domet de Vorges noted that 'M. Guieu était personnellement partisan d'un thomisme modéré mis en accord avec les progrès sérieux et constatés des sciences. Il avait pris charge de la Revue avec la résolution arrêtée d'y défendre ces idées.'¹⁵⁹ With Guieu in charge, the *Annales* published not only the short summary of the proceedings of each of the Society's meetings but also the papers themselves as full-length articles.

¹⁵⁸ Beretta, *Monseigneur d'Hulst*, p. 98.

¹⁵⁹ *SéancesSSTA*, Annual Meeting in November 1885, *AnnPhilChr*, 110 (1885), p. 494.

Domet de Vorges contributed fairly regular reviews of books and foreign journals; and professors at the Institut published articles.

The situation began to change in 1895, with the advent of Charles Denis (1860-1905) as director. At first, Denis tried to be accommodating both to Thomism and to what he called the 'spiritualist school', which was hoping to reconcile the teachings and outlook characteristic of academe with those of the Church.¹⁶⁰ During his first year in charge, Denis published the Society's proceedings, but gaps soon appeared. In 1899, on the occasion of the seventieth year of the *Annales*' publication, Denis noted that the journal had nearly disappeared under Guieu because neo-scholasticism had little appeal to anyone who might be interested in studying philosophy at the university.¹⁶¹ The last meeting of the Society which was reported in the *Annales* took place in 1900. Afterwards, Denis's attacks on the neo-scholastics became more explicit. The journal was eventually bought secretly by Duhem's friend Maurice Blondel in 1905. And in 1913 it was put on the Index by the Vatican because its director Laberthonnière was suspected of modernism. Duhem expressed his disappointment on this occasion in a letter to his daughter: 'Il n'y a qu'un mot pour qualifier ce qui se passe: *Pie X est un misérable*.'¹⁶²

The Society switched its allegiance to the *Revue de philosophie* in 1902. The report of a monthly meeting appeared along with the promise that the *Revue* would carry future reports. In fact, no further reports appear. However, in 1922 the journal carried the report of a meeting of the Société Philosophique Saint-Thomas d'Aquin. This brings up the interesting question of what happened to the original

¹⁶⁰ Denis, *AnnPhilChr*, 130 (1895), 5-8.

¹⁶¹ Denis, *AnnPhilChr*, 139 (1899\1900), p. 8.

¹⁶² Letter from Duhem to his daughter, 19 May 1913, in *Lettres*, p. 112.

Society. There is no trace of the Society in the archives of the Institut or in those of the Parisian Archdiocesan Office. Baudrillart, in his extensive and detailed biography of d'Hulst, says absolutely nothing about it. More recent historians such as Pierre Colin and Francesco Beretta also confess their ignorance of the fate of the Society.¹⁶³ It seems as though there is a conspiracy of silence around it. Beretta, although he does not exclude this suggestion, thinks that the Society just died a natural death. This may very well be true, but there is an intriguing note from Farges to one of the members of the new society, written ostensibly to excuse himself from a meeting of the new society on account of his eczema:

Je vous communique aussi confidentiellement une lettre de M. le Curé de S. Sulpice. Comme lui, je crois qu'il faudrait orienter la nouvelle Société vers les questions vitales de la *doctrine* ou *métaphysique* thomiste et non vers les questions curieuses de la physiologie ou de l'histoire. Celles-ci, sans être nullement exclues des discussions doivent passer au second plan.¹⁶⁴

One is led to speculate that the original Society fell apart as a result of an internal conflict over principles.

5. *Revue de philosophie*

As the *Annales de philosophie chrétienne* became less hospitable to neo-scholasticism, the neo-Thomists needed other means to publish their ideas. In the winter of 1900, the Abbé Élie Blanc of the Institut catholique de Lyon came to Paris to ask Peillaube and Bulliot to found a new journal, the *Revue de philosophie*.¹⁶⁵ Peillaube decided to take charge of the project, and set about planning the new journal. He had spent some time in the summer of 1899 hiking with Duhem near Cabrespine and

¹⁶³ Personal communication by telephone from Pierre Colin and e-mail from Francesco Beretta.

¹⁶⁴ Note dated 21 June 1922, in ArchICP, *fonds Farges*.

¹⁶⁵ Peillaube's reminiscences at 30th anniversary dinner, *RevPhil*, new series, 2 (1931), p. 12.

was planning to do so again. It would be the perfect opportunity to interest Duhem in the *Revue*. He wrote to Duhem shortly before the holidays:

Pendant que vous faites passer des examens et avant de partir pour la Bourbouille et la Montagne Noire, je m'occupe à lancer une [...] *Revue de philosophie*. Nous discuterons *notre* programme à Pradelles et à Cabrespine sur ces chemins toujours trop courts [...] Cette revue va vous mettre dans la nécessité de reprendre votre plume de philosophe. Il y a beaucoup d'idées à mettre au point en physique. Il y a aussi beaucoup d'idées à faire entrer dans les têtes philosophiques et scientifiques. Il me faudrait bien un article de vous pour le premier numéro, long ou court peu importe. Je ne veux pas vous en parler aujourd'hui. Nous en parlerons tout à loisir dans un mois.

Je vais essayer de faire pénétrer la *Revue* dans l'Université. C'est dans ce but que je me suis refusé à ajouter en titre toute qualification. Vous pouvez me donner, sur ce point, comme sur tant d'autres d'excellents conseils.¹⁶⁶

Duhem apparently agreed with the title of the journal. In a letter Peillaube wrote to Baudrillart on 25 February 1910, he protested that he never meant to claim autonomy for the journal from the Institut catholique: 'Si, à son origine, elle [la revue] a refusé de prendre l'étiquette [catholique], ç'a été uniquement pour ne point écarter des savants tels que M. Duhem qui déclaraient qu'ils ne pouvaient collaborer, étant membres de l'Université, à un oeuvre d'un Institut rival.'¹⁶⁷ In any case, the neutral title of the *Revue de philosophie* did not fool anyone. Pautonnier, in a letter to Duhem of 29 January 1902, said that the journal 'est peu répandu en dehors des milieux ecclésiastiques' and added, 'je ne crois pas exact que la *Revue* soit beaucoup lue dans les milieux non cléricaux.'¹⁶⁸

Hélène Duhem, in her biography of her father, describes the foundation of the *Revue de philosophie* in picturesque terms:

Il [Duhem] retrouverait encore à la cure de Pradelles-Cabardès [près de

¹⁶⁶ Letter from Peillaube to Duhem, 8 July 1900, in ArchAcSci, *fonds* Duhem.

¹⁶⁷ In ArchICP, *fonds* Peillaube, P37.

¹⁶⁸ Letter from Pautonnier to Duhem, 29 January 1902, in ArchAcSci, *fonds* Duhem.

Cabrespine] deux professeurs de l'Institut catholique de Paris, le P. Bulliot et le P. Peillaube; et ce fut là, qu'avec eux, sous les ombrages centenaires d'un bois de hêtres, fut conçue et élaborée la fondation de la *Revue de philosophie*, dont le P. Peillaube fut le directeur.¹⁶⁹

Peillaube recounts much the same story on the occasion of the journal's thirtieth anniversary, but notes that instead of Bulliot the third person was the Abbé Victor Bernies, the pastor of Pradelles-Cabardès. He also adds that the friends were slightly under the influence of a good wine: "Si nous la fondions!", s'écria Duhem,..."Je viens de terminer", ajouta-t-il, "un volume sur le *Mixte*, je vous donne mon manuscrit".¹⁷⁰

After returning to Paris, Peillaube wrote to Duhem to report on the new journal: 'Je ne vous dirai jamais assez combien je vous suis reconnaissant de l'appui que vous m'avez donné. Votre nom m'a été très utile auprès des collaborateurs, auprès de l'éditeur, auprès de tout le monde. Vos articles me seront plus utiles encore.' In the same letter, Peillaube mentioned that he already had 150 subscriptions and that each day 3 or 4 new ones were coming in. He also managed to secure the collaboration of Dr Baltus, who would write about neurology, Paul Tannery, the historian of science, and even a promise of collaboration from Maurice Blondel.¹⁷¹

Peillaube was looking for collaborators from many different disciplines. The stated aim of the *Revue* was to work towards a unification of knowledge:

La *Revue de philosophie* estime que les sciences spéciales sont reliées entre elles par des caractères communs et que de plus elles sont en continuité d'objet avec la métaphysique.¹⁷²

¹⁶⁹ Hélène Duhem, *Un savant français*, p. 105.

¹⁷⁰ Peillaube's reminiscences at 30th anniversary dinner, *RevPhil*, new series, 2 (1931), p. 12.

¹⁷¹ Letter from Peillaube to Duhem, 21 October 1900, in ArchAcSci, *fonds Duhem*.

¹⁷² *RevPhil*, 1 (1900), 1-2 (p. 1).

The initial editorial went on to say that 'l'objet des sciences et l'objet de la métaphysique ne représentent pas des réalités séparées. Ce sont deux aspects, deux points de vue de la même réalité.' Hence, 'la *Revue de philosophie* se propose-t-elle de faire entrer en collaboration savants et philosophes: aux premiers, elle demande d'apporter des données positives; aux seconds, de tenir compte de ces données dans la spéculation. Cette *méthode de travail* mène à un but: *la synthèse ou l'unification du savoir*.' Peillaube, like many of his contemporaries, was hoping for philosophy to have a scientific character. He thought he knew exactly how to ensure this in the new journal: 'il semble qu'Aristote ait circonscrit le chantier sur lequel doit s'élever l'édifice de nos connaissances, et tracé d'une main sûre les contours les plus généraux de cet édifice.'

Beretta has pointed out that the program of the *Revue* makes no mention of the doctrine of Saint Thomas nor of scholastic philosophy in general, and that even its allegiance to Aristotle is minimal.¹⁷³ This position is corroborated in a letter written in January 1902 from Émile Beurlier to Pautonnier, which Pautonnier passed on to Duhem:

Le programme de cette Revue a été conçu d'une façon large et qui me plaît. Il s'agit d'une part de combattre cette philosophie absurdemment subjectiviste qui nous est venue d'Allemagne et dont Kant est le patriarche. Il s'agit d'autre part de ramener la philosophie dans la vraie voie et d'en faire autant que possible une spéculation qui s'appuie sur le réel. On prétend se mettre à l'école des illustres *objectivistes*: Platon, Aristote, St Thomas d'Aquin etc. La Revue vous le voyez n'a pas pour but unique et particulier une restauration du *thomisme, quand même*. Dans une réunion intime, tenue au nouvel an le D^r Peillaube a insisté sur ce point, savoir qu'il n'entend pas faire de sa Revue un organe en vue de la restauration de la philosophie [scolastique]. Il est convaincu que les faits bien interprétés permettront de relever plus d'une doctrine du Stagirite, mais tant pis pour les théories du Philosophe qui sont en contradiction avec les progrès réels et les découvertes de la philosophie moderne. Il se [défend] de vouloir resusciter la philosophie scolastique à

¹⁷³ Beretta, 'La *Revue Thomiste*', pp. 29-30.

toute force.

Yet the journal tried to keep up a public image of being scholastic, as may be gathered from an editorial reflection written in 1911 to commemorate the tenth anniversary of the *Revue*:

L'esprit de la *Revue de philosophie* est toujours le même depuis sa fondation. Ce n'est ni le pragmatisme, ni l'intellectualisme, l'un et l'autre, trop étroits et trop superficiels, n'ayant pas été modelés sur l'expérience et sur le réel; mais le péripatétisme, convaincus que nous sommes que la tradition philosophique aristotélicienne et thomiste compose l'atmosphère métaphysique naturelle des sciences de la nature et des sciences de l'esprit.¹⁷⁴

In practice, the *Revue* was more open to diverse viewpoints than the editorial suggests. When Maurice Blondel wrote to Peillaube to complain that his thought has been misrepresented by a contributor to the *Revue*, Peillaube replied:

La revue n'est pas l'organe d'un *parti philosophique* comme d'autres sont l'organe, par exemple, d'un *parti apologétique*. J'ai un très vif répugnance pour tous ces partis, qui me vient peut-être des méthodes psychologiques. Voilà pourquoi, sans être hégélien, je publie des articles qui ne s'accordent pas entre eux [...] je suis prêt à publier tout ce que vous voudrez.¹⁷⁵

Peillaube did, however, try to control editorial policy. Two instances of interest to the present thesis can be cited. The first is an undated memo from Peillaube to Bulliot concerning an article by Alex Verronet:

Ayez donc la bonté de lui retourner son manuscrit et de lui expliquer ce retard. Vous pouvez lui dire qu'il serait bien aimable de nous le garder pour plus tard, en lui indiquant les rétouches à faire concernant Duhem. En toute hypothèse, ce manuscrit devra attendre assez longtemps, ainsi que tout manuscrit, quel qu'il soit, vu un sujet à propos duquel nous avons presque refusé un article de M. de Lapparent. Ces questions personnelles sont très graves.¹⁷⁶

The article in question was most probably de Lapparent's 'A propos des hypothèses

¹⁷⁴ *RevPhil*, 18 (1911), p. 5.

¹⁷⁵ Peillaube, quoted in Colin, 'La faculté de philosophie', p. 311.

¹⁷⁶ In the Archives of the Society of Mary, *fonds* Bulliot.

moléculaires' (1902) in which he expressed the hope that Duhem would use his brilliant mind to correct atomic theory so that he would not need to criticize it.¹⁷⁷

Peillaube was clearly worried about offending Duhem by publishing another paper which argued for the reality of molecular models. An article by Véronnet on 'La matière, les ions, les électrons' appeared only in 1909.

The other article that made Peillaube nervous was one of Duhem's papers in the history of science. In a letter of 20 March 1914, Peillaube wrote to Duhem:

Le P. Sérol me signale une phrase dans votre dernier article qui nous gêne beaucoup. Vous dites, paraît-il, que dans la question du temps, comme dans toutes les autres, on trouve un antagonisme entre la doctrine Catholique et la philosophie péripatéticienne. Vous seriez bien aimable de donner un correctif à cette phrase qui, présentée sous cette forme absolue nous attirerait des ennuis. S'il s'agit de la question d'Averroës, pas de difficulté; s'il s'agit de la question du temps et de plusieurs autres questions, pas de difficulté non plus. Vous nous rendez service en atténuant cette phrase ou en la supprimant; je m'en rapporte à vous, vous voyez ce que je désire.¹⁷⁸

Peillaube had to be careful in dealing with Duhem because the *Revue* owed much to him and because he continued to hope for more articles. Duhem had contributed many articles to the *Revue* other than the 'Notion de mixte' which appeared in the very first issue of the journal in December 1900. The *Revue* carried Duhem's *Théorie physique* in instalments during 1904 and 1905 before it was published in 1906 as the first volume of the *Bibliothèque de philosophie expérimentale*, which was another of Peillaube's projects, closely tied to the *Revue*. Duhem published other major articles in the *Revue*, such as his 'Le mouvement absolu et le mouvement relatif' (1908-9) and 'Le temps et le mouvement selon les scolastiques' (1913-14), as well as shorter articles. It would be interesting to know exactly when

¹⁷⁷ Albert de Lapparent, 'A propos des hypothèses moléculaires', *RevPhil*, 2 (1901/2), 201-11 (p. 211).

¹⁷⁸ Letter from Peillaube to Duhem, 20 March 1914, in ArchAcSci, fonds Duhem.

Duhem had submitted 'Le temps et le mouvement selon les scolastiques' to the *Revue*, for in 1913, on the occasion of the suppression of the *Annales de philosophie chrétienne*, Duhem wrote to his daughter:

Tu sais que depuis bien des années je soupçonne les agissements de la bande Peillaube-Bulliot. S'ils n'ont pas provoqué la condamnation, je sais bien, en tout cas, qu'ils en sont fort heureux. En tout cas, je leur avais promis un article; ils ne l'auront pas.¹⁷⁹

Busy with his *Système du monde*, Duhem did not publish any articles which would have been appropriate for the *Revue de philosophie* in the two years between 1914 and his death in 1916. And it is only fair to mention that at no time did Duhem view the *Revue* as his only publisher. For example, he had earlier given the *Annales de philosophie chrétienne* his 'Sozein ta phainomena' and his 'Physique de croyant'. Moreover, the *Revue* ceased to publish between 1915 and 1919. Whatever feelings Duhem may have had towards Peillaube and Bulliot did not cause a permanent rupture. In fact, the letters from Bulliot show no souring of relations.

The last issue of the *Revue* appeared in 1941, eleven years after Peillaube's death. The journal saw some financial difficulties in the early years with the bankruptcy of its first publisher, Naud, in 1904. But the number of its subscribers was sufficiently large to keep it going. In 1908, the actual number of subscribers was 280, although Peillaube was hoping to get more and was negotiating with the Beauchesne publishing house to get volume discounts from 450 to 500 and then from 501 to 600.¹⁸⁰ The number of actual subscribers of the *Revue de philosophie* was comparable to the number of subscribers of Louvain's *Revue neo-scolastique de philosophie*. The journal also had a large number of contributors from diverse

¹⁷⁹ Letter from Duhem to his daughter, 19 May 1913, in *Lettres*, p. 112.

¹⁸⁰ Letter from Gabriel Beauchesne to Msgr Baudrillart, 26 August 1908 and letter from Peillaube to Gabriel Beauchesne, 20 July 1908, both in ArchICP, *fonds* Peillaube, P37.

backgrounds: priests and philosophers from the Institut catholique such as Peillaube and Bulliot; and scientists such as Duhem, de Lapparent, Véronnet, and d'Adhémar.

One other significant contributor should be mentioned: Jacques Maritain.

Maritain came to philosophy after having studied biology. He was rescued from the despair of positivism by the philosophy of Henri Bergson; but after he was converted to Catholicism and became a disciple of Saint Thomas, he severely criticized Bergson's metaphysics which emphasized becoming over being. Maritain is best known in the philosophy of science for his *Distinguer pour unir* (1932), but many of his ideas about the meaning of physical science are already present in his article 'La science moderne et la raison' which appeared in the *Revue de philosophie* in 1910. Niall Martin and Stanley Jaki are probably correct in saying that Maritain never bothered to read much of Duhem.¹⁸¹ Nevertheless, the ideas of the two men are in places very similar, as readers of the *Revue* could easily see. This similarity will be discussed further in chapter 5.7.

6. *Revue thomiste*

The *Revue de philosophie* was not the first explicitly scholastic journal to be founded in France. In 1893, the Dominicans of three Francophone centres – Fribourg, Paris, and Toulouse – began to publish the *Revue thomiste*.¹⁸² The first issue unveiled the journal's programme:

Le but à atteindre est celui-ci: aider la science à demeurer ou à redevenir chrétienne, aider les savants à rester ou à devenir croyants: contribuer pour une part, si modeste qu'elle soit, à procurer aux esprits cultivés de notre temps la possession plus certaine et plus large du bien précieux entre

¹⁸¹ Martin, *Pierre Duhem*, p. 204; and Jaki, 'Maritain and Science', *New Scholasticism*, 58 (1984), 267-92 (p. 279). Jaki says that Maritain was 'fairly familiar' with Duhem's work, but not enough to accuse Duhem unjustly of being insufficiently realist.

¹⁸² For a history of the *RevThom*, see Henry Donneaud, 'Les cinquante premières années de la *Revue Thomiste*', *RevThom*, 113 (1993), 5-25, 'Les origines fribourgeoises de la *Revue Thomiste*', *Mémoire dominicaine*, 5 (1994), 43-60. See also Francesco Beretta, 'La *Revue Thomiste*'.

tous: la Vérité, la Vérité sur les réalités les plus hautes, la Vérité telle que la donnent la Science et la Foi réunies.¹⁸³

Science in this context includes history, scriptural studies, philosophy, and many other learned pursuits, as well as the natural sciences. The motto of the journal – *Vetera novis augere* (to augment the old by the new) – announced that the *Revue thomiste* was not going to be stuck in the Middle Ages. An earlier suggestion that the journal be called *Le néo-thomisme* was rejected for fear of being misconstrued as depreciating the teachings of Thomas.¹⁸⁴ But the *Revue* was determined to be part of the contemporary intellectual landscape.

The *Revue thomiste* was not always faithful to this last ambition. At the onset of the modernist crisis, for example, the journal adopted a reactionary position. In 1905, the secretariat was moved from Paris to Toulouse; and Thomas Pègues (1866-1936), ‘esprit étroit et autoritaire’, effectively directed editorial policy against ‘L’hérésie du renouvellement’. This stance cost the *Revue* both prestige and readers. Even other Dominicans ceased to collaborate with the journal. The theologians from Le Saulchoir, who went into exile to Kain in Belgium in 1903, decided instead to found their own journal, the *Revue des sciences philosophiques et théologiques* which first appeared in 1907, although some of them, such as Ambroise Gardeil and Pierre Mandonnet, had been among the founders of the *Revue thomiste*.¹⁸⁵ Yet even with this decline in the fortunes of the *Revue thomiste*, it maintained a larger number of subscribers than the *Revue de philosophie*. As early as July 1893, it had 430 subscribers; and by November 1894 it had 760.¹⁸⁶ These fell off to about 350 just

¹⁸³ *RevThom*, 1 (1893), p. 2.

¹⁸⁴ Donneaud, ‘Les origines’, p. 54.

¹⁸⁵ Donneaud, ‘Les cinquante’, pp. 9-10.

¹⁸⁶ Donneaud, ‘Les origines’, p. 55.

before the First World War.¹⁸⁷

Several contributors had important insights into modern physical science.

There was, first of all, Ambroise Gardeil (1859-1931) whose business skills in Paris managed to get the *Revue* into print in 1893.¹⁸⁸ Gardeil was not a scientist but was very much interested in the meaning of physical science and even hoped to master the subject in order to philosophize about it. In a letter to Duhem, he asked for guidance in selecting a good textbook, but he later admitted that he had yet to find the time to apply himself to the task in earnest.¹⁸⁹ Gardeil first met Duhem at the Brussels conference in 1894, wrote favourably about Duhem's controversial intervention, and then kept up a correspondence with him over a period of twenty years, albeit with some large gaps. These letters will be of special importance to the present thesis and will be often quoted. Réginald Garrigou-Lagrange (1877-1964), the most illustrious of Gardeil's students, in a necrology of his master, wrote:

Parmi les théologiens thomistes des cinquante dernières années, il en est peu qui aient exercé une influence aussi profonde que la sienne. Par son enseignement et ses directives intellectuelles comme Régent des études de la province dominicaine de Paris, il forma de nombreux professeurs de philosophie et de théologie, qui, en différents centres, continuent de suivre la direction qu'il leur a donnée.¹⁹⁰

Garrigou-Lagrange did not collaborate on the *Revue thomiste* in its first decade, which is the period of most interest to the present study. But he went on to give the journal its dominant tone for many years beginning in about 1910. The historian Donneaud describes him and another collaborator Édouard Hugon as 'esprits

¹⁸⁷ Donneaud, 'Les cinquante', p. 15.

¹⁸⁸ Donneaud, 'Les origines', p. 55.

¹⁸⁹ 'Je suis tellement occupé par la besogne journalière que j'ai remis à plus tard le projet de me mettre aux sciences spéciales sur lequel je vous ai consulté.' Undated letter from Gardeil to Duhem, written from Flavigny, in ArchAcSci, *fonds Duhem*.

¹⁹⁰ Réginald Garrigou-Lagrange, 'In memoriam: Le Père A. Gardeil', *RevThom*, 36 (1931), 797-808 (p. 797).

rigoureux et spéculatifs qui servirent avec profit la tradition thomiste mais, surtout pour ce dernier [Garrigou-Lagrange], peu capables de l'ouvrir aux difficultés contemporaines'.¹⁹¹ The truth of this assertion will become evident in chapter 4.3.C, upon examination of his correspondence with Duhem about the significance of the law of inertia to the first of Thomas's five ways.

A much closer friend of both Gardeil and Duhem was the Dominican Bernard Lacome (1856-1947). Lacome knew Duhem personally from the time that both men lived in Lille. When Duhem was attacked by Vicaire for being a skeptic about metaphysics, Lacome came to his aid with a long article spread out over the first two volumes of the *Revue thomiste*, 'Théories physiques: A propos d'une discussion entre savants', which will be analyzed in chapter 5.1. Furthermore, he kept up a correspondence with Duhem for over twenty years. Twenty-four of Lacome's letters are extant, but the handwriting is so messy that they may as well be lost. The scrawlings are, however, tantalizing because Lacome was held in great respect by both Duhem and Gardeil. In a letter to Gardeil in which Duhem revealed his exasperation with both sides in the modernist controversy, he wrote:

Notre cher P. Lacome pourrait, me semble-t-il, faire beaucoup pour la synthèse qui me paraît souhaitable car il a à la fois l'intelligence approfondie de la vieille scolastique et la claire vision des tendances modernes.¹⁹²

The writers for the *Revue thomiste* who had more explicit scientific credentials were the layman Bernard Brunhes (1867-1910) and the Dominican René Hedde (1877-1932). Brunhes is one of the few who used the familiar *tu* in his letters to Duhem. Although Duhem was a bit older, their years at the *École normale*

¹⁹¹ Donneaud, 'Les cinquante', p. 12.

¹⁹² Letter from Duhem to Gardeil, 15 Sep [1913?], in ArchAcSci, *fonds* Duhem.

overlapped, and they were both among the *talas* or practising Catholics.¹⁹³ One of Brunhes's brothers, Gabriel, was the Bishop of Montpellier; and another, Jean, encouraged Thomas Coconnier (1846-1908) to found the *Revue thomiste*: 'J'ai parlé à mon frère et à mon ami de votre projet de revue. Ils acceptent l'un et l'autre très volontiers l'honneur de collaborer à cet grand oeuvre. Mon frère est tout prêt à rédiger le *Bulletin des sciences mathématiques et physiques*.'¹⁹⁴ When the *Revue* was finally launched in 1893, Bernard Brunhes contributed the 'Revue des sciences physico-chimiques', but he did so under the pseudonym J. Franck. He had just finished his doctoral thesis on reflection within crystals and was looking for a job at a state university as his letters to Duhem indicate. It would not have been prudent for him to advertise his Catholic convictions at the time. He finally got a post at Clermont-Ferrand where he took an interest in weather and geological magnetism and began efforts to reforest the Puy-de-Dome. He is best known for his book *Dégradation de l'énergie* (1909), which has recently been reprinted by Flammarion with a preface by the French physicist Georges Lochak. According to Lochak, Louis de Broglie was deeply influenced by this book in his youth, and sixty years after its publication lent his copy to Lochak to read. Brunhes's ideas on the degradation of energy were often cited in contemporary discussion about human freedom in the light of the principle of conservation of energy.

Brunhes's collaboration with the *Revue thomiste* did not last beyond 1897.

Despite his philosophical interests, he seems to have been much more of a scientist than a philosopher, as Duhem was quick to note in a letter to Gardeil:

Je ne sais si mon ami Brunhes partage entièrement ces idées; je le crois beaucoup moins scolastique que moi et beaucoup plus porté à dédaigner la

¹⁹³ On 'talas', see Jaki, *Uneasy Genius*, p. 56.

¹⁹⁴ Jean Brunhes, quoted in Donneaud, 'Les origines', p. 51.

méthode métaphysique; je ne m'étonne donc pas que dans des comptes rendus de la Revue Thomiste, il se montre plus savant que philosophe.¹⁹⁵

René Hedde (1877-1932) published his first article in the *Revue thomiste* in 1904: 'Relations des sciences profanes avec la philosophie et la théologie'. He studied science at the Collège Stanislas from 1893 to 1895 and went on to become 'Licencié ès sciences'. He entered the Lyon Province of the Dominican order in 1895 and was ordained to the priesthood in 1901. He began to teach at the University of Fribourg in 1908 before transferring to the Institut catholique de Lyon in 1911. Most of the articles which Hedde wrote for the *Revue thomiste* were book reviews of works ranging from Duhem's *Théorie physique* to *Les martyrologes du Moyen Age*, although the emphasis was on scientific works. His original articles include 'Les deux principes de la thermodynamique' and two contributions entitled 'Chronique de cosmologie'. Five of Hedde's letters to Duhem written between 1904 and 1913 survive. They deal explicitly with questions of scholastic philosophy and testify to the acceptance of Duhem's ideas among at least some neo-Thomists. In 1909, Hedde wrote: 'J'ai constaté avec plaisir combien mes collègues de Fribourg sont sympathiques et suivent de près vos différents travaux.'¹⁹⁶

One more collaborator needs to be introduced, the Dominican Marc-Marie de Munnynck (1871-1945) of the Belgian province, who studied chemistry in Louvain under Henry.¹⁹⁷ His first article for the *Revue thomiste* was 'La conservation de l'énergie et la liberté morale' which appeared in 1897. This was a topic to which de Munnynck returned on several occasions in the pages of the *Revue*, in a separate

¹⁹⁵ Letter from Duhem to Gardeil, 4 December 1896, in ArchSaulchoir.

¹⁹⁶ Letter from Hedde to Duhem, 4 January 1909, in ArchAcSci, *fonds* Duhem.

¹⁹⁷ Marc de Munnynck, 'Notes sur l'atomisme et l'hylémorphisme' *RevThom*, 5 (1897), 585-97 (p. 586).

pamphlet in the series *Science et Religion – Études pour le temps présent*, and later in the *Revue néo-scholastique* to which he had switched allegiance in 1899, much to the consternation of Gardeil.¹⁹⁸ Yet de Munnynck was not a man of only one idea. The second article he contributed to the *Revue thomiste* was ‘Notes sur l’atomisme et l’hylémorphisme’ which was a hotly debated topic among neo-Thomists especially at the International Catholic Scientific Congresses where de Munnynck had originally delivered the paper. In 1905, de Munnynck became a professor of psychology and cosmology at Fribourg and hence for a while was one of Hedde’s colleagues, perhaps one of those who followed Duhem’s work with sympathy and interest.

7. International Catholic Scientific Congresses

Reporting on the Brussels Conference of 1894 for the *Catholic University Bulletin*, Thomas Shahan wrote that ‘the future historian of the nineteenth century will put down among the novelties of Catholic life the numerous congresses that succeed one another with ever greater frequency.’¹⁹⁹ ‘Some of these congresses’, he continued, ‘are general in their scope, embracing all Catholic interests [...] Others again narrow their attention to a specific province of Catholic life [...] Of the latter kind are the eucharistic, social, and scientific congresses which have attracted public attention within the last few decades.’²⁰⁰ The congresses, Shahan argued, became the means of free association which Universities, guilds, and civic meetings and festivities had provided in the past when European society as a whole professed Catholicism. Now that Catholics in many European countries had to hide their Catholicism in order to

¹⁹⁸ Beretta, ‘La Revue Thomiste’, p. 37.

¹⁹⁹ Thomas J. Shahan, ‘The Catholic Congress at Brussels’, *Catholic University [of America] Bulletin*, 1 (1895), 73-85 (p. 73).

²⁰⁰ Shahan, ‘The Catholic Congress’, p. 74.

be accepted at the Universities and in the civil service, it was important for them to find other venues to meet for intellectual and moral support.

The International Catholic Scientific Congresses were part of the widespread phenomena which Shahan noted. In fact, the decision to organize such congresses was made at the second Congress of the Catholics of Normandy, which met in Rouen in December 1885.²⁰¹ Msgr Marc-Antoine-François Duilhé de Saint-Projet (1822-1897), who was at the time a professor of apologetics at the Institut catholique de Toulouse, is credited with the idea of a congress for Catholics which would be devoted to science. He was perhaps 'le premier théologien qui travailla à accorder les sciences expérimentales, telles qu'elles sont pratiquées maintenant, avec la théologie, c'est à dire avec les dogmes révélées'.²⁰² Many Catholics wrote to thank him for making the actual state of science known to them through his immensely popular *Apologie scientifique du christianisme* (1877), and suggested that a congress might be a good way of giving his ideas even greater publicity.²⁰³ De Broglie invited de Saint-Projet and d'Hulst to consider the possibility of adding a session on apologetics to the Rouen Congress. They discussed the proposal at some length, including the possibility of widening the topic beyond mere apologetics to science in general. D'Hulst then tried the idea out on various 'savants' at Louvain who responded with enthusiasm. He returned to Rouen on the last day of the Congress to find himself already elected president of the proposed 'Congrès international des

²⁰¹ 'Congrès international des savants catholiques en avril 1887: circulaire de la commission d'organisation', *AnnPhilChr*, 111 (1885/6), 401-7 (p. 401). The history of the Congresses may be found in Alfred Baudrillart, *Vie de Mgr d'Hulst*, I, chapter 17 [530(?)-562(?)]. For a shorter account see Minois, *L'église et la science*, II, pp. 250-8.

²⁰² Obituary, *AnnPhilChr*, 134 (1897), 469-71.

²⁰³ Baudrillart, *Vie de Mgr d'Hulst*, I, p. 530.

savants catholiques'.²⁰⁴ (The name was eventually changed to the 'Congrès scientifique international des catholiques' because some Catholics who were not 'savants' nevertheless wanted to attend.)²⁰⁵

The Rouen Congress called for the first Scientific Congress to take place in Easter week in 1887, but this early date proved to be too optimistic. More time was needed, first of all, to secure a sufficient number of papers to be read at the Congress. The anti-religious press quickly discovered this problem and delighted in writing about the inherent contradictions of Catholics doing science. But the organizers of the Congress were more worried by Catholic opposition to the gathering.²⁰⁶ Some of the topics, such as the origin of man, would border on dogma. Would Rome tolerate a parallel magisterium of scientists? The explicit repudiation by the Vatican of a meeting of scholars in Munich in 1863 did not bode well for the proposed Congress. The ultramontane newspaper *L'Univers* voiced its opposition to the Congress and many bishops were reluctant to give it support.²⁰⁷ In this period of uncertainty, some Catholic scientists at secular universities began to withdraw their support for fear of the government and to avoid being ostracized by their colleagues. Even the support of five curia cardinals and the theologian Cardinal Newman was not sufficient to guarantee that the Congress would take place.

A direct appeal to Rome was necessary. D'Hulst was at first wary of this approach because he thought that the Vatican tended to favour a narrow interpretation of science but that it remained silent for fear of starting another Galileo affair. He was, however, greatly encouraged by his personal audience with

²⁰⁴ Beretta, *Monseigneur d'Hulst*, p. 303.

²⁰⁵ Baudrillart, *Vie de Mgr d'Hulst*, I, p. 531.

²⁰⁶ Baudrillart, *Vie de Mgr d'Hulst*, I, p. 534.

²⁰⁷ Baudrillart, *Vie de Mgr d'Hulst*, I, p. 535.

Leo XIII. On 27 January 1887, he reported to Msgr Richard, the Archbishop of Paris, who had earlier visited the Vatican to gain support for the Congress:

J'ai eu l'audience du Saint-Père dès Mardi. J'ai présenté votre lettre et mon mémoire. Le Pape m'a invité à lui résumer *viva voce* le contenu. A mesure que j'avançais dans mon explication, il paraissait plus satisfait. A la fin, il a levé les bras et a dit avec feu: mais c'est une grande chose pour la gloire de Dieu.²⁰⁸

D'Hulst's memorandum explained that the purpose of the Congresses – which he hoped would take place every four or five years – was to inform apologists and theologians about the actual state of science, to help them distinguish results from questionable assumptions and from conclusions that were based more on prejudice than on observations. The report then outlined the precautions that would be taken to ensure orthodoxy. All papers to be presented at the Congress would have to be submitted well in advance so that they could be read by scientists and, if need be, by theologians. Discussion periods would be restricted to questions formulated in advance. Each of the session presidents was trustworthy and would put a stop to debates that transgressed the preset boundaries. On 20 May 1887, the Pope gave his approval: 'L'entreprise est par elle-même louable et vous fait honneur; elle peut aussi être féconde en heureux résultats tant pour l'honneur bien entendu des sciences que pour la défense de la foi.'²⁰⁹ Nevertheless, the Pope reminded d'Hulst to be careful: 'Même dans les questions qui auraient quelque connexité avec la théologie proprement dite, chacun devra rester dans son rôle de physicien, d'historien, de mathématicien ou de critique, sans jamais usurper le rôle propre au théologien.'²¹⁰

After the Pope had given his blessing to the Congresses, many bishops quickly

²⁰⁸ D'Hulst, in Beretta, *Monseigneur d'Hulst*, p. 311.

²⁰⁹ Leo XIII, in Beretta, *Monseigneur d'Hulst*, p. 318.

²¹⁰ Leo XIII, in Beretta, *Monseigneur d'Hulst*, p. 319.

followed suit. The one significant exception was Cardinal Pitra, a supporter Moigno's understanding of Catholic science, who wrote a letter to d'Hulst on 28 February 1888 to remind him that his silence to date must not be construed as tacit approval. The number of those who paid their dues went up dramatically to over 1,600 by the time the first Congress met in Paris in April 1888. The historian George Minois reports that the level of discussion was not very high. The congressists easily upheld the positions favoured by the Vatican – Mosaic authorship of the Pentateuch, rejection of evolution as a 'gratuitous hypothesis', and praise for the philosophy of Saint Thomas. In his report, d'Hulst acknowledged that there were not many works in mathematics, physics, and chemistry 'par suite des difficultés et des hésitations que nous avons rencontrées'.²¹¹ The one significant exception was Bulliot's attempt to argue for hylomorphism in light of modern physics and chemistry in his paper 'L'unité des forces physiques au point de vue philosophique et scientifique'. With the fears of the conservative factions thus calmed, it became much easier to organize the second Congress, which took place in Paris in April 1891. This time there were 2,494 registered (which included many who signed up without attending), and 122 papers were presented. The published proceedings ran to eight volumes.

The third Congress took place in Brussels in September 1894. This was as great a step towards making the Congress international as its organizers dared to take. (A suggestion that this Congress be moved to Munich was judged premature.)²¹² The number of registrants went up to 2,500 and the number of papers to 160. The level of discussion was also raised. For the first time, 'de jeunes et

²¹¹ Minois, *L'église et la science*, p. 253.

²¹² Baudrillart, *Vie de Mgr d'Hulst*, 1, p. 550.

distingués professeurs des Facultés de l'État, plusieurs membres de l'Institut [de France], n'avaient pas craint [...] de mêler leurs noms à ceux des maîtres de nos Universités catholiques et des membres du clergé'.²¹³ Among the young professors was Duhem, whose intervention in a debate about the relationship between physics and metaphysics became the talk of the Congress. Duhem's remarks, no doubt, contributed to the 'l'essor plus libre que prirent les discussions surtout philosophiques'. In Brussels, Baudrillart reported, 'commencèrent à se faire jour sur la certitude scientifique et sur la certitude morale les théories qui devaient s'épanouir quelques années plus tard et provoquer de si ardentes contradictions'. Conservative Catholic newspapers such as *Verité* feared such ideas, but Duhem's victim Bulliot thought that free debates were essential to a congress and rebuked the *Verité*.²¹⁴

The fourth congress took place in Fribourg, Switzerland, in August 1897. Two hundred papers were presented. For the first time, the Congress took on an international flavour. The French and Belgians between them accounted for only 1,153 of over 3,000 registrants. Switzerland, Spain, and Germany each accounted for approximately 400. There were 170 from Italy; 144 from Holland; 96 from Hungary; 93 from the United Kingdom; 57 from Austria; and 29 from as far away as North America. An interesting debate about hylomorphism took place at this congress as a result of de Munynck's work on the subject (see chapter 3.3).²¹⁵ And André de la Barre (1855-1933) presented a paper, 'Points de départ scientifiques et connexions logiques en physique et en métaphysique', in which 'le savant et aimable jésuite suit pas à pas les articles devenus fameux, que M. Duhem a publiés dans la *Revue des*

²¹³ Baudrillart, *Vie de Mgr d'Hulst*, I, p. 551.

²¹⁴ Baudrillart, *Vie de Mgr d'Hulst*, I, 552.

²¹⁵ Réginald Schlincker, 'Les sciences philosophiques au congrès catholique de Fribourg', *RevThom*, 5 (1897), 551-68 (pp. 554-7).

Questions scientifiques de Bruxelles' (see chapter 5.4).²¹⁶ Duhem, however, was not there to take part in the ensuing discussions. Gardeil had hoped that Duhem would come, but Duhem thought it best to stay at home:

Je ne pense pas aller à Fribourg; l'expérience m'a montré que les congrès n'étaient guère mon affaire; j'ai envoyé mon adhésion je tacherai d'envoyer un travail *purement scientifique*, mais je crois que ma personne serait de trop. Mieux vaut que d'autres que moi et plus autorisés, continuent à faire tinter le grelot que j'ai attaché à Bruxelles.²¹⁷

The fifth congress finally took place on German soil, in Munich, in September 1900. Although de Lapparent was made president of the Congress, many of the usual French contingent stayed at home. Despite the chauvinism, the Congress turned out to be the biggest ever, with nearly 3,400 registrants and 260 works.

Plans were made for a sixth congress which was to meet in Rome in 1903. But it turned out that no future congresses took place. Leo XIII died in July 1903. Pius X made it his mission to stamp out modernism in the Church with its attacks on the Divine inspiration of the Bible. And there was good reason to suspect that the Congresses were means of popularizing modernist views. Already in Fribourg, the modernist Loisy had gained many supporters for his exegetical views.²¹⁸ After one session on the subject, two young priests and an Italian religious linked arms and intoned the 'La Marseillaise'.²¹⁹ The conservatives were understandably disturbed. The souring of relations between the Combes government in France and the Vatican provided a further reason for the cancellation of the Congress in Rome. Minois says

²¹⁶ Marc de Munynck, 'La section de philosophie au congrès de Fribourg', *Revue néo-scolastique*, 4 (1897), 333-7 (p. 333).

²¹⁷ Letter from Duhem to Gardeil, 4 December 1896, in ArchSaulchoir. Gardeil had written to Duhem on 1 December 1896 (in ArchAcSci, *fonds* Duhem): 'J'espère bien vous rencontrer à Fribourg. Nous y soutiendrons les bons combats.'

²¹⁸ Baudrillart, *Vie de Mgr d'Hulst*, I, p. 560.

²¹⁹ Baudrillart, *Vie de Mgr d'Hulst*, I, p. 561.

that 'le temps de la conciliation avec les sciences modernes était terminé; la porte, timidement entrouverte par Léon XIII sur le monde moderne, était claquée et verrouillée à double tour par le nouveau pontife.'²²⁰ But that is a bit too sweeping. As Minois himself acknowledges, the science in question was biblical exegesis.

Throughout the brief existence of the Congresses, there was persistent questioning of their purpose. D'Hulst had given two answers to the question in his report to Pope Leo XIII: (1) to bring Catholic scientists together for mutual support and (2) to enable them to instruct theologians about the current state of scientific knowledge.²²¹ De Lapparent, in his opening speech as president of the Congress in Munich, gave further reasons: 'révéler l'existence d'une force scientifique dans le sein de l'Église, [et] montrer que les catholiques n'ont pas peur de la science.'²²² The tactic had some success. In 1902, the (non-Catholic) philosopher Georges Sorel wrote that 'la science catholique a fait ses preuves et il faut prendre garde à ne pas l'attaquer sans être parfaitement certain d'apporter des démonstrations incontestables'.²²³ This was a far cry from the popular wisdom of the 1880s which portrayed faith and science as inherently incompatible.

There is no need to elaborate here on the main persons associated with the Congresses, at least as concerns its sections on physics and philosophy, because they have all been introduced before. The members of the organizing committee for the first Congress were stalwarts of Parisian neo-Thomism such as d'Hulst, de Broglie, Guieau, Ferrand, de Lapparent, and Domet de Vorges as well as neo-Thomists from

²²⁰ Minois, *L'église et la science*, p. 258.

²²¹ Beretta, *Monseigneur d'Hulst*, p. 305.

²²² As reported by F.H.A. Montagne, 'La philosophie au congrès scientifique international de Munich', *RevThom*, 8 (1900), 592-4 (p. 592).

²²³ Georges Sorel, 'La crise de la pensée catholique', *Revue de métaphysique et de morale*, 10 (1902), 523-51 (p. 524).

the provinces and abroad such as Duilhé de Saint-Projet, Gilbert, Mansion, Mercier, and Van Weddingen. Familiar too are the names of some of the presenters of papers dealing with the interpretation of physics such as Farges, Bulliot, and de Munnynck. The Congresses were a means of bringing together just about everyone who tried to understand science from a Thomist perspective.

8. Pierre Duhem: at the centre of neo-Thomist debates

It should by now be clear that Duhem interacted in significant ways with every one of the important centers of neo-Thomist thought in France and Belgium which tried to address questions arising from modern science. At the Brussels Scientific Society, he was of one mind with the secretary general Mansion; and his early essays on the philosophy of science gave a new direction to the Society. In Louvain, his approach to physics – energetics or generalized thermodynamics – was favoured by Nys, and his thought was analyzed in several doctoral theses. Whatever hesitations there were about some of his positions, they did not stop the University from awarding him an honorary doctorate in physics in 1908. In Paris, Duhem was in contact with Bulliot and Peillaube who were members of the Institut catholique and the Society of Saint Thomas. Even if certain elements within the Society found his ideas objectionable, they could not deny his importance; and some even rose to his defense. Duhem was a founder, albeit not officially, of the *Revue de philosophie* and continued to influence editorial policy for a number of years. His friendship with Gardeil and Lacombe of the *Revue thomiste* put him in touch with Dominican efforts to renew the thought of Saint Thomas; and their mutual correspondence dealt with the question of the role of science. Although Duhem attended only one International Catholic Scientific Congress, his presence was felt and raised the tone of the debates. Duhem's interaction with the institutions and persons thus far introduced provides a rich

historical record from which to assess the extent to which he can be considered a neo-Thomist.

One other historical connection will prove useful to keep in mind – Adrien Pautonnier (1853-1943).²²⁴ A native of Rennes, Pautonnier was ordained a priest of that diocese in 1876. In 1881, he became a teacher of mathematics at the Collège Stanislas; and in 1903 he became the College's director after the Marists were suppressed by the state. Duhem met Pautonnier at the Collège Stanislas where he had been a student and where he chose to stay through the academic year 1881-2 as a teaching assistant. Besides a common interest in the college and in mathematics, Duhem and Pautonnier also shared an enthusiasm for hiking. Pautonnier used to go mountain climbing with students to Monta Rosa and the Dolomites, although Duhem once talked him into joining him in the less arduous Pyrenees.²²⁵ They also had a mutual friend, Édouard Jordan, who was one of the very few to address Duhem as 'tu'.

Pautonnier and Jordan are mentioned here because of their passionate concern for the Church and the education of the clergy. At the 1894 Congress, the Holy Cross priest J.A. Zahm, from the University of Notre Dame, Indiana, pleaded for the necessity of an educated clergy. Good morals and dogmatic theology were not enough to make an effective priest, he said, because 'il ne faut pas oublier qu'il y a aussi un très grand nombre d'âmes – et leur nombre s'accroît de jour en jour – qui s'intéressent aux controverses soulevées par les recherches et les découvertes scientifiques, et que beaucoup d'entre elles sont atteintes plus ou moins de ce scepticisme croissant qui est en grande partie le résultat des affirmations de la

²²⁴ On Pautonnier, see 'Notice necrologique – Adrien Pautonnier', *La semaine religieuse de Paris*, 178 (1943), 542-5; further information is in the Archdiocesan Archives in Paris.

²²⁵ Hélène Duhem, *Un savant français*, p. 109.

science moderne'.²²⁶ A few months earlier, Pautonnier had sent to Duhem a pamphlet describing much the same situation. Perhaps he already had in mind the Association pour l'Encouragement des Hautes Études dans le Clergé which he and Jordan were about to found. They hoped that Duhem could solicit his contacts in the sciences to contribute funds to the venture. Duhem was quick to help both by writing letters and by contributing himself – on one occasion the considerable sum of 220 francs.²²⁷ He explained his support to Pautonnier as follows:

Voyez vous, la terrible plaie, c'est celle que j'ai signalée au congrès de Bordeaux: il est impossible que des esprites façonnés par des études théologiques d'une part, et des gens habitués aux sciences positives ou historiques d'autre part, arrivent à se comprendre: témoins le P. Bulliot et Jordan, ou P. Bulliot et votre serviteur. Il faut que le Clergé fasse des sciences profanes pour arriver à rendre la Science Sacrée assimilable aux laïcs.²²⁸

Eventually, the Association was able to raise sufficient funds which 'surtout de 1900 à 1914, a permis à beaucoup de jeunes prêtres [...] de compléter leur instructions ou de publier les résultats de leur premiers travaux'.²²⁹

The various attempts to educate the clergy were soon noticed by even non-sympathetic observers such as Ferdinand Lot (1866-1952), who wrote at the beginning of the twentieth century: 'Il faudrait des hommes de sciences et des spécialistes pour pouvoir lutter contre la nouvelle génération cléricale qui possède quelques hommes d'une instruction tout à fait supérieure.'²³⁰ It is now time to

²²⁶ J.A. Zahm, 'De la nécessité de développer les études scientifiques dans les séminaires ecclésiastiques', *RevQuestSci*, 36 (1894), 405-30 (p. 415): see Minois, *L'église et la science*, II, p. 255.

²²⁷ On Duhem's contribution see letter from Duhem to Pautonnier, 25 April 1896, in Archives of the Archdiocese of Paris, *fonds Pautonnier*. Letter from Pautonnier to Duhem, 1 April 1895 (in *ArchAcSci, fonds Duhem*): 'Moi aussi je ne fais plus qu'écrire des lettres...'

²²⁸ Duhem to Pautonnier, 31 May 1896, in the Archives of the Archdiocese of Paris.

²²⁹ 'Notice nécrologique – Adrien Pautonnier', p. 544.

²³⁰ Ferdinand Lot, quoted in Minois, *L'église et la science*, II, p. 259. Minois cites an untitled and undated article in *Cahiers de la Quinzaine*.

examine the various problems that the learned among the clergy and their lay counterparts debated in their attempts to see the world coherently as scientists, Catholics, and neo-Thomists.

CHAPTER 3

A Matter of Form: Neo-Thomist and Duhemian Criticisms of Modern Physical Science

Si vous me le permettez, j'y joindrai un désir, c'est que vous puissiez encore un pas de plus dans cette enquête de philosophie scientifique, jusqu'à la théorie de la matière et de la forme, *essence* de la philosophie péripatéticienne. – *Jean Bulliot to Duhem, 5 Dec. 1896.*¹

Cosmology, according to Nys, is 'the philosophical study of the inorganic world'.² This branch of philosophy was important to the neo-Thomists for several reasons. Historically, it was the subject of Aristotle's *Physics*. Through analysis of motion, the Stagirite deduced the existence of an unmoved mover. Medieval Christian theologians, and especially Thomas, favoured cosmological arguments for the existence of God over Anselm's ontological 'proof'. The visible creation gave witness to the existence of its invisible Creator; and it informed all human thought according to the scholastic adage *nihil in intellectu nisi prior in sensu*. A further reason for the importance of cosmology among scholastics after *Aeterni Patris* was the challenge to theism coming from the sciences. In the *Summa Theologiae*, Thomas proposed only two possible objections against the existence of God: (1) the presence of evil in the world and (2) the claim that the world could explain itself. In Duhem's era, scientism had revived the credibility of the second argument. Hence, neo-scholastics felt the need to address science philosophically, and especially physical science, because it was the most reductionist.

One way to reply to the scientific challenge was to point out that even if physics could explain all the workings of reality, it could not account for reality itself.

¹ Letter from Bulliot to Duhem, 5 December 1896, in ArchAcSci, *fonds Duhem*.

² Mercier et al., *A Manual of Modern Scholastic Philosophy*, 2 vols, 3rd English Edition (London: Routledge and Kegan Paul, 1953), I, p. 45.

In Aristotelian language, physics could say nothing about the efficient and final causes of the universe. Yet, the neo-scholastics did not content themselves with this criticism. They thought that it was necessary to combat the various mechanistic conceptions of physics for at least two reasons. First, a theory with great explanatory power tends to render people oblivious to questions about origins and ends. Secondly, reducing everything to matter and motion left no place for the traditional understanding of the soul as the substantial form of an organized body. Hence, the neo-scholastics tried to show that all contemporary physical theories were far from capable of accounting for the phenomena of even the inorganic realm. They then presented Aristotelian hylomorphism as the only alternative which could do justice to the complexity of the universe.

This chapter will look at the efforts of neo-scholastics to restore hylomorphism through a criticism of various alternative cosmologies. Then it will look at Duhem's critique of contemporary physical theories. This order allows Duhem's more consistent thought to be the basis of establishing the similarities and divergences between him and the neo-scholastics. Yet the analysis of the neo-scholastic arguments will bring out explicit references to Duhem and let him speak directly to particular positions when necessary. Thus an introduction to Duhem's notion of physical theory may prove useful at this point.

1. Duhem and physical theory: an introduction

In a paper entitled 'Physique de croyant' (1905), Duhem outlined the evolution of his thought from mechanism, via an empiricism based on Newton's hypothetico-deductive method, to what is now called holism. Duhem had arrived at this last stage of his thinking – or, more accurately, he had abandoned his previous positions – by the time that he began to publish articles on the philosophy of physics in the *Revue des*

questions scientifiques. These articles, 'Quelques réflexions au sujet des théories physiques' (1892), 'Physique et métaphysique' (1893), 'L'École anglaise et les théories physiques' (1893), and 'Quelques réflexions au sujet de la physique expérimentale' (1894) have been collected with two other early essays by Duhem into one volume and published by Stanley Jaki as *Prémices philosophiques* (1987); even more recently they have been translated into English and published with other selections by Roger Ariew and Peter Barker *Pierre Duhem: Essays in the History and Philosophy of Science* (1996).³ But Duhem himself had made use of these essays much earlier when he wrote his classic *La théorie physique: son objet – sa structure*. The book was first presented as a series of lectures at the University of Bordeaux in 1903-04 and then as a series of articles in the *Revue de philosophie* in 1904-5 before it was published in 1906.⁴ It was republished in 1914 with two relevant articles as appendices: 'Physique de croyant' and 'La valeur de la théorie physique' (1908). The book was otherwise left unaltered, despite nearly a decade of debate by philosophers and the development of new theories by physicists, because, as Duhem wrote in the preface, 'ni ces discussions ni ces inventions ne nous ont révélé de raisons de mettre en doute les principes que nous avons posé'.⁵ This augmented edition has been translated into English and published as *The Aim and Structure of Physical Theory* (1954). A careful reading of this book provides a sufficient grounding in Duhem's philosophy of physics.

At the beginning of the second chapter, Duhem defines physical theory as

³ Pierre Duhem, *Prémices philosophiques: Présentées avec une introduction en Anglais par Stanley L. Jaki* (New York: Brill, 1987); *Pierre Duhem: Essays in the History and Philosophy of Science*, trans. and ed. with an Introduction by Roger Ariew and Peter Barker (Indianapolis: Hackett, 1996).

⁴ Jaki, *Uneasy Genius*, p. 171.

⁵ Pierre Duhem, *Théorie physique: son objet – sa structure*, 2nd revised and augmented edition, facsimile reprint with an introduction by Paul Brouzeng (Paris: Vrin, 1989), p. xiii.

follows:

A physical theory is not an explanation. It is a system of mathematical propositions, deduced from a small number of principles, which aim to represent as simply, as completely, and as exactly as possible a set of experimental laws.⁶

Duhem was by no means the first one to propose that 'physical theory is not an explanation'. The position, as Duhem argued in his book *To Save the Phenomena*, dates back to the Greek astronomers who tried to describe without necessarily explaining the motions of the heavenly bodies with various systems of circles and epicycles. The position was also known to the medievals; and, in fact, Duhem cited Saint Thomas in support of his instrumentalist position.⁷ Newton too refused to make hypotheses about the cause of gravity and contended himself with describing its quantitative effects. And many of Duhem's contemporaries, especially in Britain, did not attribute explanatory powers to the mechanical models which they developed to account for physical phenomena.

Duhem, however, was more consistent than others in his instrumentalist convictions. Ptolemy thought that his epicycles were real. Newton too embraced the particle theory of light on insufficient evidence. And many nineteenth century physicists thought that mechanism was a true explanation of nature. Duhem was aware of the natural tendency to reify the various components of physical theory; but he did not succumb to the temptation. He had read enough history to know that sooner or later explanatory frameworks are abandoned whereas the quantitative aspect of theory is incorporated into the new developments. His retort to neo-Thomists, such as Vicaire, who accused him of skepticism was that, by refusing to see

⁶ Duhem, *AimSPT*, p. 19.

⁷ Pierre Duhem, *To Save the Phenomena: An Essay on the Idea of Physical Theory from Plato to Galileo*, translated by Edmund Dolan and Chaninah Maschler (Chicago: University of Chicago Press, 1969) p. 42. He quotes Thomas Aquinas, *Summa Theologiae*, I, q. 32, a. 1, ad secundum.

physical theory as an explanation, he was actually saving himself from becoming a skeptic about all knowledge at a later time when cherished explanations would have to be abandoned in light of new evidence.⁸

Physical theory, Duhem maintained, was a system of mathematical propositions deduced from a small number of principles or hypotheses. He knew that in practice the physicist's freedom in choosing hypotheses is severely constrained by his education and other cultural factors.⁹ But there are other constraints on the physicist's freedom dictated by more manifestly rational reasons. Duhem lists three:

In the first place, a hypothesis shall not be self-contradictory, for the physicist does not intend to utter nonsense.

In the second place, the different hypotheses which are to support physics shall not contradict one another. [...]

In the third place, hypotheses shall be chosen in such a manner that from them *taken as a whole* mathematical deduction may draw consequences representing with a sufficient degree of approximation the *totality* of experimental laws.¹⁰

The first two conditions are necessary if physics is to be a unified science. The third condition describes the link between theory and experiment. It is a radical departure from the traditional model of the development of theory. First of all, Duhem denied that a set of observations could establish a law. The elliptical orbit of Mars, for example, may have suggested to Newton the inverse-square law of gravitation, but could not prove it. If the planet's trajectory were a perfect ellipse, then the inverse-square law would almost certainly be false, for heavenly bodies other than the sun also influence Mars and their combined effect could hardly be expected to cancel out perfectly. If, as is the case, the orbit of Mars is not a perfect

⁸ Pierre Duhem, 'Physics and Metaphysics', in *Pierre Duhem: Essays in the History and Philosophy of Science*, pp. 29-49 (p. 39).

⁹ Duhem, *AimSPT*, pp. 252-7.

¹⁰ Duhem, *AimSPT*, p. 220.

ellipse, then the inverse-square law is not established with certainty. Duhem did not deny the fruitfulness of Newton's approach, but pointed out that the inverse square law is not absolute.

Duhem's third requirement also leads to the denial of the possibility of a crucial experiment.¹¹ No one hypothesis can be isolated and tested apart from others. In the case of the orbit of Mars, it is first of all impossible to observe only the effect of the sun. But even if this were possible, a perfectly elliptical path would only make it possible to assent provisionally to Newton's three laws of motion and the law of universal attraction as a whole. Were the path other than elliptical, the physicist could not know which of the laws needed revision – perhaps all of them. Duhem said that the physicist resembled a doctor rather than a watchmaker. A doctor cannot dissect his patient to see what is wrong. He has to treat the whole organism. A watchmaker, on the other hand, can open the mechanism and readily find the broken part. Physics is like 'an organism in which one part cannot be made to function except when the parts that are most remote from it are called into play'.¹² This engagement of the whole of physical theory in each experiment has inspired the name 'holism' for Duhem's philosophy of physics.

Another of Duhem's significant departures from traditional ideas about physics was the introduction of 'qualities' into theories. These 'qualities' differed from the Aristotelian category of the same name because they had to be quantified and because they were mediated by instruments rather than directly perceived by the senses (see chapter 5.4). But their introduction into physical theory was something new. Despite the differences in the physical theories of Descartes, Newton,

¹¹ Duhem, *AimSPT*, pp. 188-90.

¹² Duhem, *AimSPT*, p. 187.

Boscovich, and Maxwell, their conceptions all try to provide a mechanistic and quantitative explanation of the phenomena in which qualities play no part. Duhem thought that this was a mistake, not because of philosophical predilections, but because he thought that qualities were necessary to the success of physics:

The method that rejects all non-mechanical theories leads to great complications. It is also quite possible that it leads to impossibilities. Who assures us that all physical concepts and experimental laws may be symbolized by even a very complicated combination of purely mechanical concepts? Take the artist that you have forbidden to use any procedure except pencil sketching and ask for a rendering of an object's color that is obvious to everyone: It cannot be done. Is it not for an analogous reason that the most complex mechanical theories have not been able, up to now, to give a very satisfactory account of Carnot's principle?¹³

Duhem was aware that qualities have often been used as a smokescreen for ignorance, such as the soporific quality of opium. He argued that scientists should resist the introduction of occult qualities into physics, but he maintained that qualities were necessary to describe the world as man encounters it. Extension and local motion were important features of the physical world, but so were heat and colour. To avoid the danger of flooding physics with a great number of obscure qualities, Duhem required that physicists use only qualities that could be quantified in some way, such as heat via temperature. Furthermore, physicists ought to admit only qualities which were *primary*. A primary quality, according to Duhem, is a quality 'irreducible in fact, not by law'. As he pointed out, the notion of primary quality is analogous to Lavoisier's idea of an element: an end product, according to the current state of knowledge, of analysis. A primary quality, like an element, is not absolutely primary but provisionally so. Newly discovered phenomena might require a new quality to be posited. Ampère, for example, added electric current to physical theory in order to formulate the laws of magnetism. Enhanced understanding, on the

¹³ Pierre Duhem, 'Some Reflections on the Subject of Physical Theories', in *Pierre Duhem: Essays in the History and Philosophy of Science*, pp. 1-28 (pp. 13-4).

other hand, might lead to the recognition that two 'primary' qualities are really one, as in the case of dielectric polarization and light intensity. The refusal to specify at the outset which qualities were 'primary' was not a deficiency in physics but an advantage, insofar as it freed the physicist from any preconceptions.¹⁴

It should now be clear that Duhem understood physical theory to be a means of describing and predicting phenomena. Thus it comes as no surprise that he was against atomic theory as his contemporaries understood it. The evidence for atomism, he maintained, was insufficient. The theory could not begin to account for simple phenomena such as multiple bonding in chemistry and the thermodynamics of gases. He was aware of the great enthusiasm among physicists for building models of atoms but he thought the effort doomed to failure:

Le temps viendra sans doute où, par leur complication croissante, ces représentations, ces modèles cesseront d'être des auxiliaires pour le physicien, où il les regardera plutôt comme des embarras et des entraves. En délaissant alors ces mécanismes hypothétiques, il en dégagera avec soin les lois expérimentales qu'ils ont aidé à découvrir; sans prétendre expliquer ces lois, il cherchera à les classer selon la méthode que nous venons d'analyser, à les comprendre dans une Énergétique modifiée et rendue plus ample.¹⁵

The historian Maiocchi thinks this passage is prophetic and notes that the historian of quantum mechanics René Dugas 'soutint en 1937 que la mécanique quantique était une théorie conforme aux préceptes épistémologiques de Duhem'.¹⁶ Because Duhem died long before the development of quantum mechanics, it is impossible to know whether he would have agreed with this interpretation of his thought. His contemporaries, however, correctly understood him to deny the reality of atoms and

¹⁴ Duhem, *AimSPT*, pp. 124-31.

¹⁵ Pierre Duhem, *Notice sur les titres et travaux scientifiques de Pierre Duhem* (Bordeaux: Imprimeries Gounouilhau, 1913), p. 114.

¹⁶ Roberto Maiocchi, 'Duhem et l'atomisme', *Revue Internationale de Philosophie*, 46 (1992), 376-389 (p. 387). He cites René Dugas, 'La méthode physique au sens de Duhem devant la mécanique des quanta', *Revue générale des sciences*, 38 (1937), 68-71.

found his stance obstinately skeptical.

Duhem alienated himself further from the physics community by his refusal to embrace Maxwell's electrodynamics.¹⁷ As usual, he had good reasons for his stance. First of all, Maxwell's theory was not a logical development of electrodynamics as practised on the Continent, and hence offended against Duhem's notion of the continuity of physics. Apart from this, however, he maintained that it had internal contradictions. The accusation, it turns out, was false, but it was believed to be true by other competent mathematical physicists such as Henri Poincaré.¹⁸ However, Poincaré was in favour of the theory because it promised fruitful lines of investigation. Duhem found this attitude discouraging. He was also skeptical of an electromagnetic theory that could not handle simple permanent atoms. Furthermore, he believed – wrongly, as he later admitted – in the existence of a longitudinal component of electromagnetic waves which was ruled out by Maxwell's theory.¹⁹ (In this too, Duhem was in good company, William Thomson's (Lord Kelvin)).²⁰ But these details are of secondary importance. The main point is that, once again, Duhem found himself separated from his colleagues and judged wrong by future developments.

Duhem's own brand of physics was generalized thermodynamics or energetics. (He preferred the term 'energetics', which he adopted after reading Rankine's

¹⁷ On Duhem's criticism of Maxwell see his *Les théories électriques de J. Clerk Maxwell: étude historique et critique* (Paris: Hermann, 1902) and his posthumously published war-time polemic 'De Maxwell et de la manière allemande de l'exposer', *Revue de mois*, 20 (1919), 113-31.

¹⁸ Henri Poincaré, *Électricité et Optique. I. Les théories de Maxwell et la théorie électromagnétique de la lumière* (Paris: 1890), p. ix.

¹⁹ Pierre Duhem, 'Sur l'électrodynamique des milieux conducteurs', in *Comptes Rendus de l'Académie des sciences*, 162 (6 March 1916), pp. 337-42.

²⁰ On Kelvin and longitudinal ether waves, see M. Norton Wise and Crosbie Smith, 'The Practical Imperative: Kelvin Challenges the Maxwellians', in *Kelvin's Baltimore Lectures and Modern Theoretical Physics*, ed. by Robert Argon and Peter Achinstein (Cambridge, MA: MIT Press, 1987), pp. 323-48 (pp. 339-43).

treatise on the subject.)²¹ Duhem hoped to unify all of physics through this one theory, although he was conscious that certain elements, such as electromagnetics, were proving to be intractable. Thermodynamics was in the vanguard of science when Duhem was at the École Normale in the 1880s and he contributed some important concepts to it such as the notion of chemical potential. But physics soon followed different directions so that his monumental work *L'Énergétique*, arguably the best exposition of the subject, seemed dated by the time it was published in 1911. Given Duhem's penchant for consistency, it is not surprising that energetics eschewed all causal explanations. It made use of concepts such as temperature, pressure, and chemical potential without trying to assign mechanical causes for them. Instead, it treated them as experimentally measurable qualities which could be incorporated into a mathematical framework that described and predicted an ever-widening range of physical phenomena.

Duhem's understanding of physical theory left him open to attacks on two sides. On the one hand, he was accused by some neo-Thomists of being a positivist for denying the validity of metaphysics and, hence, of denying the possibility of rational theology. On the other hand, the philosopher of science Abel Rey accused Duhem of adopting his positivist position precisely in order to make it possible for a thinking person to retain religious beliefs in light of mechanistic theories, which, Rey believed, provided complete explanations of the universe.²² Rey might have added that such theories were commonly perceived as a threat to the Catholic belief in man's ability to choose freely (see chapter 4.B).

Rey's accusation prompted Duhem to clarify his own thought in 'Physique de

²¹ Jaki, *Reluctant Heroine*, p. 127.

²² Abel Rey, 'La philosophie scientifique de M. Duhem', *Revue de Métaphysique et de Morale*, 12 (1904), 699-744 (p. 741).

croyant'; and a later book by Rey prompted Duhem to take up his pen once again and write 'La valeur de la théorie physique'.²³ Both these essays emphasized Duhem's notion of *natural classification* as a link between physics and metaphysics.

Duhem first introduced natural classification as a concept in the philosophy of physics in 'L'École anglaise et les théories physiques' (1893). He then devoted a chapter to the idea in *La théorie physique*. But there seem to have been determined efforts to ignore the concept from some very diverse camps. The neo-Thomists and Rey have already been mentioned. More significant is the Vienna Circle who adopted Duhem's positivistic ideas probably through the influence of Ernst Mach. In his first essay on physical theory, Duhem arrived independently at Mach's conception of laws as mere means of providing an economy of thought. He clearly acknowledged Mach's priority in his review of the Austrian physicist's *The Science of Mechanics: A Critical and Historical Account of Its Development*: 'Please allow us to excuse in this way the absence of the name of Mach from publications in which we have sometimes put forth thoughts that had more than mere similarity with his.'²⁴ Natural classification, however, was not one of the concepts that linked Duhem to Mach, who had no sympathy for metaphysics. It is no surprise then that when Mach wrote the preface to Duhem's *Ziel und Struktur der physikalischen Theorien* (1908), he failed to mention anything about natural classification and, hence, presented a merely positivist Duhem to the Vienna Circle.²⁵

For Duhem, natural classification, in the strong sense, was the ideal and perfect

²³ The book in question was *La théorie de la Physique chez les physiciens contemporains* (Paris: 1907).

²⁴ Pierre Duhem, 'Analysis of Mach's *The Science of Mechanics: A Critical and Historical Account of Its Development*', in *Pierre Duhem: Essays in the History and Philosophy of Science*, pp. 112-30 (p. 113).

²⁵ On the influence of Duhem on the Vienna Circle and on Mach's preface to the German translation of *Théorie physique*, see Jaki, *Uneasy Genius*, p. 358.

theory which motivates all who seek understanding. As he put it:

Now we have defined this ideal and perfect theory elsewhere. It would be the complete and adequate metaphysical explanation of material things. This theory, in fact, would classify physical laws in an order which would be the very expression of the metaphysical relations that the essences that cause the laws have among themselves. It would give us, in the true sense of the word, a *natural classification* of laws.²⁶

Such a theory, according to Duhem, was infinitely above the reach of the human mind. Human beings would have to be content with a more modest notion of natural classification, for man's metaphysical understanding is limited to general statements which are too few and contain too little detail to permit the construction of the perfect theory. The experimental method did not bear directly on the essences of things but only on their manifestations to the senses. Hence, it could at best give rise to a theory that saves the phenomena. This theory would no longer explain but would nevertheless provide an image of the ontological order. The physicist must be content to strive for a weaker notion of natural classification.

Duhem thought that the link between the weaker notion of natural classification to which physical theory tends and natural classification in the strict sense is analogy, as will soon become evident. It may be fruitful, however, first to address in what sense a physical theory is a natural classification. The term 'natural classification' is usually found in biology. Several different systems of classification have been developed since Aristotle started classifying animals in antiquity.²⁷ Some are clearly artificial; others aspire to be natural, but this latter category is loaded with philosophical difficulties. Artificial systems are easy to describe and to use. A specific feature of a plant or animal defines a broad heading such as a phylum, and

²⁶ Pierre Duhem, 'The English School and Physical Theories', in *Pierre Duhem: Essays in the History and Philosophy of Science*, pp. 50-74 (p. 68).

²⁷ A brief introduction to classification systems can be found, for example, in Stephen A. Mason, *A History of the Sciences* (New York: Collier, 1962), pp. 331-48.

its variations can define smaller classes such as genera, and species. Linnaeus, for example, divided plants into orders according to the number of their pistils, and classes depending on the number of their stamens. The problem with such artificial systems is that they sometimes lead to counter-intuitive groupings. A snail, for example, belongs to the order of testacea because it has a hard shell, and a slug belongs to the order of molluscs because it has no rigid protection for its soft body. Yet, most people tend to think of snails and slugs as close cousins. The temptation to develop a natural system is easy to explain, but such a system is as hard to define and to justify as is common sense. Darwin understood the tendency, and appealed to the 'Natural System' of classification in the *Origin of Species* to argue for his theory of evolution. He believed that his theory could explain why such natural affinities should arise. Prior to his theory, the classifications were just descriptive; his theory provided the causal explanation for the phenomena: 'All the foregoing rules and aids and difficulties in classification are explained, if I do not greatly deceive myself, on the view that the natural system is founded on descent with modification.'²⁸ The argument was powerful because it suggested that nature itself, rather than mere human convention, had caused the similarities which biologists were linking together. Duhem's ideal natural classification of physical laws would also be a causal explanation. But he was convinced that all that physicists could hope for was a logical means of describing the phenomena.

Duhem was aware of the biological provenance of natural classification because he illustrated the concept in physics with references to conchology.²⁹ In introducing the concept into physics, he retained the salient feature of unification. The

²⁸ Charles Darwin, *The Origin of Species* (London: Penguin, 1968), p. 404.

²⁹ Pierre Duhem, 'Physics of a Believer', in *AimSPT*, pp. 273-311 (pp. 297-8).

similarities in the realm of life were due to a common descent. All lifeforms could, in theory, be traced back to a common ancestor. In physics, he hoped to show that all phenomena had to be understood in terms of some common principles. He thought that the first two laws of thermodynamics might provide a base for such a natural theory. Certainly no physical phenomenon was known to violate these principles. In *L'évolution de la mécanique* (1903), he spoke of physics as a tree, growing out of the same root. He acknowledged that not all branches came out of the main trunk – electrodynamics in particular seemed to be a rebellious shoot – but at least the law of conservation of energy prevailed throughout.

Duhem introduced the concept of natural classification in a review of a collection of Kelvin's lectures on scientific topics. William Thomson (Lord Kelvin) (1824-1907) is particularly well known for his equating of physical understanding with devising a mechanical explanation. Duhem acknowledged that in limited fields such an approach may have had its uses – at least for shallow and imaginative minds – but it could never unify physics, for the models chosen to explain different phenomena were often incoherent. Although no physical theory in Duhem's era could account for all phenomena in a unified way, Duhem believed that a true theory must be coherent because the universe is coherent. For him, this was a common-sense metaphysical assumption that must ground all physical research and which led him to reject any theories that tolerated an internal contradiction: *'In physical theory, we must avoid logical incoherence BECAUSE IT INJURES THE PERFECTION OF SCIENCE.'*³⁰ His reader could hardly miss the point. The first requirement of a true natural classification would be internal consistency.

In 'Le mixte', Duhem offered further reasons for considering physics unified

³⁰ Duhem, 'The English School', p. 67.

through thermodynamics as more natural than mechanical conceptions of the universe. In generalized thermodynamics, a carefully chosen sum of energy terms – multiples of force and distance, torque and degrees, pressure and area, chemical potential and concentration, etc. – could be used to predict not only the local motions of a system of matter, but also to determine some of the system's other changes, such as its chemical or thermal development over time. The calculus of variation to minimize or maximize the function yielded the desired information. The determination of such functions, as one might well imagine, was no trivial matter. (Duhem is credited along with Gibbs for the development of the Gibbs-Duhem function which continues to be important in industrial chemistry.) Nevertheless, once found, such functions are extremely useful, for they provide the general principles from which particular results can be deduced. As Duhem put it:

Les lois du mouvement local se présentent maintenant comme des corollaires de la Thermodynamique, et la Mécanique rationnelle n'est plus qu'une application particulière de cette vaste science, la plus simple et la mieux connue de ses conséquences.³¹

The laws of mechanics could be derived from thermodynamical expression only because one put them into the equation. Nevertheless, most results in thermodynamics could not be derived from Newton's three laws of motion. A logical presentation of physical theory would therefore begin with the basic laws of thermodynamics.

It is possible to surmise then that a classification in physics is deemed 'natural' in the sense that it is (1) unified and (2) logically ordered, proceeding from the general to the particular. Duhem was aware that energetics did not meet these stringent requirements, but he thought that it was moving towards being a natural

³¹ Pierre Duhem, *Le mixte et la combinaison chimique: essai sur l'évolution d'une idée* (Paris: Naud, 1902; repr. Paris: Fayard, 1985), p. 170.

classification. Energetics, as will soon become apparent, was thus natural, because the ontological reality it analogically revealed corresponded to the perennially valid elements of Aristotle's cosmology, which are arguably the natural way for man to understand the world.

In 'Physique de croyant', Duhem first stated that a sufficiently developed physical theory would begin to resemble ontological reality:

There would be a very exact correspondence between this natural classification or physical theory, after it had reached its highest degree of perfection, and the order in which a finished cosmology would arrange the realities of the world of matter; consequently, the more physical theory, on the one hand, and cosmology, on the other, approach each other in their perfect form, the more clear and detailed should be an analogy of these two doctrines.³²

Duhem compared the physicist to the prisoner in Plato's cave:

The knowledge at his disposal allows him to see nothing except a series of shadows in profile on the wall facing him; but he surmises that this theory of silhouettes whose outlines are shadowy is only the image of a series of solid figures, and he asserts the existence of these invisible figures beyond the wall he cannot scale.³³

Although the physicist cannot get a clear view of ontological reality, his understanding can be of help to the metaphysician. Analogy provides a relation between physical theory and the world as it exists. Analogy, however, is a tenuous link, as Duhem warns:

This appeal to analogy forms in many cases a valuable means of investigation or test, but it is well not to exaggerate its power; if at this point the words 'proof by analogy' are uttered, it is well to determine their meaning exactly and not to confuse such a proof with a genuine logical demonstration. An analogy is felt rather than concluded; it does not impose itself on the mind with all the weight of a principle of contradiction.³⁴

³² Duhem, 'Physics of a Believer', p. 301.

³³ Duhem, 'Physics of a Believer', p. 299.

³⁴ Duhem, 'Physics of a Believer', pp. 301-2.

It should already be clear that Duhem was not a positivist in the sense that he denied the validity of metaphysics. His belief that physics is ultimately justified by a metaphysical conviction separates him further from the positivist enterprise:

the physicist is compelled to recognize that *it would be unreasonable to work for the progress of physical theory if this theory were not the increasingly better defined and more precise reflection of a metaphysics; the belief in an order transcending physics is the sole justification of physical theory.*³⁵

Duhem believed that the connection between physics and metaphysics could not be derived from a logical examination of scientific methodologies. Rather it is something that informs the very core of the physicist's outlook:

The analysis of the methods by which physical theories are constructed proves to us with complete evidence that these theories cannot be offered as explanations of experimental laws; and, on the other hand, an act of faith, as incapable of being justified by this analysis as of being frustrated by it, assures us that these theories are not a purely artificial system, but a natural classification. And so, we may here apply that profound thought of Pascal: 'We have an impotence to prove, which cannot be conquered by any dogmatism; we have an idea of truth which cannot be conquered by any Pyrrhonian skepticism.'³⁶

Duhem used the phrase 'act of faith' to describe the conviction that physics provides at least a reflection of reality. This 'act of faith' is derived from his belief in the power of the human mind to attain to know basic truths. In a letter to a childhood friend he wrote:

J'ai cru de mon devoir de savant comme de mon devoir de chrétien de me faire sans cesse l'apôtre du sens commun, seul fondement de toute certitude scientifique, philosophique, religieuse. Mon livre sur la théorie physique n'avait pas d'autre objet que de mettre en évidence la vérité scientifique de cette thèse.³⁷

Duhem did not bother to defend his belief in common sense, probably because he

³⁵ Duhem, 'The value of physical theory', p. 335.

³⁶ Duhem, *AimSPT*, p. 27.

³⁷ Duhem, as quoted in Émile Picard, *La vie et l'oeuvre de Pierre Duhem* (Paris: Gauthier-Villars, 1922), pp. 52-3.

recognized that he could not find prior concepts upon which to base his arguments. He would certainly deny that common sense is restricted to Christians, for he thought that Aristotle was particularly well endowed with it. But at the same time, Duhem spoke of Providence as ultimately assuring the convergence of physical theory to a natural classification.³⁸ And his historical works argued that the Church was the ‘midwife’ of modern science.³⁹ There is no need to enter the debate about the possibility of establishing the validity of objective knowledge apart from theism. Once the validity of common sense is assumed, Duhem thought that it was possible to discern that a theory was approaching a natural classification without appeals to Providence. He maintained that a theory’s ability to predict hitherto unknown phenomena was a strong indication, although not a proof, of its being on the right track.⁴⁰

In ‘Physique de croyant’, Duhem speculated on the metaphysical realities to which generalized thermodynamics pointed. This science, he thought, had come to embody all the ‘legitimate and fruitful tendencies’ of physics throughout the ages.⁴¹ Although not yet perfect, it could suggest what the ideal natural classification would reveal: an essentially Aristotelian cosmology stripped of its anachronistic explanations. How is this so?

First, Aristotle taught that quantity and quality are both essential attributes of substance. General thermodynamics, alone among the various systems of physics, did not seek to banish qualities from theory. It incorporated them into mathematical

³⁸ Pierre Duhem, ‘L’évolution des théories physiques’, in *Prémices philosophiques*, pp. 198-234 (p. 234).

³⁹ See letter from Duhem to Bulliot, 21 May 1911, in Jaki, *Scientist and Catholic*, pp. 235-40 (p. 239).

⁴⁰ Duhem, *AimSPT*, pp. 27-30.

⁴¹ Duhem, ‘Physics of a Believer’, p. 306.

expressions through quantitative symbols such as temperature and pressure.

Secondly, Aristotle's idea of motion was not restricted to local motion.

General thermodynamics studied accidental changes such as temperature variations, expansion and contraction, and variations in electric and magnetic states without seeking to reduce them to local motions of atoms.

Thirdly, general thermodynamics even accounted for the most profound of Aristotle's changes – substantial change or generation and corruption. Chemical thermodynamics concerned itself with these deeper transformations. It considered chemical change not as a mere rearrangement of substances but as a change by which substances are transformed to form new ones in which they retain their prior being only in potency.

Fourthly, Aristotle appealed to final causes to explain motion. Rocks fall down because they seek their rightful place at the center of the universe – the earth; fire rises to seek its proper place in the moon's orb. Duhem admitted that these reasons sound childish to the modern physicist but that their essential meaning was consonant with some quite recent concepts which had proved extremely useful in the development of physics – the maximization or minimization of some potential function. For example, in 1845, Kelvin was able to solve a hitherto elusive problem – the calculation of the force between two charged conductors – because he had the insight to recognize that the charge distribution on the spheres was such as to minimize the total energy of the system.⁴² Modern physics, Duhem said, could be used to support the Aristotelian notion of final causality:

We find there the affirmation that a state can be conceived in which the order of the universe would be perfect, that in this state would be a state of equilibrium for the world, and what is more, a state of stable

⁴² M. Norton Wise and Crosbie Smith, 'Work and Waste: Political Economy and Natural Philosophy in Nineteenth Century Britain', *History of Science*, 27 (1989), 263-301 (p. 265).

equilibrium; removed from this state, the world would tend to return to it, and all natural motions, all those produced among bodies without any intervention of an animated mover, would be produced by the following cause: they would all aim at leading the universe to this ideal state of equilibrium so that this final cause would be at the same time their efficient cause.

Now, opposite this metaphysics, physical theory stands, and here is what it teaches us:

If we conceive a set of inanimate bodies which we suppose removed from the influence of any external body, each state of this set corresponds to a certain value of its entropy; in a certain state, this entropy of the set would have a value greater than in any other state; this state of maximum entropy would be a state of equilibrium, and, moreover, of stable equilibrium; all motions and all phenomena produced within this isolated system make its entropy increase; they therefore all tend to lead this system to its state of equilibrium.

And now, how can we not recognize a striking analogy between Aristotle's cosmology reduced to its essential affirmations and the teachings of thermodynamics?⁴³

Although Duhem did not specify the details, he noted that many other comparisons could be adduced to show the harmony between modern thermodynamics and Aristotelian and scholastic physics shorn of their outmoded clothing. If 'generalized thermodynamics' were to be replaced by the broader term 'modern physical science', then Duhem's statement would be exactly what the neo-Thomists were hoping to prove. It is time to look at their efforts.

2. Hylomorphism: an introduction

Each of the four Aristotelian causes – efficient, material, formal, and final – provides a reason for the existence of a particular being. The existence of a statue, for example, is explained by the craftsman (efficient cause), by bronze (material cause), by its shape (formal cause), and by a need for adornment (final cause). It should be clear from the example that these causes are not uniquely determined. The craftsman's patron too can be called an efficient cause of the statue; and the

⁴³ Duhem, 'Physics of a Believer', pp. 309-10.

craftsman's desire to make money is also a final cause. This flexibility makes it possible to understand instrumental causality.

Hylomorphism accounts for the actual being of a substance, as distinct from its coming into being. It teaches that every substance (except angels and God) is composed of matter – *hyle* – and form – *morphe*. An essential (or substantial) form determines the nature of an individual; and a multitude of other forms, called accidental forms, determine its attributes. Thus a man, for example, is human because his body is informed by the essential form of man (also called the human soul). A particular man can be swarthy, six feet tall, with an athletic build, and tone-deaf. All of these attributes or accidental forms specify the individual but not his nature. The scholastic tradition insists that although the number of accidental forms can be multiplied in an individual, there can only be one essential form – an individual can have only one essence or nature.

The duality of matter and form is a powerful tool for explaining change, especially substantial change. It is a middle ground between the Parmenidean universe which denies all change and the Heraclitean vision which denies any stability. The limitation of these two rival philosophies, according to scholastics, is that each has only one principle of explanation. An example will illustrate the hylomorphic account of substantial change. When wood is burned and becomes ashes, the matter is what persists. First, the matter is defined by the form of wood and then by the form of ashes. Matter is thus the principle of potency because it can be potentially anything. Form provides the present actuality of a being. Although matter and form are two principles, they can never be separated in natural objects: thought alone can distinguish them. The matter that underlies substantial change is *prime* matter which is to be distinguished from *formed* matter such as bronze which is

merely rearranged by the statue maker. Prime matter in itself is unknowable. It is what is left conceptually after the mind strips away every determining feature provided by the form.

A few problems with hylomorphism immediately come to mind. The first pertains to the definition of an individual substance. Hylomorphism lends itself extremely well to biology where it is usually easy to identify an individual animal. Aristotle himself recognized, however, that artificial 'substances' do not easily fit the scheme. For example, are a few planks nailed together a bed, or a desk, or a bench? What is the nature – principle of action or rest – of such a haphazard arrangement? The very use of the word 'nature', derived from the word 'birth', indicates a problem with artificial products.⁴⁴

The natural world presents its own set of problems for hylomorphism. Does it make sense, for example, to talk of the substantial form of a sand dune? And if not, is it any better to talk about the substantial form of a grain of sand or a chunk of silicon? Sand is a substance, but what constitutes the individual? An analogous problem exists in biology: is the water in man a substance separate from him? Aristotle, in the *De Generatione et Corruptione*, said that the constituents of a body 'neither (a) *persist actually*, as "body" and "white" persist: nor (b) are they destroyed (either one of them or both), for their "power of action" (*dynamis*) is preserved'.⁴⁵ Later commentators differed in their translation and understanding of the passage. William Wallace writes that Avicenna understood it as saying that elements are actually present in the compound while Averroës thought that the elements were present only potentially. Thomas adopted a middle position. He spoke of the virtual

⁴⁴ See, for example, Aristotle, *Metaphysics*, Book 8, chapter 3, 1043b19-23.

⁴⁵ *De Corruptione et Generatione*, Book I, Chap. 10, 327b 31. The translation is by Harold H. Joachim in *The Basic Works of Aristotle*, ed. by Richard McKeon (New York: Random House, 1941).

presence of water in man in order to safeguard the unicity of the substantial form of *man* but also to acknowledge that many constituents of the body retain, or rather almost retain, their own nature.⁴⁶ These problems, as will soon become evident, tormented the neo-Thomists of Duhem's era.

Physical science after Descartes rejected hylomorphism. The essence of matter, according to Descartes, was extension and motion. This scheme lacks a principle of individuation. All the things which normally qualify as substances are really just a re-arrangement of matter. The Newtonian or rather Gassendian ontology of extended atoms in a void runs into the same problem. Yet the human world and the language used to describe it cannot do without the notion of individual substances. Even Spinoza, who thought that there was only one substance – *Deus sive Natura* – tried to account for the persistence of living beings with the notion of *conatus*, a striving to remain together. Any philosophy that is not willing to jettison human concerns will need some principle of individuation of substances as human beings encounter and name them. Yet, at the same time, such a philosophy will have to be aware of the relationship between its explanatory schemes and those of the sciences if it is to retain its credibility in the modern world.

Debates about hylomorphism among neo-Thomists predate *Aeterni Patris* by some twenty years. In 1856, Matteo Liberatore began to publish articles on the human being in the *Civiltà Cattolica*. In the course of the articles, he invoked the theory of matter and form, fully aware that he would face severe criticism. A fellow Jesuit who taught at the Roman College, Tongiorgi, soon responded by opposing chemical atomism to hylomorphism in the course of his teaching at the Roman College. Liberatore in turn published an article defending his stance in the *Civiltà*

⁴⁶ William Wallace, 'Are Elementary Particles Real?', in *From a Realist Point of View* (New York: University Press of America, 1983), pp. 171-83 (p.179).

Cattolica. This was only the beginning of a projected series of articles on the subject, but the others never appeared. After a meeting of Liberatore, Tongiorgi, Kleutgen, and Franzelin at the Gesù, the superior general of the Jesuits, Beckx, forbade the polemic to go on either in the *Civiltà Cattolica* or in the classrooms of the Roman College although he gave permission to continue it in separate publications which he would oversee.⁴⁷

The same debate cropped up a decade after *Aeterni Patris*. Domet de Vorges published a neo-Thomist bibliography in the September 1888 issue of the *Annales de philosophie chrétienne* in which he criticized Cornoldi and other members of the Philosophico-Medical Academy of Bologna for their intransigent opposition to modern atomic theory:

Nous sommes avec le P. Cornoldi et ses amis s'il s'agit de maintenir la composition substantielle des corps, constitués par l'union de la forme avec la matière, et de leur reconnaître certaines propriétés réelles, principes de leurs opérations. Il n'est pas nécessaire pour cela de partir si vivement en guerre contre les systèmes plus ou moins atomiques.⁴⁸

In responding to Domet de Vorges on behalf of the Bolognese society, Dr Liverani insisted that the reason that he and his colleagues were against atomism was because 'ces hypothèses n'ont aucun fondement dans les faits observés, et plus encore qu'elles répugnent à l'unité substantielle des organismes vivants et spécialement à l'unité bien plus importante de composé humain'.⁴⁹ The second point was, in his estimation, by far the more important. He noted that if the hypothesis of atoms were admitted, there would be no way to speak about the individual nature of a living body or to attribute a single substantial form to the human person. All one

⁴⁷ Jacquin, 'Une polémique romain'.

⁴⁸ Edmond Domet de Vorges, 'Bibliographie thomiste de 1878 à 1888', *AnnPhilChr*, 116 (1888), 577-602 (p.582).

⁴⁹ Liverani, 'Hylémorphisme moderne: d'un blâme adressé à quelques écrivains de l'Académie philosophico-médicale de Bologne', *AnnPhilChr*, 117 (1888/9), 610-18 (pp. 613-4).

could do would be to speak of an amalgam of infinitesimal particles whose thermal, electrical, and magnetic properties were merely the manifestations of microscopic motions.⁵⁰

Domet de Vorges, in his response to Liverani, noted that admitting the existence of atoms was not fatal to scholastic philosophy:

Pourquoi ces atomes ne seraient-ils pas unis par leur substance, tout en restant distincts par certains de leurs propriétés ou par les actions qui en résultent? La théorie scolastique n'enseigne-t-elle pas la distinction réelle des propriétés et de la substance? Des atomes dans un corps vivant pourraient donc à la fois être unifiés dans une même substance individuelle et conserver distincts certains des phénomènes qui leur étaient propres.⁵¹

This was essentially a restatement of Thomas's teaching of the virtual presence of elements in a substantial form which the neo-scholastics were quick to appropriate.⁵² Domet de Vorges also thought that Liverani was mistaken in insisting that the same explanatory principles need be applied to both living beings and chemical compounds. The tendency towards reductionism in the sciences, he conceded, was common enough, but it was responsible for just about all errors in the history of philosophy and in the sciences.⁵³ However, hylomorphism was supple enough, he insisted, to adapt itself to all explanatory schemes. Whatever scientists would establish as the ultimate element, be it the body itself, or be it a molecule or atom, it would still be composed of matter and form.⁵⁴

⁵⁰ Liverani, 'Hylémorphisme moderne', p. 614.

⁵¹ Edmond Domet de Vorges, 'Hylémorphisme moderne: réponse de M. Domet de Vorges à M. le docteur V. Liverani', *AnnPhilChr*, 117 (1888/9), 618-25 (p. 621).

⁵² See, for example, Nys, *Le problème cosmologique* (Louvain: Fonteyn, 1888), p. 195; De Munnynck, 'Notes sur l'atomisme', p. 594; and Louis Baille, 'La question du mixte: la "permanence virtuelle" des éléments et le contigu', *RevPhil*, 10 (1907), 259-71 (p. 261).

⁵³ Domet de Vorges, 'Hylémorphisme moderne', p. 622.

⁵⁴ Domet de Vorges, 'Hylémorphisme moderne', p. 621.

3. *Hylomorphism and mechanism*

Bulliot, in a letter he wrote to Duhem on 5 December 1896, insisted that hylomorphism was the essence of scholasticism.⁵⁵ Most of the neo-Thomists who took an active interest in modern science admitted the existence of atoms and sought to understand them in terms of hylomorphism. Paul de Broglie argued for hylomorphism at one of the first meetings of the Society of Saint Thomas Aquinas. He identified the form of atoms as the principle of their unity and activity. In particular, the form was responsible for the internal elasticity of the atom. Matter, on the other hand, was a principle of quantity which was manifest as extension, energy, volume, and mass.

De Broglie's understanding of hylomorphism was connected with Aristotle's notions, but it betrayed its modernity. Aristotle did not speak of quantity in his definition of matter; only in the Middle Ages did people begin to speak of mass as a quantity of matter. De Broglie's derivation of matter and form was also different from Aristotle's. Whereas Aristotle arrived at the concept of matter and form by considering substantial change, de Broglie began by considering what happens when a body is divided into two: the form of the whole is destroyed and two separate forms are produced; matter is what passes from the whole to the parts. D'Hulst pointed out that de Broglie's derivation was not the usual approach to the subject but did not think that it was essentially flawed. There were many ways of arriving at the one truth of hylomorphism.⁵⁶

In 1889, the question of hylomorphism and modern science was again presented before the Society. Bulliot, in a paper entitled 'L'unité des forces

⁵⁵ Letter from Bulliot to Duhem, 5 December 1896, in ArchAcSci, *fonds* Duhem.

⁵⁶ *SéancesSSTA*, 25 February 1885, *AnnPhilChr*, 110 (1885), 109-12.

physiques au double point de vue philosophique et scientifique', argued against the theory which tried to explain all the phenomena of physics in terms of extension and motion. Bulliot kept referring to this understanding of physics as the 'theory of the unity of forces' which had the virtue of being descriptive even if cumbersome.

Vicaire, in his criticism's of Bulliot's paper, chose to call it the 'kinetic theory', which was a particular understanding of mechanism. Nys, who was arguing for hylomorphism at the same time in Louvain, chose to call the opposing view the atomic theory or simply mechanism. The variety of names reveals a problem which Bulliot and Nys would have preferred not to have to face. They both tried to establish hylomorphism by revealing the insufficiencies of the alternatives; and it was easier to argue against a single alternative than to address several.

To be sure, the kinetic theory (in Vicaire's usage) enjoyed favour among contemporary physicists. It became especially popular after the development of the law of conservation of energy. If heat could be transformed into motion and vice-versa, and if heat could also be transformed into electricity and chemical potential, then it seemed reasonable that all of these different forms of energy were motion. Nys cited Helmholtz to the effect that no changes in nature were possible other than a rearrangement of elements in space, which is to say a movement. And he quoted Hirn who said, with regard to the kinetic theory, 'si sur le domaine de la science, le suffrage universel avait une valeur effective, il n'y aurait plus lieu de discuter la question'.⁵⁷ Catholic scientists were very much aware that the eminent Jesuit astronomer, Angelo Secchi (1818-1878), who had scrapped with the Roman neo-Thomists on the subject of hylomorphism, adopted the kinetic theory in his book *L'unité des forces physiques* (1869). The very name of the book provided Bulliot with

⁵⁷ Hirn, *Analyse élémentaire de l'univers* (Paris: Gauthier-Villars, 1868), p. 57, quoted in Nys, *Le problème cosmologique*, p. 9.

a title for his attempted refutation.

One of the problems with these citations of Helmholtz, Hirn, and Secchi, is that they date from 1870 and earlier and not from the late 1880s when Bulliot and Nys were writing. Mechanism, in its broadest meaning, continued to be the prevalent theory in their time, but it was ceasing to be a uniform metaphysical explanation. Rather it became a methodology which tried to account for all physical phenomena by reducing them to motion. This changing perspective can be illustrated by looking ahead a few years. Alfred Cornu, in his opening speech at the International Congress of Physics held in Paris in 1900, spoke of the triumph of Descartes.⁵⁸ Émile Picard also shared this view in his report of the meetings but Robert d'Adhémar pointed out that Picard could boast of the success of mechanism only because 'il y a autant de conceptions du Mécanisme qu'il y a de penseurs'.⁵⁹ Abel Rey, in his *La Théorie de la Physique chez les physiciens contemporains* (1907), found that most physicists were favourable to mechanism, although 'there is no one to my knowledge who has proposed to expound and define thoroughly the mechanistic theory of physics. It appears so natural, assisted by tradition, that no one dreams of analyzing it.'⁶⁰ Thus conceived, mechanism was a scientific methodology, a skill to be learned by apprenticeship, rather than a self-consistent metaphysics. In fact, as Duhem pointed out in *L'évolution de la mécanique* (1903), the same physicist often did not scruple to devise different mutually irreconcilable mechanisms to account for

⁵⁸ A. Cornu, 'Congrès international de physique: discours d'ouverture', *Revue générale des sciences pures et appliquées*, 11 (1900), 919-20.

⁵⁹ R. d'Adhémar, 'L'état actuel de la science d'après le "rapport" de M.É. Picard', *RevPhil*, 2 (1902), 466-94 (p. 490).

⁶⁰ Rey, quoted in Duhem, 'Value of Physical Theory', pp. 317-8.

diverse phenomena.⁶¹

More recent scholarship has also identified many different meanings of mechanism. P.M. Harman, for example, lists three contemporary understandings of mechanism. The first meant the enterprise of explaining natural phenomena in terms of ‘the arrangement of particles of matter and the forces acting between the particles’. The second was the use of springs and pulleys and weights – dear to Kelvin and anathema to Duhem – to picture phenomena. And the third method was the use of Lagrangian analysis, which did not pretend to reveal the underlying structure of nature.⁶² Both Duhem and Maxwell could be said to be mechanists in this third sense.⁶³ The last two meanings of mechanism were clearly not meant to provide metaphysical explanations and hence were no threat to hylomorphism. The danger could only come from the first category which, although it is useful for writing a history of physics, is too broad for the present purposes. Bulliot would have been pleased by a mechanistic theory that admitted forces. In order to avoid misunderstanding, the term ‘kinetic theory’ rather than ‘mechanism’ will henceforth denote the metaphysical theory that everything in the inorganic world can be understood in terms of extension and motion.

Bulliot’s paper at the Society of Saint Thomas was an argument against the kinetic theory. Although he was aware that physicists had modified it in all sorts of ways, he did not shrink from proceeding, because he was convinced that metaphysics and physics should be closely bound. Bulliot began his scientific criticism of

⁶¹ Pierre Duhem, *L'évolution de la mécanique* (Paris: Joannin, 1903; repr. Paris: Vrin, 1992 (with introduction by Anastasios Brenner)), pp. 192-3.

⁶² Peter Michael Harman, *Energy, Force, and Matter: The Conceptual Development of Nineteenth-Century Physics* (Cambridge: Cambridge University Press, 1982), p. 9.

⁶³ For Maxwell, see Jed Z. Buchwald, *From Maxwell to Microphysics: Aspects of Electromagnetic Theory in the Last Quarter of the Nineteenth Century* (Chicago: University of Chicago Press, 1985), p. 21.

mechanism by turning to the laws of collision because 'comme Descartes l'a bien vu, les lois des chocs sont en réalité les seules lois de la nature'.⁶⁴ Experiment had shown that if two inelastic bodies such as balls of clay of equal size approach each other with equal speed and collide, they will deform, stick together, and come to a stop. Their kinetic energy is dissipated by the deformation and turned into heat, which the kinetic theory understands to be an increase in the motion of the atoms and molecules making up the solids. Bulliot then invited the reader to imagine what happens in the collision of two atoms of equal mass which approach one another with equal speed. He maintained that they would stop and remain at rest because they lacked an internal principle of elasticity. (Unlike macroscopic bodies, which were postulated to be elastic on account of the arrangement and interaction of their constituent atoms, the atoms themselves were assumed to be rigid.) Furthermore, being rigid, the atoms in Bulliot's thought experiment could not deform and thus the kinetic energy of the two atoms could not be transformed into heat. Such a collision, then, would violate the first law of thermodynamics which was one of the great achievements of modern science.

Bulliot contrasted Descartes's laws of collision with later experiments that established the conservation of *vis viva*, which, in today's terminology, is double the kinetic energy. Descartes had proposed his various laws of collision based on *a priori* reasoning about abstract matter and was not willing to abandon them even when experiment had made them untenable. Bulliot turned to the history of science to argue that after 1688, it had become clear that Descartes's laws were for the most part wrong. The conserved property of the system was not the total motion as Descartes had defined it -- in today's terminology, the sum of the absolute values of

⁶⁴ Jean Bulliot, 'L'unité des forces physiques au double point de vue philosophique et scientifique', *AnnPhilChr*, 117 (1888/9), 381-95, 118 (1889), 151-64, 226-40 (p. 228).

the momentum of each mass – but the *vis viva*. The conservation of *vis viva* was due to the elasticity of physical bodies which is precisely what Descartes's abstract rigid bodies lacked. It seemed to Bulliot that those who wanted to maintain that all physical forces were essentially the result of the laws of collision were put into the embarrassing position of having the laws of collision disproved by experiment.⁶⁵

The partisans of the kinetic theory recognized that they had somehow to account for the effects of elasticity arising out of rigid bodies and were hoping to do this by assigning a rotational motion to atoms in addition to their translational motion. They appealed to Poinsot's theorems which showed that under certain conditions the loss of translational motion caused by a collision could be exactly compensated by an increase in rotational motion so that the total energy would be conserved. Bulliot thought that this was a vain hope since Poinsot had shown that in most cases there would be a net loss of kinetic energy or even its total annihilation; yet the fact that such fragile bases were used to support books such as Secchi's *L'unité des forces physiques* showed the persistence of Descartes's vision.⁶⁶

After focusing on thought experiments at the atomic level, Bulliot turned to real experiments to discredit Cartesian mechanism. He noted, first of all, that the net statistical effect of non-elastic collisions should be to produce a uniformity of speeds, because two colliding molecules would stick together and continue with a common speed. Thus it should be impossible for the three phases – solid, liquid, and gas – of the same substance to co-exist, although in fact they do.⁶⁷ If one assumes elastic collisions, other problems arise. Substances composed of lighter

⁶⁵ Bulliot, 'L'unité des forces', p. 233.

⁶⁶ Bulliot, 'L'unité des forces', pp. 233-4.

⁶⁷ Bulliot, 'L'unité des forces', p. 234.

molecules, for example, should have a lower boiling point than those composed of heavier molecules. Yet, carbonic acid, whose molecular weight is 38, boils at a much lower temperature than water, whose molecular weight is 18.⁶⁸ Bulliot then cited chemical affinity as inexplicable regardless of whether one assumed elastic or inelastic collisions. Why was it that some elements react quickly with others while some do not react at all, if chemical change was just a matter of collisions and not also of molecular forces? Bulliot next turned his attention to explosives. These substances, on the mechanist assumption, were composed of molecules with a high rotational velocity. Like spinning tops, they appear to be at rest but once tapped from the outside they release their energy by changing their rotational momentum into translational motion. But on this hypothesis, Bulliot continued, it should be impossible to move a box of explosives without detonating it. The problem of explosives was just a particular case of Bulliot's final point concerning potential energy. Given that all macroscopic motion, except in a perfect vacuum, constantly encounters resistance and is dissipated, how is it that motion could preserve almost indefinitely the charge on a Leyden jar, the magnetization of a piece of soft iron, or the energy stored in some chemicals?⁶⁹

The point of all of these criticisms was to argue for a diversity of forces in nature. Just because energy was conserved did not mean that all forces are one. A banker is willing to exchange bills for coins, but that does not mean that bills and coins are the same thing:

Dieu, qui est activité pure, a dû donner et a donné en effet à la matière plus que le mouvement. Il a mis jusque dans l'atome, comme une lointaine image de sa propre vie, des principes actifs et des inclinations naturelles qui meuvent tous les êtres vers leur fin et qui sont ainsi les

⁶⁸ Bulliot, 'L'unité des forces', pp. 235-6.

⁶⁹ Bulliot, 'L'unité des forces', pp. 237-8.

vraies sources de l'énergie et les lois directrices du monde.⁷⁰

Carried away by his enthusiasm, Bulliot provided no arguments for why God 'had to give' to matter more than motion, but he was satisfied that the world shows that He did. Bulliot was convinced that the active principles and natural inclinations of material objects manifest the truth of hylomorphism.

Bulliot's paper was the subject of debate at the May and June 1889 meetings of the Society. At the May meeting, Vicaire objected that he did not think that elasticity and compressibility were necessarily linked as could be seen from considering the two properties in steel and rubber. De Broglie, on the other hand, sought to help Bulliot's cause by reminding the Society that infinite forces were necessary to change the speed of an incompressible atom from $-v$ to $+v$ instantaneously. Vicaire acknowledged the difficulty although he did not think that it was insurmountable. The members agreed to take up the question again at the next meeting.⁷¹

Both Vicaire and Bulliot returned in June with prepared papers.⁷² Vicaire began by declaring that he had no intention of defending the kinetic theory of matter but that several of Bulliot's arguments against it were not valid. Instantaneous changes of speed were indeed problematic, he conceded, 'cependant on peut encore se demander si les principes de la mécanique rationnelle s'appliquent aux atomes, et si les lois de la communication du mouvement ne sont pas tout autres dans ceux-ci

⁷⁰ Bulliot, 'L'unité des forces', p. 240.

⁷¹ *SéancesSSTA*, 22 May 1889, *AnnPhilChr*, 118 (1889), 391-2.

⁷² *SéancesSSTA*, 19 June 1889, *AnnPhilChr*, 118 (1889), 481-8; Vicaire, 'L'Unité des forces physiques: remarques à propos du travail du R.P. Bulliot', *AnnPhilChr*, 118 (1889), 334-45; Bulliot, 'L'unité des forces physiques: réponse aux remarques de M. Vicaire', *AnnPhilChr*, 118 (1889), 515-27.

que dans les corps finis, sur lesquels seuls portent nos expériences'.⁷³ As far as elasticity was concerned, the increased elasticity of steel over rubber indicated that in the limit the most elastic body was also the least compressible.⁷⁴ Bulliot was mistaken then in assimilating the collision of incompressible atoms to the collision of soft macroscopic bodies. Vicaire also noted that Bulliot's reasoning about the impossibility of the co-existence of the solid, liquid, and gaseous phases of the same substance based on the inelastic collisions of molecules was not clear. The argument was really another way of arriving at a net loss of energy and thus a violation of the first law of thermodynamics. Bulliot's argument about the boiling points of various substances neglected the possibility that molecules in the liquid state might stick together and thus that their mechanical weight might be quite different from their chemically determined molecular weight. Furthermore, Bulliot had neglected the shape of atoms, which might yet prove to be an important resource to the kinetic school. Explosives, Vicaire continued, provided a grave problem for every school of physics. But perhaps a theory that admitted compressible atoms might prove useful. Moving on to more philosophical considerations, Vicaire noted that it was very difficult to make a set of simple hypotheses correspond to the real world. One must not be too demanding of scientists, especially considering that imperfect hypotheses can sometimes lead to fruitful results. Bulliot would be much more effective in establishing the 'noble edifice' of scholastic physics were he to show how it could lead to positive results instead of criticizing other systems with dubious arguments.

Bulliot, in responding to Vicaire, was scandalized by Vicaire's suggestion that macroscopic laws might not apply to atoms:

⁷³ Vicaire, 'L'Unité des forces physiques: remarques à propos du travail du R.P. Bulliot', pp. 336-7.

⁷⁴ Vicaire, 'L'Unité des forces physiques: remarques à propos du travail du R.P. Bulliot', p. 337.

Car, dans cette hypothèse, on en pourrait dire autant des principes de la géométrie et peut-être de ceux de la métaphysique. S'il n'y aucun moyen pour nous de conclure avec quelque assurance de ce que nous voyons à ce que nous ne voyons pas, il n'y aura plus au delà de la sphère des sens que de le pur inconnaissable.⁷⁵

In this passage, Bulliot appears to be an epistemological alarmist, especially now that the widespread acceptance of quantum mechanics has removed the novelty from Vicaire's surmise. Yet Vicaire was not always so *avant garde*. A few years later, he argued that Duhem's 'Quelques réflexions', which denied that physical theories were causal explanations and cast doubt on the truth of molecular theories, was calculated to infect science with the poison of skepticism (see chapter 5.1).

Bulliot tried to prove that his analysis of the collision of atoms was correct. His arguments were consistent at one level, because he applied images derived from macroscopic collisions involving elasticity and compression to the atomic scale. There had to be some cause for elasticity, which he could imagine to be none other than compressibility. Yet, in resorting to this tactic, he was leaving himself open to the charge that he was enslaved to the imagination, the very accusation he had made against Descartes.

Bulliot tried to re-inforce his arguments about boiling points by recourse to Avogadro's hypothesis about the number of independent molecules in a given volume of gas. If one considered the transition from the gaseous state to the liquid, in a mixture of water and carbonic acid, one would expect the carbonic acid to liquify first on account of its heavier molecular mass, although experiments showed that the water vapour was the first to become liquid. Bulliot then produced a new argument for his main thesis against the kinetic theory. The theory could not be made to account for irreversible processes. For this view, he could cite the authority of

⁷⁵ Bulliot, 'L'unité des forces physiques: réponse aux remarques de M. Vicaire', p. 516.

Poincaré.⁷⁶

Other members of the Society got involved in the debate. Auguste Ackermann, although he too wanted to argue for scholastic physics, thought that some kinetic theory of the universe might be possible. Given the difficulty of understanding motion in general, the definition 'nothing but matter and motion' was much vaguer than one might suspect. Bulliot's response to this shows his characteristic intellectual boldness. True, the laws of motion were difficult to discern, 'mais ces lois, une fois découvertes, se sont trouvées presque toutes être intelligibles ou même nécessaires'.⁷⁷ The question of motion would be debated at the Society again.

Bulliot next tried to establish hylomorphism at the June and October 1891 meetings of the Society by arguing from the differences between force and mass.⁷⁸ Force was active; mass was passive. Force had a direction; mass did not. Some members of the Society were skeptical of this approach. Ackermann's comments account for most of the minutes of the June meeting. He criticized Bulliot on account of the obscurity of the notion of force. Human beings have an idea of force because they encounter resistance in moving external objects. Yet the idea of force becomes problematic when it is applied in physics. There it stands for the unknown cause of motion. According to the theory of gravitation, two masses have a tendency to come together. The tendency remains a mystery despite the convention that appeals to the force of gravitation. Yet no visible force is applied and the facts suggest that the masses are the principles of this action. A mass offers resistance to

⁷⁶ Bulliot, 'L'unité des forces physiques: réponse aux remarques de M. Vicaire', pp. 526-7.

⁷⁷ *SéancesSSTA*, 19 June 1889, *AnnPhilChr*, 118 (1889), p. 485.

⁷⁸ *SéancesSSTA*, 17 June 1891, *AnnPhilChr*, 123 (1891/2), 371-6; *SéancesSSTA*, 21 October 1891, *AnnPhilChr*, 123 (1891/2), 376-9.

movement. Why should this resistance be called a pure passivity and not a force of reaction? And as for directionality, gas pressure is commonly called a force, and yet it is exerted equally in all directions.

This time Vicaire came to Bulliot's defence. His habit of thought as a physicist made it difficult for him to appreciate Ackermann's intervention. Surely force is different from mass, Vicaire said, because a force can never be balanced by a mass. No matter how small a force is applied to no matter how large a mass, it will eventually be able to accelerate it to any given speed. Bulliot thought that although rational mechanics may have derived the concepts of force without metaphysical concerns, the metaphysician is nevertheless permitted to use the concepts to confirm a metaphysical thesis.

Most of the further points in this debate need not be repeated. But two, made at the October meeting, are significant. First, D'Hulst acknowledged Ackermann's point about causality when he said: 'Il serait difficile, en effet, de dire aujourd'hui que l'idée de cause nous vient des corps, et non de l'expérience intime de notre activité.'⁷⁹ And secondly, Ackermann pointed out that Bulliot rightly defined the scholastic conception of matter as *nec quid, nec quantum, nec quale*. Mass, on the other hand, was certainly a *quantum* – it was a mathematical co-efficient. Hence, 'qu'on l'appelle active ou passive, je n'y trouve aucun des caractères de la matière scolastique'.⁸⁰

Outside of the Society, Bulliot argued for hylomorphism at the second International Scientific Congress of Catholics in a paper entitled 'Examen des

⁷⁹ *SéancesSSTA*, 21 October 1891, *AnnPhilChr*, 123 (1891/2), p. 379.

⁸⁰ *SéancesSSTA*, 21 October 1891, *AnnPhilChr*, 123 (1891/2), p. 378.

principales théories de la combinaison chimique'.⁸¹ Every chemical reaction, he said, was accompanied by three phenomena: variation in energy, change of molecular structure, and change in the properties of substances. Thermochemistry, represented in France by Berthelot and his disciples, focused on the variation of energy levels. The approach was legitimate but it could not be exhaustive because it did not account for affinity: a study of the quantity of energy released or absorbed did not explain its quality or specificity. The science of chemical structure also did not provide a complete explanation of chemical reactions. Not long ago, Jean-Baptiste Dumas thought that the properties of a compound depended more on the structure or arrangement of the atoms than on the atoms themselves. He was impressed by the fact that when acetic acid was transformed into chloroacetic acid by the substitution of an electro-negative chlorine atom for an electro-positive hydrogen atom, the new compound retained the principal properties of the old. Nevertheless, the two acids were not identical. And other simple substitutions sometimes produced widely dissimilar products: potassium hydrate, for example, was a base, whereas chloric hydrate was an acid. Bulliot noted that energy and structure were separate categories, neither of which attains the essence of the chemical compound. Even the eminent French chemist, Adolphe Würtz, whose own researches focused on chemical structure, recognized that structure was as much an effect as a cause and 'qu'en réalité ces réactions, ces saturations des acides par les bases, ces échanges d'éléments sont liés à des phénomènes d'énergie qui les régissent'.⁸² Bulliot then hoped to show that the lacunae found in both thermochemistry and structural atomism could be filled by the scholastic doctrine of substantial change.

⁸¹ Jean Bulliot, 'Examen des principales théories de la combinaison chimique', *AnnPhilChr*, 123 (1891/2), 313-30.

⁸² Würtz, quoted in Bulliot, 'Examen des principales théories', p. 324.

An undeniable feature of chemical change was the emergence of new properties in the substances produced. Bulliot argued that some of these properties, especially in the case of organic compounds that exist virtually in living beings, are so complex that there is no way that they could be actually present in the elements which compose them. The successive transformations that lead from simple carbon, oxygen, hydrogen, and nitrogen to complex organic molecules is no doubt influenced by thermochemical considerations and the virtual presence of the atoms in the molecules, but it could not proceed without the direction of the tendencies or properties arising from the substantial forms of the intermediate compounds. A chemist, he said, must know these properties if he is to understand and be able to predict the behaviour of a particular substance. To know only that a compound is made of sulfur and oxygen is to know very little about it. To know that such a compound is an acid is to be able to predict much about its behaviour.

Bulliot argued that the elements which make up a compound can be considered as its material cause whereas its chemical properties reveal its actual nature or substantial form. Only hylomorphism, with its two principles of explanation, could account for all the phenomena of chemical change. This kind of analysis would not be too controversial, at least among neo-scholastics, had Bulliot not wanted to strengthen the link between science and the metaphysical categories used to understand it. But Bulliot went further. Aristotle, he said, had introduced the concept of prime matter by considering substantial change. But advances in science made it possible to specify prime matter. The distinctions of matter and form in chemistry were analogous to the distinction of mass and movement in mechanics because, (one supposes), the two are inseparable and yet distinct concepts. A given mass could take on any speed. Appealing to this analogy, Bulliot concluded:

La matière première du philosophe grec n'est pas autre chose, au fond, que la masse, telle que l'entend la mécanique, par elle-même inactive, inerte, mais cependant réceptacle et soutien de toutes les forces. Seulement Aristote y est arrivée par l'étude de la transformation chimique, et les savants de la Renaissance par celle du mouvement. La forme substantielle est le principe des énergies spécifiques, la source des propriétés des corps.⁸³

Bulliot's reader might be forgiven if he did not immediately follow the analogy. Part of the problem was that Bulliot equated 'specific energies' and 'properties of bodies'. This is only legitimate if 'energy' is understood according to its Greek meaning of 'actualization' or principle of action. Otherwise, it is stretching things to assimilate 'specific energy' to the carefully defined concept of kinetic energy. Yet, even if Bulliot were to be granted this identification, one could still object that mass was an abstract aspect of matter. Although all of Bulliot's contemporaries believed that mass was conserved in every reaction, it remained an aspect of matter and not matter itself.

It would be interesting to know the reaction of Bulliot's audience at the 1891 Congress to his identification of mass and prime matter. If there was opposition, it was not strong enough to change his mind. Bulliot's discourse on this very theme at the 1894 Congress was the immediate cause of Duhem's broadside against philosophers who thought they could speak authoritatively about the meaning of science by reading the prefaces of a few textbooks of physics and chemistry (see chapter 5.2). Soon after the incident Bulliot and Duhem entered into correspondence that would continue for twenty years. If Bulliot thought that he could win Duhem over to his point of view, he was mistaken. In a letter to Gardeil, Duhem wrote:

J'ai reçu une longue lettre de l'excellent Père Bulliot, qui rêve de me

⁸³ Bulliot, 'Examen des principales théories', p. 329.

convertir savez vous à quoi? *Au retour de la science moderne à la philosophie scolastique!* Cela me semble une énormité aussi grosse que chercher à rejoindre les deux côtés d'un angle. Philosophie scolastique et science moderne partent assurément du même point; mais à partir de là, elles divergent en poursuivant deux buts absolument différents et tous deux légitimes. L'une et l'autre prennent l'expérience qui nous révèle l'existence des corps; mais l'une cherche le *quid proprium* de ces corps et le trouve dans la matière première et dans la forme substantielle – l'autre cherche à symboliser par un nombre, la *masse*, l'effort qu'il faut faire pour mettre ces corps en mouvement. Et le P. Bulliot veut ramener l'une à l'autre! Chercher l'identité de la matière première de la masse! Cela me semble fou, tout simplement.⁸⁴

Duhem's distinction between science and philosophy should be familiar by now, although it will be analyzed in greater detail in chapter 5. Bulliot's confounding of the two may be patently illegitimate. But others shared his hopes while trying to avoid his cruder errors.

In Louvain, Desiré Nys earned a doctorate in Thomist philosophy in 1888 with a thesis on *Le problème cosmologique*, which was published as a book in the same year. Like Bulliot, he was writing against the kinetic theory. Nys mentioned some of the same points as Bulliot in his criticism of the kinetic theory but then went on to add some more. Among the chemical data, kinetic theory could not explain why atomic masses were constant and more or less multiples of the atomic mass of hydrogen. It could not explain affinity and valence. Nor could it distinguish between a chemical combination and a physical mixture. And among the facts provided by physics, kinetic theory could not account for crystalline structure, density, co-existence of phases, as well as acoustical, thermal, optical, and electric properties. Finally, the kinetic theory could not explain potential energy. 'Si le mécanisme était vrai, il ne nous resterait plus qu'à recourir, avec Descartes, à l'existence d'un mauvais génie, pour lui attribuer la cause des hallucinations de nos sens abusés.'⁸⁵

⁸⁴ Letter from Duhem to Gardeil, 24 January 1895, in ArchSaulchoir.

⁸⁵ Nys, *Le problème cosmologique*, p. 64.

Nys claimed that the scholastic theory could explain all the facts that the kinetic theory could not because it posited a substantial form in each atom or molecule. First of all, Thomas had spoken of some substantial forms which needed a definite amount of matter.⁸⁶ Nys used this to explain why the elements each had a characteristic mass. This particular use of Thomas needs to be explained, for Nys was not the only one to seize upon a suggestive passage in the Angelic Doctor's commentary on Aristotle: 'In a natural body, there is natural form that requires a determinate quantity just as it requires other accidents.'⁸⁷

The quotation comes from a passage in which Thomas was distinguishing between a body considered mathematically, and a body as it occurs in nature. A body considered mathematically was potentially infinitely divisible, because quantity, abstractly considered, was infinitely divisible. A body as it exists in nature, on the other hand, could not be divided infinitely because there was more to such a body than the category of quantity. To use Thomas's example, if one cuts flesh into smaller and smaller pieces, at some point it will cease to be identifiable as flesh.⁸⁸ Or, to develop Thomas's thought, for a substance to be called a pebble it must be bigger than a grain of sand and smaller than an ostrich egg. The substantial form of pebble – if indeed there be such a thing – demands a determinate quantity of matter. It should be clear that Nys was stretching Thomas's meaning to suit his purposes. Atomic and molecular weights did not permit the variation in size that

⁸⁶ Nys, *Le problème cosmologique*, p. 90.

⁸⁷ 'In corpore naturali consideratur forma naturalis, quae requirit determinatam quantitatem sicut et alia accidentia.' *In Primum Physicorum*, Lectio 9 (Marietti edition). Nys had 'invenitur' instead of 'consideratur', which however does not make any difference to the argument: the translation is unproblematic; nevertheless, it is found in Wallace, 'Are elementary particles real?', pp. 177-8.

⁸⁸ 'Non ergo est possibile quod sint aliquae partes carnis aut ossis quae sint insensibiles propter parvitatem.' (It is not possible therefore that there be some parts of flesh or bone that cannot be perceived by the senses on account of their smallness.) *In Primum Physicorum*, Lectio 9 (Marietti edition).

Thomas had envisioned. No doubt, the text is suggestive and continues to attract attention among Thomists such as William Wallace today, but it does not establish that Thomas had foreseen the periodic table.

Yet Nys was pointing to a real puzzle. Why did the various elements each possess a characteristic mass? Substantial forms were a good scholastic answer to the question, but they could not give any real insight into the solution. Nys took advantage of other characteristic properties of elements and compounds to argue for hylomorphism: chemical affinities, valences, and crystalline shapes. Substantial forms could, at one level, provide an explanation for as many characteristic properties as one should choose to invoke. With such an adaptable intellectual resource, Nys could easily establish hylomorphism as a legitimate explanation in the face of the evident defects of the kinetic theory. But the question remained as to the value of the scholastic explanation. Did it escape from the charges leveled against the dormitive properties of opium? The clear answer is 'no'. Nor was it evident that hylomorphism could in any way help the development of science.

The Dominican priest Marc-Marie de Munnynck praised Nys's work, albeit with some reservations, at the 1897 *International Scientific Congress in Fribourg*. De Munnynck first presented further arguments for hylomorphism based on the work of his teacher Louis Henry. Their common theme was to show that there is a 'functional solidarity' among the atoms in a chemical compound. Thus, for example, the compound $\text{CH}_2\text{O}(\text{CH}_2\text{Cl})_2$ contains the radical CH_2Cl twice. An atomist could not distinguish between the two chlorine atoms. But the chlorine in one of the radicals reacts violently with compounds of hydrogen and with metallic compounds whereas the chlorine in the other radical does nothing of the sort:

Quelle peut-être la raison de cette différence si marquée? Pour l'atomiste il n'y a pas de cause possible. Dire qu'elle se trouve dans le voisinage de

l'oxygène, c'est avouer que O a modifié *essentiellement* le carbone sur lequel il se trouve fixé, que le carbone *essentiellement modifié* a modifié *essentiellement* le chlore; en un mot, c'est repudier l'atomisme comme concept philosophique et accepter l'hylémorphisme dans sa thèse fondamentale.⁸⁹

De Munnynck thought that the essential modification of one atom by another could also be demonstrated in the case of valences. Nitrogen was trivalent with respect to hydrogen. But NH_3 could readily bond with chlorine, which then made it possible for a fourth hydrogen atom to bind to the nitrogen. De Munnynck chose this example as one that made the renowned atomist Adolphe Würtz grasp at straws: 'Au milieu des "peut-être" et des "qui sait?" il finit par formuler une nouvelle hypothèse, qui, si elle signifie quelque chose, implique le rejet de l'atomisme.'⁹⁰ Although variable valency proved to be troublesome to explain, C. A. Russell has shown that by the time that De Munnynck was writing there were several ingenious accounts of the phenomena, including appeals to polymers, chains, and paired valencies, to name only some of the simpler proposals.⁹¹ De Munnynck either did not know of these theories or chose not to be bogged down in details in his dismissal of chemical atomism.

De Munnynck agreed with Nys that in chemical compounds the individual is the molecule, but he thought that Nys was wrong in making an exception in the case of simple substances such as H_2 or Cl_2 by attributing individuality to the atoms. Nys had adopted this view for several reasons which all have to do with atoms retaining at least some of their properties within the compound. First, they retain their atomic weights; secondly, the Dulong-Petit law for specific heats holds good, that is,

⁸⁹ De Munnynck, 'Notes sur l'atomisme', p. 588.

⁹⁰ Würtz, *La théorie atomique*, quoted in De Munnynck, 'Notes sur l'atomisme', p. 589. De Munnynck gave no page numbers.

⁹¹ C.A. Russell, *The History of Valency* (Leicester: Leicester University Press, 1971), pp. 171-223.

$$(\text{atomic mass}) \times (\text{specific heat}) = 6.4;$$

and, thirdly, when compounds such as HCl break down, the atoms in each molecule are freed as single entities rather than as diatomic molecules. De Munnynck pointed out that none of these reasons was conclusive and that there was no need to make an exception for simple substances. Avogadro's law for gases held good for H₂ rather than for each of the hydrogen atoms. The Dulong-Petit law was just a special case of the Kopp-Woestyn law which said that:

$$(\text{molecular mass}) \times (\text{specific heat}) = 6.4 \times (\text{number of atoms in molecule}).$$

Moreover, it was clear that the single hydrogen and chlorine atoms which were released in the decomposition of HCl had a different nature from their diatomic molecular state, which was manifest in their chemical properties. The monatomic hydrogen searched for a partner, whereas diatomic hydrogen did not.

Nys had been led to his view by attributing too much to the persistence of atoms and their properties within molecules. De Munnynck recognized that scholastic theory must somehow try to account for their persistence and went so far as to consider the Dulong-Petit law as perhaps the most serious difficulty that one could advance against hylomorphism.⁹² He heartily approved of the notion of virtual presence of atoms in molecules but he thought that it was important to specify that this presence did not imply a homogeneity of substance. By this he meant that, if the molecule could be seen, it would be possible to distinguish the individual atoms composing it. Their incorporation into the molecule would not completely destroy their identity. Just as in the case of human beings the eye is distinct from the liver although both of them are part of the one substance, so it is with the individual

⁹² De Munnynck, 'Notes sur l'atomisme', p. 591.

atoms in molecules.⁹³

De Munnynck and Nys agreed that each chemical compound was essentially different from other compounds. Thus, hydrogen, oxygen, and water are three essentially different substances. This was the common teaching among the neo-scholastics but it was not universal.⁹⁴ An alternative view held that only elements were essentially different; the properties of chemical compounds were not essential properties but only accidental, arising from the relations among the combined elements.⁹⁵ A more radical view, not to be found among neo-Thomists, denied that there were any essential differences at all between even the elements: all inorganic matter was the same substance. (Prout's hypothesis could be interpreted in this way, but any monist conception of the universe is also consonant with this alternative.) De Munnynck, in a paper on 'Les propriétés essentielles des corps bruts', acknowledged that it was extremely difficult to distinguish between *essential* and *accidental* properties but thought that it was possible to establish the common thesis by a combination of scientific and metaphysical arguments. Such a proof, were it to exist, would have the merit of confirming the common-sense intuition that there were essential differences among inorganic substances.⁹⁶

De Munnynck began by trying to show the continued relevance of the scholastic adage *operari sequitur esse* (action follows upon existence) by appealing to Newtonian physics. Every corporeal substance in the universe reacts with every other

⁹³ De Munnynck, 'Notes sur l'atomisme', p. 596.

⁹⁴ Marc de Munnynck, 'Les propriétés essentielles des corps bruts', *RevThom*, 8 (1900), 155-69. De Munnynck lists 10 neo-scholastic authors who adopted this point of view, including Zigliara, Lepidi, de San, Kleutgen, and Nys.

⁹⁵ A. Charoussat, 'Le problème métaphysique du mixte: Y a-t-il des "changements" substantiels dans le monde minéral?', *RevPhil*, 3 (1902/3), 529-47, 661-81.

⁹⁶ De Munnynck, 'Les propriétés essentielles', p. 161.

according to Newton's law of gravity. Thus every body has a principle of action – its mass – which arises out of its existence. What holds in mechanics, by analogy, should hold in other spheres of action. Thus every material substance has an operation which flows from its nature and which entails the deployment of an essential property. The scholastic adage, in de Munnynck's estimation, could continue to provide cosmological insights.

The most fundamental property of corporeal substances, he continued, was extension. But extension could not be the principle of unity in a substance, for it presupposed a determined substance. Hence, there had to be other essential properties besides extension. What were these? They could not be physical phenomena such as temperature and local motion because it was possible to observe a given substance getting hotter or speeding up and hence undergoing changes which were only accidental. Thus, by default, the essential properties had to be chemical properties. De Munnynck dismissed the suggestion that other properties whose effects would forever remain hidden to the senses might be the true essential properties. Such arguments, he thought, just illustrate the danger of allowing pure metaphysics into cosmology, which must find its confirmations in the reality of the world.⁹⁷

De Munnynck developed his argument further in a manner more rhetorical than conclusive:

Toutes ces espèces corporelles, *essentiellement* diverses, sont donc, par leur nature totale, le principe de la quantité. Dès lors, n'est-il pas infiniment probable que chaque espèce exige une quantité *déterminée*, généralement différente de toutes les autres, et qui par conséquent permettra de caractériser la substance, si l'on parvient à la déterminer? Il nous semble que cela ne peut faire l'ombre d'un doute.⁹⁸

⁹⁷ De Munnynck, 'Les propriétés essentielles', p. 166.

⁹⁸ De Munnynck, 'Les propriétés essentielles', p. 167.

To support this opinion, he quoted a passage from Saint Thomas's *De potentia* which resembled the passage from the Commentary on Aristotle's *Physics* which Nys had made use of in arguing for the fixity of atomic weights: 'Although mathematical bodies can be divided indefinitely, natural bodies can be divided only to a certain point, for a determined quantity of matter is allotted to each and every form.'⁹⁹ Like Nys, de Munnynck did not scruple to adapt the principle to modern chemistry. Molecular weight thus became an essential property; and compounds no less than elements were different substances. (He got around the problem of isomers by appealing to their generation as the cause of further specific properties.) On this view, then, the change of hydrogen and oxygen into water was a true substantial change.

A. Charousset argued the opposite point in an article entitled 'Le problème métaphysique du mixte: Y a-t-il des "changements substantiels" dans le monde minéral?' which appeared in the *Revue de philosophie* in 1903. Charousset argued mostly from philosophical principles against the notion that the appearance of a new chemical property in a mix or compound implied a new substance. It was necessary to distinguish between essential and accidental properties. Essential properties were those which were inseparable from the substance. Charousset implicitly accepted that each of the chemical elements were distinct substances. He thought, as did most neo-scholastics, that a physical mixing of elements was a mere accidental change. But then he went on to deny any substantial change in the inorganic order because he believed it was impossible to distinguish between a physical mixing of chemicals

⁹⁹ 'Etsi corpora mathematica possint in infinitum dividi, corpora tamen naturalia ad certum terminum dividuntur, cum unicuique formae determinetur quantitas secundum naturam.' Thomas Aquinas, *De Potentia*, q. 4, a. 1, ad 5, quoted in de Munnynck, 'Les propriétés essentielles', p. 167; probably from the Vives edition.

and chemical combination:

Aucun mixte minéral n'implique, selon nous, un changement substantiel, au sens ontologique du mot. Tout mixte minéral, mélange ou combinaison, est un simple *agrégat* de substances, plus ou moins altérées, plus ou moins unifiées dans leurs propriétés sensibles, mais gardant toujours leur individualité respective.¹⁰⁰

Charousset drew heavily upon Duhem's 'Le mixte et la combinaison chimique' to deny that modern science could distinguish between these two forms of union. It was not possible, he maintained, to say that a mixture was merely physical whereas a combination was chemical because chemistry was a branch of physics. To illustrate the difficulty, Charousset gave two examples: (1) the decomposition and reconstitution of water and (2) the decomposition and reconstitution of calcium carbonate. The details of the first case will suffice to explain the general argument. At sufficiently high temperatures (from 1200° to 1500°C), water vapour partially decomposes into oxygen and hydrogen. If the temperature is further increased, a prodigious amount of the constitutive gases is released; if, on the other hand, the temperature is decreased, water vapour begins to appear. The same kind of phenomenon can be seen at a given (sufficiently high) temperature by varying the pressure. If there is an equilibrium of oxygen, hydrogen, and water, increasing the pressure will reduce the amount of oxygen and hydrogen and increase the amount of water vapour, whereas reducing the pressure will have the opposite effect.¹⁰¹ The example shows that the distinction between a mixture and combination is at least blurred. Charousset believed that the boundary was in fact eliminated. Every mixture of elements was precisely that – a mixture. Hence, the possibility of substantial change was eliminated from the inorganic order.

¹⁰⁰ Charousset, 'Le problème', p. 544.

¹⁰¹ Charousset, 'Le problème', p. 545.

Most neo-scholastics disagreed with Charousset, but the question continued to attract attention. Nys, in the third edition of his *Cosmologie* (1916), devoted nearly a hundred pages to the discussion of modern scholastic attitudes concerning chemical composition. He could find only one ally for Charousset, a Father Schaaf, who merely favoured the opinion. On the other hand, Nys listed thirty-four neo-scholastic authors besides himself who believed in the essential unity of chemical compounds. The stakes in the debate were high. Nys acknowledged that the distinction between organic and inorganic chemistry was nearly completely eliminated since organic compounds could be synthesized in the laboratory. Hence, 'si l'unité substantielle des composés inorganiques est condamnée par les principes de la chimie moderne, il faut reléguer dans le domaine des chimères l'unité essentielle des êtres vivants'.¹⁰²

Nys used many arguments drawn from science to argue for the majority position. His strategy was to show that properties of elements were altered by the incorporation of atoms into molecules. Nys acknowledged that atomic weight remained constant: molecular weight was the sum of the weights of the constituent atoms. But this, he said, was hardly surprising since weight arises from prime matter which is conserved in every substantial change. Specific heat too seemed to be a problem for hylomorphism. But Nys pointed out that the Dulong-Petit law was only more or less accurate; moreover, as the law depended on atomic mass, it was not surprising that it too was additive on account of the conservation of prime matter. It was easier to dismiss other alleged arguments for the essential persistence of atoms in molecules. Molecular volumes, refraction, and magnetic moments had been cited as properties that could be deduced by summing the corresponding properties of the constituent atoms. But Nys pointed out that there were too many exceptions to the

¹⁰² Nys, *Cosmologie*, I, p. 302.

alleged laws for the arguments to be conclusive. He dismissed spectral properties as being dependent on physical circumstances such as temperature and pressure. And he handled chemical affinities by appealing to the argument about the change in valence of nitrogen when joined to other elements.

There was nothing new in the arguments. Significantly, Nys did not respond directly to Charoussset's point that chemistry and physics were essentially the same science. Nor did he cite Duhem's 'Le mixte et la combinaison chimique'. But Nys had the weight of neo-scholastic opinion on his side which he disseminated further through the many editions, printings, and translations of his *Cosmologie*.

The arguments for hylomorphism examined so far have relied on a mixture of metaphysics and results of the positive sciences. Not wanting to appear skeptical or out of touch with modern theories, the neo-scholastics granted ontological status to atoms and molecules, the hypothetical entities of empirical science. They then tried to understand these submicroscopic entities in terms of hylomorphism, which had been developed to understand entities on a human scale. When one recognizes the difficulty of specifying what is an essential property of substances such as cats, the effort to do so for more problematic entities such as molecules soon appears insoluble. Most people would say that a mottled cat and a grey cat are not a different species. Why then is a chemical compound that differs from another only by its interaction with polarized light substantially different? Species is a concept that is dependent on human intuition rather than on laboratory measurements.

The various contributions to the debate about what constitutes a substance shows that the neo-scholastics were at least implicitly aware of the problem. Bulliot and Nys trusted their intuition to identify essential properties. De Munnynck tried to develop an *a priori* criterion for substantial properties and thought that chemical

properties, as distinct from physical ones, fit the bill. He thus attempted to justify the majority position, which at least had the merit of corresponding to the belief of the common man that water was a distinct substance from oxygen and hydrogen. Charoussat argued for the counter-intuitive position. He had the acumen to notice that it was not easy to distinguish between physics and chemistry and that the confidence of the majority was unwarranted. Yet, by implicitly assuming that the elements of the periodic table were the only real substances, he made chemistry the ultimate arbiter over substance.

One obvious response to these difficulties was to limit the scope of science. Man will continue to differentiate between water and wine regardless of whether physicists or chemists decide that wine is a mix or a compound. This, as will become apparent later in the chapter, was Duhem's position, at least as concerns the right of physics to be the ultimate arbiter of reality. But this was not an option that neo-scholastics were willing to acknowledge for two reasons. First, in a scientific climate, such a separation would seem to be motivated by the desire to escape the truth. (Rey's accusation that Duhem devised a philosophy of physics that made it possible to retain religious belief is a case in point.) Secondly, the neo-scholastics, or at least those interested in cosmology, came to believe that physics was at the basis of philosophy. As Nys put it, 'la science physique [...] [doit] constituer la base de toutes les disciplines philosophiques'.¹⁰³

Physical science, however, was a very poor basis for re-establishing Aristotelian natural philosophy. The debates about hylomorphism and chemical compounds were mere logomachies. The arguments for hylomorphism only pointed out the deficiencies of rival cosmologies. This was easy to do when arguing against the

¹⁰³ Nys, *Cosmologie*, 1, p. 374.

kinetic theory and even against dynamism, as will be apparent shortly; but hylomorphism was hardly a theory which could be tested scientifically. It was the only apparent alternative which remained after Descartes's vision of matter was shown to be insufficient to account for all its properties. But what did the neo-scholastic theory say? Nothing, except that the world is more complicated than various reductionist schemes would like to pretend. It was with regret that Nys cited Laminne: 'Nous ne prétendons pas qu'aucun fait scientifique contredise la théorie péripatéticienne de la matière et de la forme substantielle; nous croyons seulement que les phénomènes physico-chimiques, tels qu'ils nous sont connus aujourd'hui, ne fournissent pas d'argument en faveur de cette théorie.'¹⁰⁴ Although neo-scholastics such as Bulliot and d'Hulst spoke of the potential of hylomorphism to advance science, it was capable of no such thing. The various essential properties which were proposed to overcome the shortcomings of competing physical theories remained mere words.

4. Neo-Thomist views of dynamism and energetics

When Nys published his *Le problème cosmologique* in 1888, the only rival theory to hylomorphism which he felt the need to examine was the kinetic theory. In subsequent editions of his *Cosmologie*, he went on to examine neo-mechanism, atomic dynamism, dynamism, and energetics. Dynamism, along with the kinetic theory, was also criticized by Farges in the many editions of his *Cours de philosophie scolastique*. An examination of the neo-scholastic attitudes towards dynamism and energetics will reveal some further neo-scholastic concerns. The case of energetics is especially important because it is Duhem's approach to physics.

¹⁰⁴ Laminne, *Les quatre éléments, le feu, l'air, l'eau, la terre* (Bruxelles: Hayez, 1904), p. 191, quoted in Nys, *Cosmologie*, II, p. 292.

One might argue that it would have been more relevant to focus on neo-mechanism which by all accounts was the reigning methodology in physics. Yet, insofar as it was a methodology, it did not pose a challenge to scholastic philosophy.¹⁰⁵ Atomic dynamism also did not worry the neo-scholastics. (Harman would call this a form of mechanism.¹⁰⁶) It taught that atoms were made of a homogeneous matter and could exert a force on others. Although the assumed homogeneity of matter was problematic for the neo-Thomists, the positing of force as an internal principle of action was seen as an important step towards the truth of hylomorphism.¹⁰⁷ But both dynamism and energetics could be turned into a rival metaphysics. Hence there was a need to examine them more closely.

A. Dynamism

Strict dynamism was philosophically problematic because it denied that matter was extended. The system sought to explain all physical phenomena by positing inextended points which exert forces on one another that vary with distance. The neo-scholastics attributed the origin of the system to Leibnitz's doctrine of monads and saw in Boscovich its most influential scientific development. Dynamism attracted more attention among the neo-scholastics than in other circles because it was the preferred system of Carbonnelle, the editor of the *Revue des questions scientifiques*, a self-professed admirer and follower of Boscovich. But there were other nineteenth century scientists who were influenced to varying degrees by his ideas. Among the French, Lancelot Law White lists Laplace, Ampère, Cauchy, and later on de Saint-Venant; among the English, Faraday, Maxwell, Kelvin, and J.J. Thomson; and among

¹⁰⁵ Nys, *Cosmologie*, I, p. 241.

¹⁰⁶ Harman, *Energy, Force, and Matter*, p. 9.

¹⁰⁷ Nys, *Cosmologie*, I, p. 249.

the German and Dutch, Weber, Helmholtz, and Lorentz.¹⁰⁸ In fact, any theory that admitted the existence of force could be seen as a modified form of dynamism. The neo-scholastics were especially intrigued by Hirn's attempts to argue against the kinetic theory by attributing a separate existence to force, as will soon be apparent. But the main reason for their interest was Carbonnelle.

In 1881, Carbonnelle published Paul de Broglie's 'Dynamisme et atomisme' in the *Revue des questions scientifiques*. De Broglie conceded that experimental science could not and probably would not be able to decide between the two systems.¹⁰⁹ He thought, however, that metaphysical arguments could be used to demonstrate the absurdity of dynamism. Common sense dictated that extended substances exist in space. Dynamism had to show how unextended monads could account for extension. De Broglie thought that Carbonnelle's attempt to get around the problem by saying that 'la substance atomique est dans l'espace par son action et non par son essence' was not an adequate answer because it led to the conclusion that there is nothing real in space.¹¹⁰ De Broglie had other arguments against dynamism including the absurdity of action at a distance and the impossibility of force being the essence of a substance.

As one might expect, a series of letters between Carbonnelle and de Broglie appeared in the pages of the *Revue des questions scientifiques*. But somewhat unexpectedly, the neo-Thomist Domet de Vorges published a lengthy article 'La notion de l'étendue et ses causes objectives' a year later in the same journal in which he argued for dynamism. At the beginning of the article, Domet de Vorges

¹⁰⁸ Lancelot Law Whyte, 'Boscovich's Atomism', in *Roger Joseph Boscovich, S.J., F.R.S., 1711-1787: Studies of His Life and Work on the 25th Anniversary of His Birth*, ed. by L.L. Whyte (London: Unwin, 1961), pp. 102-26 (pp. 120-1).

¹⁰⁹ Paul de Broglie, 'Dynamisme et atomisme', *RevQuestSci*, 10 (1881), 353-412 (pp. 358-9).

¹¹⁰ De Broglie, 'Dynamisme et atomisme', pp. 370-1.

acknowledged that common-sense ideas about extension supported the neo-scholastic position that extended bodies are really extended and composed of extended atoms. To deny this, it was feared, was to open the door to subjectivism. Domet de Vorges too wanted to avoid the danger, but in this case, he thought that reason showed that the common sense position was untenable. Only dynamism could satisfy the just demands of reason.

In trying to follow Domet de Vorges's reasoning, one begins to appreciate why scholastic debates were dismissed as sterile logomachy in the seventeenth century. This judgment is not meant to endorse the common-sense view of the majority of neo-scholastics, for it is clear that their application of hylomorphism to atomic and eventually to subatomic levels was problematic. It merely points out the inadequacy of human language to get at the essence of concepts which are fundamental to thought, such as extension and substance. A few of Domet de Vorges's arguments will illustrate these generalizations. Fortunately, there is no need to go into greater detail because neither the common scholastic manuals nor Duhem nor the more informed neo-scholastics took up the argument.

Domet de Vorges, after proving to his satisfaction that the void could not exist, turned his attention to proving that the plenum also could not exist. The plenum was inseparable from the sense-experience of continuity. Continuity thus conceived undoubtedly existed but the continuum as a metaphysically real essence did not. This, he maintained, could be seen by considering that any continuum was divisible into smaller parts, each of which was continuous and had extension. The same argument could then be repeated for each of the smaller parts. This quickly introduced the notion of infinity. Each body, on this account, would be composed of an infinite number of infinitely small parts. There would be nothing, he concluded,

to distinguish a meter from a kilometer.

Domet de Vorges thought that it was only by equivocating on actual and potential infinities that the medievals were able to safeguard the common-sense notion of the continuum. But neo-scholastics should not resort to such equivocation, especially since physics provided further arguments against the continuum.

Attributing much more to the claims of physics than empirical evidence allowed, Domet de Vorges continued:

On sait que tout se passe dans le monde matériel comme si les corps étaient composés d'un nombre immense de molécules exerçant des actions l'une sur l'autre dans la direction qui joint leur centres. Ces actions sont considérées par les savants comme des attractions ou des répulsions. Elles sont attribuées à des forces toujours fonctions de la distance.¹¹¹

Interior forces, he said, maintained the shape of a body. Moreover, Cauchy and Poisson had independently shown, at least according to Domet de Vorges – he gave no references –, that if the distances between the centres of force between the molecules were equal to zero, the forces tangential to the boundary of the body would disappear. This would mean that no solid body could exist. Rather, the molecules would dissipate into space. And if this were true for bodies in general, it should be applicable to the atom. Thus extended bodies could not be built up out of extended atoms.

Domet de Vorges thought that he could avoid contradicting both sound metaphysics and sound science by defining distance as the action which inextended elements exert on one another:

L'action peut donc très bien suppléer la distance et jouer le même rôle. Où notre imagination se représente un plus grand rapprochement, nous verrons une intimité plus grande entre les éléments. Ce que nous appelons changement de lieu sera, dans la réalité, changement de relations. Les mêmes lois continueront à s'appliquer; mais à un certain

¹¹¹ Edmond Domet de Vorges, 'La notion de l'étendue et ses causes objectives', *RevQuestSci*, 13 (1883), 193-232 (p. 212).

point la distance, perdant sa valeur sensible, prendra une valeur transcendante antérieure au plein, au vide, au continu et à toute donnée issue des apparences relatives où se meut le monde de sense.¹¹²

By such reasoning, Domet de Vorges arrived at a dynamic conception of nature which he tried to justify by further metaphysical arguments. The usual scholastic notion of matter as an inert and passive substance was deficient, he said, because it removed purpose from the sensible world. 'Une créature qui n'a rien à faire ne vaut pas la peine d'être créée.'¹¹³

Domet de Vorges did not make converts of his fellow neo-scholastics. They continued to be more concerned about defending the common sense proposition that what appears as extended is in fact composed of extended parts. Idealism continued to be perceived as a threat by neo-scholastics; and Bulliot thought that stressing the reality of extension was an effective means of establishing the reality of the world outside the mind. In 1895, he argued before the Society of Saint Thomas that the success of science, because it was based on measurements of extension, was a powerful argument against idealism. Others at the meeting thought that subjectivism could best be refuted by different means; but the point here is that dynamism, with its denial of extended elements, could hardly be expected to gain neo-scholastic approval.¹¹⁴

Another problem with dynamism was that it could not be easily reconciled with hylomorphism. Domet de Vorges, in his arguments for dynamism, had alerted his readers that the traditional notion of matter would have to be rethought in light of the new theory, but tried to make this into a virtue by arguing that force or activity

¹¹² Domet de Vorges, 'La notion de l'étendue', p. 218.

¹¹³ Domet de Vorges, 'La notion de l'étendue', p. 219.

¹¹⁴ *SéancesSSTA*, 30 October 1895, *AnnPhilChr*, 131 (1895/6), 532-4.

was a higher mode of being than passivity. The scholastics, of course, had no trouble agreeing to the latter proposition; but they maintained that a principle of potency was still necessary to explain change.

In 1884, Gardair argued against a modified form of dynamism proposed by Gustave-Adolfe Hirn (1815-90). Hirn had proposed a cosmology that had two components: material atoms and force. He thought that action at a distance was absurd; hence it was necessary that there be an intermediate agent between two masses which affected one another by gravity, electricity, or heat. He also believed that the intermediary would have to be imponderable. In *Constitution de l'espace celeste*, he presented calculations to show that the ether, although believed to be extremely tenuous, would nevertheless be sufficiently ponderable to affect the motion of the moon and planets, to be heated through collisions with planets, and to strip the atmospheres of whatever heavenly bodies had them.¹¹⁵ Hirn believed that the intermediary reality was force. Gardair's main objection to Hirn's system was that the intermediary was not a substance endowed with force but essentially a force. This was metaphysically untenable, said Gardair, because a force by definition must be an attribute of some substance.¹¹⁶ He was happy when Hirn eventually changed his mind and attached his force to a substance; yet he noted that insofar as this substance was immaterial, the theory was still deficient, because such a force could not be distinguished from the angels or God.

There is no need to pursue further the arguments against Hirn. The main deficiencies of dynamism, in the opinion of neo-Thomists, were that (1) it denied

¹¹⁵ Jean D'Estienne, 'La constitution de l'espace céleste d'après M. Hirn et d'après la théorie atomique moderne', *RevQuestSci*, 26 (1889), 544-564 (pp. 543-5).

¹¹⁶ Joseph Gardair, 'L'activité dans les corps inorganiques', *AnnPhilChr*, 109 (1884/5), 133-153, 224-239 (p. 150).

extension, (2) it lacked a passive element, and (3) it implied action at a distance.

Through the many editions of Nys's *Cosmologie*, these arguments became the standard neo-Thomist criticism of dynamism.¹¹⁷

B. Energetics

Energetics, the physical theory favoured by Duhem, came closest to receiving a stamp of approval by the neo-Thomists. As a former student of Ostwald, Nys might be suspected of partiality in recommending the theory, but he was certainly not above criticizing his teacher's monism. Energetics was based on three principles: (1) the conservation of energy, (2) Carnot's principle, and (3) the principle of least action. It differs from mechanism methodologically by refusing to consider hidden realities behind the phenomena and by admitting 'qualities' as well as quantities into its mathematical formulations. This, at least, is energetics as Duhem conceived it. For Ostwald, however, energetics was not a physical theory or methodology but a monist metaphysics, which claimed to abolish the dualism between matter and energy. Matter, Ostwald maintained, was a particular grouping of energy. In order to illustrate his point, he asked his audience, the members of the *Gesellschaft Deutscher Naturforscher und Ärzte* in 1895, to consider, when they are hit by a stick, whether they feel the stick or the energy: 'Die Antwort kann nur eine sein: die Energie.'¹¹⁸ Duhem gave a different answer: 'Nous avouerons ressentir l'énergie du bâton, mais nous continuerons à en conclure qu'il existe un bâton, porteur de cette énergie.'¹¹⁹ There was clearly a significant difference in the two men's conception of

¹¹⁷ Nys, *Cosmologie*, I, pp. 320-36.

¹¹⁸ Wilhelm Ostwald, 'Die Überwindung des wissenschaftlichen materialismus', in *Abhandlungen und Vorträge allgemeinen inhaltes (1887-1903)* (Leipzig: Von Veit, 1904), pp. 220-40 (pp.235-6).

¹¹⁹ Duhem, *L'évolution*, p. 179.

energetics.

Energetics, even as a physical theory, had the difficult task of defining energy, for there were many aspects and forms of energy. One could speak of the quantity as well as the intensity of energy. There was potential and actual energy – a distinction stemming from mechanics. Perhaps a better distinction was between superior and inferior forms of energy, introduced by Bernard Brunhes, or at least implied by his doctrine of the *degradation* of energy.¹²⁰ This qualitative difference was based on the fact that only some energy can be made to do work. For example, a temperature gradient can be used to do mechanical work. After some time, unless there is an input of energy from an external source, the temperature gradient will disappear. Insofar as the whole system will not be at absolute zero, it will possess energy, but that energy will no longer be utilizable. Energy, abstracted from a particular context, necessarily remained a vague term, but Nys hoped to characterize it as something (1) real and positive, (2) measurable, (3) transformable, and (4) invariable in closed systems.¹²¹

Nys praised energetics for several reasons. The most important of these was the restoration of qualities into physics. Ever since Descartes, he said, there has been an antagonism between the scholastic conception of the material world and the reigning physical theories, on account of the banishment of qualities from physics. 'Il faut donc savoir gré aux énergétistes d'avoir rompu avec cette vieille tradition mécanique, en donnant à la physique une base naturelle où la science et la philosophie peuvent désormais se concilier.'¹²²

¹²⁰ Bernard Brunhes, *La dégradation de l'énergie* (Paris: Flammarion, 1909).

¹²¹ Nys, *Cosmologie*, I, p. 353.

¹²² Nys, *Cosmologie*, I, p. 366.

Nys also noted with approval that energetics was not a metaphysical doctrine: energetics had 'le mérite d'exclure de la physique un genre de recherches qui n'est pas de sa compétence, savoir, les recherches relatives à la substance même des êtres. [...] Certes, la cosmologie ne peut qu'applaudir à cette nouvelle délimitation du champ de la physique.'¹²³ It seemed that Duhem's teaching was finally getting through to the neo-scholastics.

Nevertheless, Nys found some flaws in energetics. The first one he mentioned was the very thing he had praised about it:

La théorie nouvelle [...] est une méthode de classification, sans plus. Or, est-il souhaitable, dans l'intérêt de la science et de la philosophie, que la physique érige en principe pareil exclusivisme, s'abstienne de parti pris, de toute recherche, de tout jugement sur la constitution des propriétés de la matière? Nous ne le croyons pas.¹²⁴

Nys thought that a mere classification of phenomena would not satisfy the legitimate human desire to explain the world. The physicist was especially well qualified to make hypotheses about the constitution of matter. Even if these hypotheses would not stand the test of time, he believed that some of them could nevertheless be retained in a modified form in future theories. In the meantime, the hypotheses could help the philosopher in his cosmological speculations. 'L'exclusivisme préconisé par les énergétistes nous paraît donc un défaut plutôt qu'une qualité.'¹²⁵

In writing about energetics, Nys was aware of Duhem's views. He cited Duhem's claim that scientists are sometimes unconscious creators of a theory because their hypotheses are the building blocks of a future edifice.¹²⁶ What Nys failed to understand, however, was that the building blocks which Duhem had in mind were

¹²³ Nys, *Cosmologie*, I, p. 367.

¹²⁴ Nys, *Cosmologie*, I, p. 369.

¹²⁵ Nys, *Cosmologie*, I, p. 371.

¹²⁶ Nys, *Cosmologie*, I, p. 372.

not hypothetical explanations but the descriptive aspects of theory. That, according to Duhem, was where historical continuity was to be found.¹²⁷

Nys also failed to understand the freedom that Duhem envisaged for physicists in choosing their hypotheses. The passage is worth quoting in full because it reveals why Duhem was viewed with such suspicion among many neo-scholastics:

Selon ce savant, le physicien n'a pas à se préoccuper des données expérimentales dans la construction de sa théorie. Il choisit à son gré ses principes et ses postulats, et à partir de ces principes, il peut suivre n'importe quelle voie, ne tenir aucun compte des faits. La théorie est admissible si elle évite toute contradiction, si elle reste d'accord avec elle-même et si ses conclusions viennent rejoindre les faits d'expérience. Elle n'est donc ni vraie ni fausse; elle est une simple classification, ou mieux, elle tend à devenir une classification naturelle; mais aussi longtemps qu'elle n'a pas atteint sa forme définitive, elle ne peut avoir qu'une valeur méthodologique et instrumentale.¹²⁸

Nys then dismissed such theories as 'dépourvues de tout intérêt cosmologique'. The above passage shows that Nys understood (accurately) that, according to Duhem, physical theory was neither true nor false but a more or less exact classification. But the first two sentences betray a misunderstanding of Duhem's thought; for in what way can the physicist ignore experimental facts in the construction of his theory? Surely, each experimental fact was a constraint on theory. The facts, according to Duhem, do not determine the hypotheses, but they constrain them. The physicist must take them into account. Furthermore, Duhem said that the physicist was all but constrained by his education and other cultural factors in choosing hypotheses. Hence, he benefits from the work of others in selecting hypotheses that conform to experimental data.

It is hard to explain how Nys could so evidently misunderstand Duhem.

Perhaps it was because of Duhem's belief that the postulates of energetics need not

¹²⁷ See, for example, Duhem, *AimsSPT*, pp. 38-9.

¹²⁸ Nys, *Cosmologie*, I, p. 373.

have a physical meaning or that not all intermediate stages of a calculation need involve terms with a physical significance.¹²⁹ But that is different from saying that a physicist 'n'a pas à se préoccuper des données expérimentales dans la construction de sa théorie'. Duhem would also have disagreed with Nys's dismissal of classificatory theories as 'dépourvues de tout intérêt cosmologique'. True, such theories did not explain; but they could provide an analogical access to the real world, as Duhem had argued in his 'Physique de croyant', and which Nys had included in his bibliography.

Nys had two further criticisms of energetics which were more serious but which he knew were not essential to the system. The first was the denial of matter. Ostwald said that volume, weight, and mass all figure in the determination of energy. But the union of these constitute the total nature of matter.¹³⁰ Hence, what was commonly called matter was really included under the concept of energy. This reduction of matter and everything else to energy led to Nys's fourth criticism of energetics – it was a monist philosophy. He knew, however, that this was not essential to the physical theory and that Duhem rejected this interpretation.

Although critical of Ostwald's metaphysical use of energetics, Nys was not above suggesting his own. He thought that since energy and matter were always linked and tied to other phenomena, it was possible to argue for a substantial cause of this grouping. And he thought that the duality of energy, that it had both a quantitative and a qualitative, factor was a further argument that its constitutive cause had two principles: (1) the principle of quantity, extension, passivity and (2)

¹²⁹ See, for example, Duhem, *L'évolution*, p. 227.

¹³⁰ Ostwald's view of energy is summarized not only by Nys, *Cosmologie*, I, p. 366, but also by Robert J. Deltete in 'Gibbs and the Energeticists', in *No Truth Except in the Details: Essays in Honor of Martin J. Klein*, ed. by A.J. Kox and D.M. Siegel (Netherlands: Kluwer Academic, 1995), pp. 135-69.

the principle of activity or intensity.¹³¹ This analogy has to be felt rather than understood. But Nys hoped that it would be a further argument for the truth of hylomorphism.

5. *Hylomorphism in light of further developments in physics*

The arguments for hylomorphism examined thus far have not taken into account developments in science in the twentieth century. From the point of view of the history of physics, the years 1900 until the outbreak of the First World War are filled with significant developments: Planck's quantum theory, work on radioactivity, Einstein's special relativity and his explanation of the photoelectric effect, Perrin's investigation of Brownian motion, the Bohr-Rutherford atom, and the attempt to understand all physical reality in terms of electrodynamics. Yet these developments had very little impact on neo-scholastic debates.

Several reasons can be given for this apparent lack of interest. First, one must remember that at least some of the topics, such as Planck's quantum theory and special relativity, were the domain of a small group of individuals. According to Stanley Goldberg, no one in France prior to World War I noticed the theory of special relativity.¹³² And Thomas Kuhn argues, though not conclusively, that even Planck did not appreciate his radical departure from classical physics for nearly a decade.¹³³

Secondly, the new theories had yet to be worked into a metaphysical system

¹³¹ Nys, *Cosmologie*, I, p. 389.

¹³² Stanley Goldberg, 'As If It Never Happened: The French Response', chapter 7 in *Understanding Relativity: Origin and Impact of a Scientific Revolution* (Boston: Birkhauser, 1984), pp. 205-20.

¹³³ Thomas Kuhn argues this case in *Black-Body Theory and the Quantum Discontinuity, 1894-1912* (Oxford: Clarendon Press, 1978). But his arguments have been criticized by Martin Klein in 'Paradigm Lost? A Review Symposium', *Isis*, 70 (1979), 430-34.

that could challenge hylomorphism. No one knew quite what some of these discoveries meant. Did radioactivity contradict the first law of thermodynamics? Perhaps the mass of an electron was electromagnetic in origin, but was all matter essentially electronic? The discoveries provided interesting avenues of research, but not yet serious matter for cosmological reflection.

Thirdly, institutions such as the International Catholic Congresses and the Société de Saint Thomas d'Aquin had ceased to exist. The Société scientifique de Bruxelles acknowledged that it had a difficult time getting quality material to print. And at the Institut catholique in Paris and the Institut supérieur de philosophie in Louvain, Bulliot and Nys, veterans of the early debates who still worried about the kinetic theory, were the professors of cosmology. Younger thinkers such as Jacques Maritain and Ferdinand Renoirte had yet to appear on the scene.

Fourthly, Duhem had little to say about these developments. Although viewed with suspicion by many neo-scholastics, he was at least read by some of them. There was no scientist of note who regularly came into contact with the neo-scholastics who at the same time favoured the new theories.

It would be wrong, however, to think that the neo-scholastics were completely unaware of the new developments. The third edition of Nys's *Cosmologie* (1916) contains an up-to-date bibliography including Eugène Bloch's *La théorie électronique des métaux* (1913), Marie Curie's 'Sur les rayonnements des corps radioactifs' (1913), four of Paul Langevin's works on electricity, space and time, and quantum radiation (1911-13), Jean Perrin's *Les atomes* (1914), many works by Henri and Lucien Poincaré, as well as Ernest Rutherford's *Radium* (1909). Moreover, Nys gave plenty of evidence that he had actually read these works. Yet it is clear that the new developments did not cause a major rethinking of his position or of the arguments

used to establish it. The arguments from the thesis of 1888 still form the basis of the *Cosmologie* of 1916.

Nys summarized the new developments in a preface to the new edition. Citing the convergence of thirteen different means of determining molecular dimensions such as the viscosity of gases, Brownian motion, radioactivity, the blue colour of the sky, and the spectrum of black body radiation, he concluded that 'l'existence des atomes, leur nombre, la détermination de leur poid absolu et de leur grandeur, s'imposent comme autant de faits définitivement acquis à la science'.¹³⁴ Yet the new developments also showed that these atoms were complex entities. Nys explained that, according to the most probable contemporary hypothesis, the atom was like the solar system: a massive positive electron was at the center, about which revolved rapidly moving electrons. The electrons were of two types: *essential* and *accidental*. The essential electrons were so linked to the positive centre that their removal would change the essence of the atom; the accidental electrons, on the other hand, had a more tenuous connection with the centre and could be removed by ionization without altering the basic chemical properties of the atom. Nys thought that these electrons were probably responsible for the absorption and radiation of heat and light.¹³⁵ (At the time of Nys's writing, the existence of protons and neutrons had yet to be accepted. The essential electrons were used to explain radioactive decay. According to present theories, they do not exist.)

Nys summarized the main results of experiments on radioactivity and outlined the theory of alpha and beta particles as well as gamma rays.¹³⁶ He introduced

¹³⁴ Nys, *Cosmologie*, 1, p. 8.

¹³⁵ Nys, *Cosmologie*, 1, pp. 9-11.

¹³⁶ Nys, *Cosmologie*, 1, pp. 14-25.

Planck's theory of energy quanta but noted that according to eminent physicists such as Bloch and Henri Poincaré it was too early to predict its importance. Nys specifically mentioned that the quantum theory had helped to understand the production of X-rays by cathode rays and the emission of gamma rays by radioactive elements, but did not cite the Bohr-Rutherford atom.¹³⁷

How did these developments affect the scholastic theory of matter and form?

The disintegration of atoms and the explanatory power of electrons had given some hope to those who believed in the homogeneity of matter. However, Nys argued that the facts did not allow such an interpretation. First of all, he cited Lucien Poincaré and Bloch to remind his reader that the electronic theory could not handle some phenomena and that one must not mistake an image or model for reality. But even if the electron theory could account for all the phenomena, and if the image were supposed to be reality, the homogeneity of matter would still not be established. Everyone agreed, he said, on the existence of a positive atomic nucleus. Although it was common to speak of positive and negative electricity, thus suggesting one substance, the two electricities were in fact irreducible. Thus at least two primordial elements had to be admitted, which was enough to destroy the thesis of homogeneity.¹³⁸

Nys was aware of the theory that the total mass of the electron was due to the electromagnetic energy radiated whenever the electron was accelerated.¹³⁹ Yet he pointed out that the theory that all mass is electromagnetic in origin was, as even

¹³⁷ Nys, *Cosmologie*, I, pp. 28-30.

¹³⁸ Nys, *Cosmologie*, I, pp. 266-71.

¹³⁹ On the electromagnetic view of nature, see Russell McCormach, 'H.A. Lorentz and the Electromagnetic View of Nature, *Isis*, 61 (1970), 459-97.

one of its champions Edmond Bouty had said, 'une hypothèse presque gratuite'.¹⁴⁰ If anything, the relatively large mass of the nucleus with respect to the electron suggested the existence of matter other than electricity. Once again, hylomorphism had nothing to fear from the electron theory.

The kinetic theory seemed to receive a powerful boost from the explanation of Brownian motion as the macroscopic result of perpetual collision of molecules in a liquid. Nys was clearly bothered by this phenomenon. Such an explanation, he said, seemed to be an instance of perpetual motion and a violation of Carnot's principle. He was aware of the arguments to the contrary used by Perrin and other physicists. The perpetual motion inside the liquid, they said, need not lead to an increase in the total energy of the universe because as one molecule speeds up another slows down. As to Carnot's principle, Maxwell, Boltzmann, and Gibbs had suggested that it might not apply to individual molecules. It was a statistical law that gained in rigour as the number of molecules in a system was increased. However, Nys was not impressed by these arguments: 'Le principe de Carnot est un fait, et même le fait de beaucoup le plus important de la science.'¹⁴¹ Maxwell's statistical interpretation had yet to convince eminent scientists such as Poincaré, Duhem, Lippmann, and Mach. And even if it were admitted, he continued, it might still be possible that Brownian motion was the result of more profound mechanical energies than the kinetic theory suggests: perhaps hitherto unknown energies were responsible for the effect. Nys then resorted to the old argument against perfectly elastic collisions; and he finished by reminding his readers that metaphysics had shown that movement could not engender movement. Brownian motion was clearly a painful topic for Nys, but it

¹⁴⁰ Bouty, quoted in Nys, *Cosmologie*, I, p. 272.

¹⁴¹ Nys, *Cosmologie*, I, p. 280.

could not shake his confidence in hylomorphism.

Nys's manual of cosmology continued to be revised and reprinted. For example, in 1953, it was published as part of the sixth printing of the third English edition of *A Manual of Modern Scholastic Philosophy*. It is difficult to believe that it was meant to be more than a historical curiosity. The section on cosmology is an abridged version of the 1916 third French edition. The discussion of space and time cites Aristotle, Augustine, and Thomas, but not Einstein. An appendix of ten pages tries to bring the reader up to date on atomic theory, which meant the early 1920s, for it stopped with the Bohr-Sommerfeld atom. The claim was that the new developments did not necessitate a rethinking of scholastic cosmology:

Now do these new theories weaken the Aristotelian and Thomistic conceptions of matter? By no means. To-day as much as before the discovery of the electronic theory the atom remains as the real type of the simple body. It is presented to us with the same group of physical and chemical properties which, in conjunction with its constancy, its indissolubility and its specific qualities, allows us to distinguish one species from another. Furthermore, even up to the present, we have never yet managed to find the sufficient explanatory reason for such characteristics except in the very nature of the atom.¹⁴²

No doubt, a basic understanding of contemporary scientific theories belongs to a good philosophical education. Unfortunately, by 1953, the Bohr-Sommerfeld atom was hardly contemporary science. But even in the 1920s, appeals to the 'nature' of the atom were not very informative except in imparting a technical philosophical vocabulary. Although the manual was standard neo-Thomist fare, there were better thinkers among the neo-scholastics. Their teachings, as will become apparent, owe much to the influence of Duhem.

¹⁴² Nys, in Mercier et al., *A Manual of Modern Scholastic Philosophy*, I, p. 584.

6. *Duhem's criticism of chemical atomism and of mechanism*

Duhem's first article for the *Revue de philosophie* was 'Le Mixte et la combinaison chimique', which was subsequently published as a book. Duhem began 'Le mixte' by considering two ancient rival explanations of the dissolution of sugar in water. The Aristotelian school denied that the resulting sugar-water *actually* contained sugar and water; the two elements were there only in *potency*, as could be seen from the possibility of recovering them by evaporation. The homogeneity of the resulting mixture was evident in all its parts, no matter how small the intellect chose to imagine them. On this view, there was no means of distinguishing between a mixture and what is commonly called a chemical combination. The ancient atomists, on the other hand, thought that the homogeneity was only apparent. Sugar-water contained its constituents in act, that is to say, molecules of sugar and molecules of water were present as chaff and wheat, and could be seen through a hypothetical microscope of sufficient magnification.¹⁴³

Duhem examined the fate of these opposed conceptions of mixture by tracing the development of chemistry, jumping over the Middle Ages to Bacon, Descartes, and Gassendi, and then continuing in detail down to his own era. After presenting some of the more impressive achievements of the nineteenth century, such as van t'Hoff's and Lebel's work in stereochemistry, Duhem devoted a chapter to the criticism of the atomic theory. He had no problems with the notation commonly used in chemistry; he even thought that the notation used by stereochemistry was fruitful; but he insisted that it was not necessary to interpret this notation in an atomistic framework:

Triomphe prématuré! Les symboles qu'emploie la Chimie moderne,

¹⁴³ Duhem, *Le mixte*, pp. 11-5.

formule brute, formule développée, formule stéréo-chimique, sont des instruments précieux de classification et de découverte tant qu'on les regarde seulement comme les éléments d'un langage, d'une notation, propre à traduire aux yeux, sous une forme particulièrement saisissante et précise, les notions de composés analogues, de corps dérivés les uns des autres, d'antipodes optiques. Lorsqu'on veut, au contraire, les regarder comme un reflet, comme une esquisse de la structure de la molécule, de l'agencement des atomes entre eux, de la figure de chacun d'eux, on se heurte bientôt à d'insolubles contradictions.¹⁴⁴

The great problem for atomic theory was to explain valences. Duhem used some of the same examples as de Munnynck to illustrate the problem. Nitrogen had a valence of three in ammonia and five in ammonium iodide. But Duhem added many other examples and went on to argue against an ingenious solution proposed by atomists. The idea was that atoms could saturate their own valences. Thus, nitrogen was pentavalent, but in some cases, it appeared to be trivalent because two of its valences mutually saturated one another. Würtz noted that the fact that in most cases apparent changes in valence took place in increments of two gave support to this explanation. But he was honest enough to admit that there were exceptions to the rule, which Duhem cited to bolster his case against atomism. (Although Duhem was more thorough than de Munnynck, he did not address all the extant proposals to explain multiple valencies.¹⁴⁵)

The law of definite proportions seemed to be perhaps the most compelling argument in favour of atomism. But Duhem did not find it conclusive. In determining the formula of a hydrocarbon C_mH_n , a chemist weighs the carbon and the hydrogen to get a ratio, R . He then solves the equation $R = 12 \times (m / n)$, to find the chemical formula. Not only will an infinity of solutions for m and n be possible when they are assumed to be integers, experimental error will never be

¹⁴⁴ Duhem, *Le mixte*, pp. 138-9.

¹⁴⁵ Details can be found in Russell, *The History of Valency*, pp. 171-223.

reduced sufficiently to ascertain whether $R / 12$ is a rational number. 'Ainsi donc, que nous admettions ou que nous rejettions la loi des proportions multiples, nous sommes également certains que les faits ne nous prendront point en défaut.'¹⁴⁶ This analysis was not meant to destroy the conviction that the law of multiple proportion must somehow be grounded in reality. The law had proved its fruitfulness in too many scientific discoveries and technical applications to be a mere coincidence. But Duhem maintained that there was a big difference between saying that the law was founded in reality and specifying that it arose from the atomist hypothesis:

Pour qu'il en fût ainsi, il faudrait que l'interprétation de la loi des proportions multiples, fournie par la théorie atomique, fût non pas seulement une interprétation plausible, séduisante, mais encore la seule interprétation possible.¹⁴⁷

In the case of contemporary chemistry, he claimed, the law of multiple proportion could not establish atomism, especially in the light of the other arguments against the system.¹⁴⁸

Duhem proceeded to argue for chemical mechanics. This science was advanced by the work of Henri Sainte-Claire Deville (1818-81) on disassociation of various chemicals. Sainte-Claire Deville had argued that the phenomena showed that physics and chemistry could hardly be distinguished. As he put it:

Si la combinaison affecte surtout ce que nous appelons les propriétés chimiques des corps, si la dissolution n'en altère sensiblement que les propriétés physiques, enfin si la combinaison et la dissolution se confondent en un seul et même phénomène dont elles représentent les effets extrêmes, il est clair que toute différence cesse d'exister entre les propriétés physiques et les propriétés chimiques de la matière. Les uns et les autres sont sous la domination absolue de la chaleur et, par elle, des agents mécaniques. Les expériences modernes tendent à donner de plus en plus à ceux-ci une influence prépondérante sur les résultats obtenus en

¹⁴⁶ Duhem, *Le mixte*, p. 145.

¹⁴⁷ Duhem, *Le mixte*, p. 147.

¹⁴⁸ Duhem, *Le mixte*, p. 147.

physique et en chimie, deux sciences qui tendent de plus a plus à se confondre entre elles et avec la mécanique.¹⁴⁹

In support for this view, Sainte-Claire Deville could point to the tight analogies between the point of decomposition of calcium carbonate and the boiling points of water and of arsenic. Duhem also noted that the idea of a mobile physical equilibrium, derived from the kinetic theory of gases, was fruitfully adapted to the development of a chemical statics in the 1860s by Guldberg and Waage in Christiania. Although Duhem was hardly a partisan of the kinetic theory and did not use it to explain chemical mechanics, the development remained a valid illustration of the fusion of physics and chemistry.¹⁵⁰

Duhem argued that the resulting science of chemical mechanics was a branch of thermodynamics. According to him, this science was the trunk upon which all of physical science was to grow. Thermodynamics accepted as hypotheses the equivalence of heat and mechanical work and Carnot's principle. In renouncing the vain attempts to interpret these in terms of mechanics, the new science could account for a great variety of change – condensation and expansion of fluids, magnetization, deformation of elastic solids, as well as local motion. This was revolutionary:

Quel bouleversement dans les idées des physiciens! Il y a quelque trente ans, la Mécanique rationnelle semblait encore la science reine dont toutes les autres doctrines de la Physique devaient se réclamer; on exigeait que la Thermodynamique réduisit toutes ses lois à n'être que des théorèmes de Mécanique; aujourd'hui, la Mécanique rationnelle n'est plus que l'application au problème particulier du *mouvement local* de cette Thermodynamique générale, de cette *Énergétique* dont les principes embrassent toutes les transformations du monde inorganique ou, selon la dénomination péripatéticienne, tous les *mouvements physiques*.¹⁵¹

¹⁴⁹ Sainte-Claire Deville, quoted in Duhem, *Le mixte*, p. 154.

¹⁵⁰ See Duhem, *Le mixte*, p. 163. On the development of physical chemistry, see John W. Servos, 'Modern Chemistry in Need of Reform', chapter 1 of *Physical Chemistry from Ostwald to Pauling: The Making of a Science in America* (Princeton: Princeton University Press, 1990), pp. 3-45.

¹⁵¹ Duhem, *Le mixte*, p. 170.

And what did this science say about the difference between a physical mixture and a chemical combination? 'Elle n'établit aucune distinction.'¹⁵²

Duhem thought that the only possible distinction that chemical mechanics could introduce would be between substances which combine according to a definite ratio and those which do not. But even there it was incapable of deciding whether in mixtures formed according to definite proportions the elements were merely mixed or bound together.¹⁵³ The scholastics certainly welcomed Duhem's conclusion: 'En résumé, dans tout ce que la Mécanique chimique actuelle suppose touchant la génération ou la destruction des combinaisons chimiques, nous ne trouvons rien qui ne s'accorde avec l'analyse de la notion du mixte donnée par Aristote.'¹⁵⁴

Scholastics could thus cite Duhem to argue that hylomorphism was not unscientific.¹⁵⁵ But his was not an unqualified endorsement of their views. First of all, he said that the development of chemical mechanics owed nothing to preconceived philosophical opinion. Sainte-Claire Deville could not care less about the opinions of Aristotle. Secondly, and this was the more important point, although peripatetic physics and modern physics started from the same preliminary logical analysis of the facts, they followed different paths in their development. Modern physics, he said, set out to measure in ever greater detail and to classify an ever growing array of complex phenomena. It did not pretend to arrive at the essence of its object. Peripatetic physics, on the other hand, was a metaphysics. It posited substantial and accidental forms as the basis in reality for the phenomena it encountered. Duhem acknowledged that sometimes the concepts from science were

¹⁵² Duhem, *Le mixte*, p. 173.

¹⁵³ Duhem, *Le mixte*, p. 173.

¹⁵⁴ Duhem, *Le mixte*, p. 172.

¹⁵⁵ Louis Baille, 'La question du mixte', p. 261.

so closely related to Aristotle's notions that they seemed to complete and enrich them rather than modify them: '*corruptio unius generatio alterius*, disait la Scolastique; la Chimie moderne complète et précise ce principe en nous montrant que la masse détruite est toujours égale à la masse créée.'¹⁵⁶ Lest this sound like one of Bulliot's more enthusiastic pronouncements, the final paragraph of 'Le mixte' was a reminder not to confuse the terms of physics with concepts from metaphysics:

Il est clair qu'entre cette représentation symbolique des données de l'expérience [l'objet de la physique moderne] et une étude métaphysique des choses que nos sens perçoivent, il n'y a plus lieu d'établir aucun rapprochement; les théories de la Physique moderne sont radicalement hétérogènes à la Physique péripatéticienne. Ces deux Physiques ne sont liées l'une à l'autre que par l'analyse logique, qui est leur point de départ commun.¹⁵⁷

What was the purpose of 'Le mixte'? In the preface, Duhem said that the book was written primarily for philosophers. The main message was that after many vicissitudes, chemical theory seemed to be rediscovering the wisdom of Aristotle which it had abandoned in the sixteenth century. Duhem thought that philosophers should know about these developments in science. At the same time, he expressed the hope that chemists might read the book as well. Hence, 'Le mixte' was also an argument in favour of chemical thermodynamics.

Duhem's *L'évolution de la mécanique* (1903) appeared first as a series of articles in Louis Olivier's *Revue générale des sciences pures et appliquées*, whose stated goal was to induce 'les auteurs des découvertes à exposer eux-mêmes leurs travaux sous une forme telle que toutes les personnes cultivées puissent en saisir au moins les grandes lignes, et que, cependant, les spécialistes de même activité trouvent

¹⁵⁶ Duhem, *Le mixte*, p. 183.

¹⁵⁷ Duhem, *Le mixte*, p. 185.

leur profit à cette même lecture'.¹⁵⁸ The success of Duhem's articles may be gathered from a letter Olivier wrote to thank him:

Ce beau travail a fait sensation dans le monde pensant (...). En dehors de l'Académie, des mathématiciens et physiciens, vous avez été lu, sinon complètement, du moins en très grande partie par des savants de spécialités diverses que, je l'avoue, je ne m'attendais pas à classer parmi vos lecteurs; des physiologistes, des botanistes, des géologues (...). De sorte qu'indépendamment de son intérêt fondamental, votre travail aura eu ce mérite d'amener bon nombre de personnes étrangères à la Mécanique et à la Philosophie de la Nature à considérer les questions que vous avez traitées et à en discerner la portée.¹⁵⁹

This was not just polite praise, for, in the same year, the articles were published in Polish; and a German translation by Philipp Frank, one of the founders of the Vienna Circle, was published in 1912.

The first half of *L'évolution de la Mécanique* is a historical account of various approaches to mechanics. Duhem began his analysis with Aristotle, and then continued with Descartes, Newton, Lagrange, d'Alembert, Poisson, Hertz, and Kelvin. In some chapters, he took a more topical approach – kinetic theory of gases, perpetual motion, and theories of heat and electricity. Duhem's analysis is both clearer and deeper than any efforts by the neo-scholastics. It could not have been written by someone whose sole knowledge of physics came from reading prefaces to textbooks.

Duhem's discussion of the difference between Lagrange's analytical mechanics and Poisson's physical mechanics gives a good indication of the kind of arguments found in *L'évolution*.¹⁶⁰ Joseph Louis Lagrange (1736-1813) had developed a

¹⁵⁸ C.E. Guillaume, 'Louis Olivier', in *Hommage à Louis Olivier* (Paris: Marentheux, 1911), p. xv, quoted by Brenner in the introduction to Duhem's *L'évolution de la mécanique*, p. xviii.

¹⁵⁹ Letter from Louis Olivier to Duhem, 16 May 1903, quoted in Brenner in his introduction to Duhem's *L'évolution*, p. xviii; the ellipsis are due to Brenner.

¹⁶⁰ Harman provides a more recent history of the two approaches. Lagrange's method was used to great advantage by John Baptiste Joseph Fourier (1768-1830) in his theory of heat. See Harman, *Energy, Force, and Matter*, pp.15-1 and pp. 27-30.

powerful mathematical apparatus to treat mechanical problems involving extended bodies instead of just point masses. The method was based on the calculus of variation of a potential function. Only two details are pertinent to the present discussion. First, in calculating the potential function, Lagrange did not just consider forces and linear displacements. He generalized the concept of force to include torque, surface tension, and pressure. These generalized forces were then multiplied by the corresponding kind of virtual displacement – degrees, area, or volume – so that the sum would always involve units of energy. This generalization was extended in the nineteenth century to include electricity, magnetism, temperature, and chemical potential – hence Duhem's great hope for generalized thermodynamics as the unifying physical science. For purposes of calculation, the physicist did not need to know anything about the forces in particular. The same potential function could be produced by two linear forces or by a force and a torque or three forces and a torque – the possibilities were endless.

The second salient feature of Lagrange's method was the use of auxiliary equations to define legitimate deformations of the system for the purposes of the calculus of variations. If, for example, the system under consideration was an incompressible fluid, the auxiliary equation would demand that the total volume of the system remain constant; if two or more solid bodies were involved, then the auxiliary equations would demand that none of the bodies change its shape and that they do not penetrate one another. No physical hypotheses were needed to account for the solidity of the bodies. The mathematics assured the constancy of their shapes.

Siméon-Denis Poisson (1781-1840), although he admitted that Lagrange's methods had been fruitful in bringing to light various laws of equilibrium and

motion, nevertheless thought that they were too abstract. It was the task of the physicist to account for the stability of solid bodies and other conditions stipulated by Lagrange's auxiliary equations in terms of molecular forces. Poisson thought that those who cared only about macroscopic results were free to choose either Lagrange's method or his for their calculations but that if they wanted to get a better idea of what nature was really like, they should choose his. Duhem noted that the idea of the theoretical equivalence of Lagrange's and Poisson's method was believed to be true by many physicists but that it had yet to be demonstrated. He then went on to show that in fact the two methods did not give equivalent results.¹⁶¹

Calculations using Poisson's approach were predictably complicated. In summing over vast numbers of finite points, the physicist was almost always constrained to use integrals which smoothed out the assumed discontinuity of matter. Thus one was not really sure what was being calculated and what was the point of using the more cumbersome method. But even apart from mathematics, it was obvious that Poisson's method could not distinguish between elastic solids and compressible fluids. Poisson, of course, recognized the problem and had to add further hypotheses to his system. Extended molecules of various shapes took the place of inextended points; and he added a 'secondary action', a force dependent on the shape of molecules, which had the same function as Lagrange's auxiliary equations.

Duhem thought that further criticisms of Poisson's system were pointless:

Lorsqu'une théorie, pour se défendre, multiplie ainsi les ruses et les chicanes, il est inutile de la poursuivre, car elle devient insaisissable; mais il serait oiseux de la saisir, car, pour tout esprit juste, c'est une doctrine vaincue. Telle est la Mécanique physique.¹⁶²

¹⁶¹ Duhem, *L'évolution*, p. 81.

¹⁶² Duhem, *L'évolution*, p. 88.

Among the other mechanical theories which Duhem criticized, there are two which are relevant to the present thesis. In a chapter on the mechanics of Heinrich Hertz, Duhem confirmed the great repugnance that until recently many physicists had felt for the notion of force. Lagrange's mechanics had reduced all physical phenomena to extension, motion, mass, and force. Hertz hoped to show that all 'forces' could be shown to be fictive like inertial forces or the conditions imposed by Lagrange's auxiliary equations. For example, a person unaware of the rotational motion of a gyroscope would deduce the existence of a real torque were he to try to rotate the gyroscope from its axis of rotation. Yet most physicists would hold that he was wrong, for the apparent force could be explained by the hidden motion of a mass. The mathematical formulation of Hertz's theory was equivalent to Lagrange's equations; only the interpretation was different. Hertz did not live long enough to show how his force-free mechanics could account for particular phenomena. Nor did anyone else continue his work, for it seemed unnecessarily complicated and even full of mystery – the very thing that Hertz was trying to banish by eliminating real forces. Helmholtz put it very well in the introduction to Hertz's mechanics:

He was obliged to assume that there exists a great number of masses which are hidden from the senses and a great number of invisible motions of these masses in order to explain the existence of forces between non-contiguous bodies. Unfortunately, he gave no example which could demonstrate how he conceived of these intermediate terms. It is evident that he would have been obliged to appeal to a considerable number of fictive forces in order to account for the simplest physical actions.¹⁶³

Duhem thought that it was impossible to prove that Hertz's mechanics were wrong by empirical means. The imagination could always hope to devise some complicated system of hidden masses and their motion. But the system was sterile. And the

¹⁶³ Helmholtz, quoted in Duhem, *L'évolution*, p. 166, my translation from the French.

explanations were no less mysterious than the occult forms of the medievals.¹⁶⁴

The last mechanical system which Duhem analyzed was Kelvin's vortex atoms. He chose this example because it had gone further than any other system in reducing the number of substances and forces in its explanatory system. There was only one substance – a homogeneous and incompressible fluid – filled with a large number of vortices which were indestructible on account of Euler's equations for perfect fluids. The vortices had been formed initially by the intervention of forces which were incompatible with any fluid equilibrium. Once these creative forces disappeared, any apparent forces could be explained by inertial forces and pressures within the fluid. As elegant as the system may have been, Duhem noted that it was so far removed from the common phenomena of physics that it was useless. The simplest phenomena seemed to be unrelated to the theory. For example, to explain gravitation, Kelvin had to resort to a scheme resembling Lesage's hypothesis.¹⁶⁵ And even the basic equations of mechanics could not be deduced from Kelvin's system because it contained no invariable element that could correspond to mass.¹⁶⁶

Duhem then criticized mechanical systems in general. First, he stressed the importance of common sense. His target here was Ostwald's energetics which had tried to go further even than Kelvin in simplifying the world. It suppressed the substance of the fluid and sought to transform mechanics into a study of pure

¹⁶⁴ Duhem, *L'évolution*, p. 190.

¹⁶⁵ According to the Genevan George-Louis Lesage (1724-1803), invisible particles were constantly arriving from every direction from the farthest reaches of the universe. A heavy body would attract another because it would create a shadow region into which the other body would be pushed (rather than pulled). Insofar as the angular area that a body would block varies as the square of the distance to it, Lesage's hypothesis could explain Newton's inverse square law for gravitational attraction. But it could not explain why a sphere made of lead should attract more strongly than a hollow metal ball. The theory is described in his *Essai de chimie mécanique* (Rouen, 1758); Entry 'Le Sage', *Dictionary of Scientific Biography*, VIII, pp. 259-60.

¹⁶⁶ Duhem, *L'évolution*, pp. 175-6.

extension and its changes constrained only by the law of the conservation of energy suitably modified to fit into the system. Duhem's criticism was scathing:

Au moment de quitter la terre ferme de la Mécanique traditionnelle pour nous élancer, sur les ailes du rêve, à la poursuite de cette Physique qui localise les phénomènes dans une étendue vide de matière, nous nous sentons pris de vertige; alors, de toutes nos forces, nous nous cramponnons au sol ferme du sens commun; car *nos connaissances scientifiques les plus sublimes n'ont pas, en dernière analyse, d'autre fondement que les données du sens commun*; si l'on révoque en doute les certitudes du sens commun, l'édifice entier des vérités scientifiques chancelle sur ses fondations et s'écroule.¹⁶⁷

Duhem's insistence on common sense was in line with neo-scholastic pre-occupations.

It also clearly separated his understanding of energetics from Ostwald's.

Duhem distinguished two kinds of explanatory systems. He called the first category the *synthetic method*, by which he meant systems whose component parts and the relations which bind them were carefully specified at the outset, with the hope of accounting for physical phenomena. This was the method of Descartes, but Duhem gave other examples as well: Laplace's caloric theory, Lesage's theory of gravitation, and, closer to his time, attempts by Lorentz, Larmor, Langevin, and Perrin to explain light, electricity, and other radiation. Such schemes, Duhem thought were judged to be deficient by the majority of contemporary physicists. The systems were at best suited to a small domain of physical phenomena; and there was no obvious means of linking them to account for all the phenomena of the inanimate world.¹⁶⁸

Duhem grouped mechanical explanations of the second kind under the heading *analytic method*. Mathematical expressions of experimental laws were often analogous to equations from mechanics. Hence, physicists with a lively imagination,

¹⁶⁷ Duhem, *L'évolution*, pp. 178-9.

¹⁶⁸ Duhem, *L'évolution*, pp. 189-90.

especially the British, tended to explain all phenomena in terms of mechanical systems. Although Duhem did not favour this approach to physics himself, he conceded its usefulness for others. Nevertheless, a complete explanation of the whole universe would have to include so many hidden masses and movements as to be useless even to the imaginative. Furthermore, if an explanation that could account for all the phenomena were to be found, there would be an infinity of others that could do it equally well. The physicist would look in vain within his discipline for a criterion to decide among the systems.¹⁶⁹

The actual state of physics was far from putting the physicist into such a predicament. Duhem had given enough examples of particular mechanical systems that promised to explain the world but could not account for its simplest manifestations to strengthen his argument for a new type of approach. The second part of *L'évolution de la mécanique* was a description of this new approach, which he called general thermodynamics. Duhem did not hesitate to draw comparisons between this new science and Aristotelian physics. The first chapter is called 'La physique de la qualité': 'au risque de nous entendre reprocher le retour aux *virtus occultes*, nous sommes contraints de regarder comme une qualité première et irréductible ce par quoi un corps est chaud, ou éclairé, ou électrisé, ou aimanté; en un mot, renonçant aux tentatives sans cesse renouvelées depuis Descartes, il nous faut rattacher nos théories aux notions les plus essentielles de la Physique péripatéticienne.'¹⁷⁰

The new direction Duhem was advocating did not mean an abandonment of mathematical physics, for only qualities which could be quantified were to be

¹⁶⁹ Duhem, *L'évolution*, p. 191.

¹⁷⁰ Duhem, *L'évolution*, pp. 197-8.

admitted into the theory. In fact, the mathematical formulations of the new approach were based on Lagrange's equations which had been developed to handle problems in mechanics. This fusing of methods was not as odd as one might first think, for Duhem had pointed out on several occasions in the book that the notion of *force* as used by physicists had analogies with the scholastic ideas of quality and occult virtues.¹⁷¹ Generalized thermodynamics accepted forces as well as other qualities so as to achieve as complete a description of the inanimate world as possible: 'La creation de cette Mécanique fondée sur la Thermodynamique est donc une réaction contre les idées atomistiques et cartésiennes, un retour – bien imprévu de ceux-là mêmes qui y ont le plus contribué – aux principes les plus profonds des doctrines péripatéticiennes.'¹⁷²

7. Duhem and neo-Thomists: some essential differences

Duhem's endorsement of Aristotelian physics might appear to be a strong argument for including him in the neo-scholastic camp, but one must not forget the differences between him and people such as Bulliot, Nys, and de Munnynck. First, Duhem did not mix physics and metaphysics. Aristotle had brilliantly analyzed the principles of change. The resulting metaphysics or cosmology still had much to recommend it, especially its agreement with common sense. On the other hand, the physics that now seemed to resemble Aristotelian doctrines was beyond the scope of antiquity. It required precise experimentation and an elaborate mathematical apparatus for its development. The cosmologist could draw analogies between his science and physics, but the two were not the same. Mass and prime matter belonged to two different disciplines.

¹⁷¹ See, for example, Duhem, *L'évolution*, p. 42 and p. 89.

¹⁷² Duhem, *L'évolution*, p. 344.

A second difference between Duhem and most neo-scholastics was the level of substantial attribution. For the neo-scholastics, the molecule was the individual. It was the bearer of different qualities. Duhem, on the other hand, worked at the level of what Eddington called 'molar physics'.¹⁷³ This is why Duhem, more so than the neo-scholastics, could appreciate Aristotle's *logical analysis of science*. The qualities that generalized thermodynamics accepted into its equations were more closely related to qualities as the scientifically illiterate named them. The science which Duhem favoured was thus closer to the level of philosophy than the science which most neo-Thomists insisted on casting into a hylomorphic mold.

Duhem's analysis also differed from most neo-scholastic efforts in that it provided a *scientific* alternative to the mechanistic and atomistic explanations it was criticizing. Generalized thermodynamics could make predictions susceptible to experimental testing. The neo-scholastic theory could only apply a tag to an already known result in the form of a new quality. Duhem might legitimately expect to be heard by scientists who were aware of the very limited results of the kinetic theory. Most neo-scholastics could argue only at the philosophical level. Their arguments against scientific cosmologies might be well founded, but they were not likely to get a fair hearing in a scientific climate, for they did not present a scientific alternative.

Duhem's technical abilities also allowed him to offer much more sophisticated criticisms of mechanical explanations. He was undoubtedly aware of the historical debates about the problems of infinite forces arising in various collisions. Yet he did not bother to consider them. Natural philosophers had developed mathematical tools to describe collisions that manifestly occurred at the molar level despite the philosophical difficulties. Duhem too chose to focus on the mathematics and to

¹⁷³ A.S. Eddington, *The Philosophy of Physical Science* (New York: MacMillan, 1939), p. 77: see Jaki, *Uneasy Genius*, p. 372.

criticize physical mechanics on account of its inability to account for various macroscopic phenomena. It may be also that Duhem's knowledge of history made him reluctant to turn to the more metaphysical arguments of the neo-scholastics. For them, metaphysics meant Aristotelian metaphysics. Yet Duhem was aware that there were other metaphysical systems and could point to the failure of Descartes's metaphysics to establish or refute a given mechanical explanation.¹⁷⁴

These important differences between Duhem and the neo-scholastics must not obscure the fact that some neo-Thomists eventually adopted his major ideas. Also, one must not get the impression that Duhem was against metaphysics per se or that he was content to dismiss physics as irrelevant to the rest of philosophy. In the introduction to *L'évolution de la mécanique*, he wrote:

Certes, cet état de doute [sur la vraie conception de la mécanique] est, pour tout homme qui pense, un objet bien digne de méditation; car du sort de la Mécanique, de la méthode selon laquelle elle développera ses théories, dépend la forme même de toute Philosophie naturelle.¹⁷⁵

In the next chapter, the bearing of physics on some metaphysical questions will be explored, to see how the neo-scholastics and Duhem understood the connection.

¹⁷⁴ Duhem, *L'évolution*, p. 186.

¹⁷⁵ Duhem, *L'évolution*, p. 2.

CHAPTER 4

Physics and Metaphysics: Freedom, Creation, and God

Among the greatest objections raised by the progress of modern science against theism, the possibility of miracles, free-will, the immateriality of the human soul, its creation and immortality, are, according to many thoughtful men, those based on the Law of the Conservation of Energy. *Michael Maher, s.j. (1909)*¹

The meaning of physics and metaphysics and the relation between them has changed much throughout history, but the tendency to look to physics in metaphysical debates is perennial. Aristotle used his laws of motion to establish the existence of an invisible unmoved mover. Today, the Big Bang is present in nearly every discussion of creation; and the paradoxes of quantum mechanics feature in debates about epistemology, freedom, and creation. Philosophers feel obliged to say something about physics, if only to dismiss it as irrelevant. Such discussions provide an excellent means of capturing a particular thinker's understanding of the connection between physical theories and metaphysics.

In the scientific climate of Duhem's era, philosophers assessed the implications of thermodynamics on human freedom and creation in time. In addition, neo-Thomists also addressed the law of inertia in proofs of the existence of God based on motion. This chapter will analyze these debates as a preparation for the final chapter, which will look more philosophically at the differences between physics and metaphysics.

1. Human liberty and the first law of thermodynamics

Human freedom is one of the perennial questions of philosophy. It has been affirmed on the basis of the intimate experience of human beings; and biblical

¹ Michael Maher, 'Energy', in *Catholic Encyclopedia* (New York: Appleton, 1907-12), v, pp. 422-8 (p. 422); see Erwin Hebert, 'The Uses and Abuses of Thermodynamics in Religion', *Daedalus*, 95 (1966), pp. 1046-80 (p. 1065).

authority has come to its aid.² But human freedom has also been denied in the name of physics, philosophy, and theology. The ancient atomists, Islamic occasionalists, Calvin, and Spinoza all produced plausible reasons for denying freedom. Kant affirmed it when speaking of moral philosophy and denied it in the name of physics, hoping to reconcile the contradiction by appeals to the unknown relations between the *noumenon* and the *phenomenon*. The argument for determinism from modern physics derives its power from its mathematical framework, for in most people's minds mathematics is the ultimate example of necessary deduction. The threat to freedom from physical determinism, then, is the subject of the first case study in this chapter. It is important, however, to situate the debate in the wider context of nineteenth-century culture.

A. Science as threat to freedom: popular arguments and preliminary notions

Laplace believed that the universe was a mechanism governed by differential equations. Thus he postulated that a *superhuman intelligence* could calculate the past and the future from a knowledge of the state of the world at a given instant.³ This demon – not to be confused with its Maxwellian counterpart – has since come to symbolize the case for strict physical determinism, but it did not immediately cause widespread angst. Cartesian dualism and the more contemporary Kantian distinction between the phenomenon and the noumenon could be used to reconcile freedom of the will and the unbending regime of mathematical physics.⁴ And even within physics, there were many disparate phenomena which had yet to be brought

² Sirach 15.15-17.

³ See Pierre Simon de Laplace, *A Philosophical Essay on Probabilities*, trans. F.W. Truscott and F.L. Emory (New York, 1951), p. 3.

⁴ See Ian Hacking, 'Nineteenth Century Cracks in the Concept of Determinism', *Journal of the History of Ideas*, 44 (1983), 455-75 (p. 458).

into a unified quantitative framework. Moreover, it was not clear that living organisms could be reduced to chemistry and physics. Thus, in the early decades of the nineteenth century, Laplace's demon was not a credible threat to human freedom. The beast was a product of the rationalist hopes of physicists which had yet to justify themselves empirically.

The development of the law of conservation of energy in the 1840s provided hope for the unification of physics. In 1843, James Prescott Joule (1818-89) showed that water could be heated by stirring and calculated the rise in temperature per unit volume as a function of mechanical work. Heat thus came to be understood as motion; hence an imponderable fluid was incorporated into the reductionist mechanical scheme of extension and motion. And there was reason to believe that further reduction was possible. Mayer's approach to the first law of thermodynamics via a study of the oxygen content of blood – regardless of whether or not he rather than Joule should be given credit for the law – was one indication that the domain of physics extended to the processes of life.⁵

Other advances in physiology gave support to this view, especially the work of the famous French physiologist Claude Bernard (1813-1878) on the functions of the liver. In 1865, he published the immensely influential *Introduction à l'étude de la médecine expérimentale* which argued for physico-chemical determinism in biology and against vital forces: 'D'abord la médecine expérimentale repose sur ce premier principe de toutes les sciences expérimentales, à savoir: que *tous les phénomènes, quels qu'ils soient, ont leur déterminisme absolu.*'⁶ Admittedly, Bernard was not trying

⁵ See Thomas S. Kuhn, 'Energy Conservation as an Example of Simultaneous Discovery', in *Critical Problems in the History of Science*, ed. M. Clagett (Madison, WI: University of Wisconsin Press, 1959), pp. 321-56 (p. 322).

⁶ See, for example, Claude Bernard, *Principes de médecine expérimentale* (Paris: 1947), p. 7.

to deny moral freedom but only to make medicine into a science by ridding it of capricious vital forces.⁷ But his arguments were often cited as support for those who would deprive man of liberty in the name of science. He is almost invariably mentioned in surveys of the subject of determinism, both by his near contemporaries, such as Désiré Mercier and Léon Noël, and by more recent commentators such as Ian Hacking.⁸

Parallel to this development of physics, another science seemed to deprive man of his freedom – statistics. In *The Rise of Statistical Thinking: 1820-1900*, Theodore M. Porter describes the influence of Henry Thomas Buckle's *History of Civilization* (1847) as destroying the spirit of statistical moderation evident in earlier debates:

Buckle's book was an enormous success, reaching a popular as well as an intellectual audience. The fear that he provoked that a new and all-embracing determinism had at last succeeded in excluding the possibility of divine or human freedom extended from America and Britain to Germany and even to Dostoevsky in Russia, whose underground man complains about statistics and then about Buckle. It is far from clear that Darwin or Comte was discussed with greater urgency during the 1860s and 1870s.⁹

Buckle's claim was that the laws of statistics were no less rigorous than the laws of physics. For example, if statistics predicted a particular murder rate for a given year, then a certain number of people would have no choice but to commit murder. The accused could then plead their innocence on the ground of conformity to the law of statistics, but then again judges could point to a particular conviction rate to justify sending them to prison.¹⁰ Adolphe Quetelet (1796-1874), who had previously showed

⁷ See Claude Bernard, 'Les définitions de la vie', *Revue scientifique*, 2nd series, vol. 13 (1877), p. 515.

⁸ Désiré Mercier, 'Le déterminisme mécanique et le libre arbitre', *Revue Catholique*, 54 (1883), 687-704, 830-50 and 55 (1884), 50-9, 108-23 (p. 690); Léon Noël, *Le déterminisme* (Louvain: [n.pub.], 1904), p. 68; Hacking, 'Nineteenth Century Cracks', p. 459.

⁹ Theodore M. Porter, *The Rise of Statistical Thinking: 1820-1900* (Princeton, NJ: Princeton University Press, 1986), p. 164.

¹⁰ Porter, *The Rise of Statistical Thinking*, pp. 165-6.

moderation in interpreting the laws of statistics, was pleased by Buckle's book, for it gave him publicity in France. Statistical determinism did not offend him.¹¹ It would be going too far afield to track the details of this debate. But it is worth noting that Louvain's manuals of scholastic philosophy, in arguing for the freedom of the will, continued to address the objection from statistics into the 1920s.¹²

Ernst Cassirer (1874-1945) cites a speech which the German chemist, physicist, and neurophysiologist, Émile Du Bois-Reymond (1818-96) delivered in 1872, as the first important statement of determinism. Its influence is undeniable, for it went through many editions and it was debated in various German journals and even daily newspapers.¹³ Although Du Bois-Reymond did little but repeat the Laplacian argument, he brought to the forum his conviction that electricity would fully explain the workings of the brain. He himself was subtle enough to distinguish the workings of the brain from consciousness and free-will, but many in his audience had been prepared by the materialist propaganda of Vogt, Moleschott, and Büchner to do away with such niceties.¹⁴ In the 1850s and 1860s, Vogt had travelled throughout Europe preaching that 'thoughts came out of the brain as gall from the liver, or urine from the kidneys'.¹⁵ (He was in fact plagiarizing a contemporary of Laplace, the physician Cabanis (1757-1808) who 'summed up his view of man in the words *Les nerfs – voilà tout l'homme* and declared that the brain secretes thought as the liver

¹¹ Porter, *The Rise of Statistical Thinking*, p. 167.

¹² Mercier et al., *A Manual of Modern Scholastic Philosophy*, 1, p. 275.

¹³ Ernst Cassirer, *Determinism and Indeterminism in Modern Physics* (New Haven: Yale University Press, 1956), p. 6: see Hacking, 'Nineteenth Century Cracks', p. 456.

¹⁴ Chadwick, *The Secularization*, p. 165.

¹⁵ Chadwick, *The Secularization*, p. 166.

secretes bile'.¹⁶) If Du Bois-Reymond succeeded where Laplace had failed, it was because, in the intervening decades, materialism had become more widespread and researches in physics and physiology actually gave some support to the rhetoric of determinists.

Hacking has written a paper against what he calls the 'Cassirer thesis' – the attribution of the beginning of the debate about determinism to Du Bois Reymond's speech. Although Hacking admits that there was an intensification of interest in the subject at the time, he thinks that the 1870s were in fact the beginning of the end of determinism. He argues that the regularities in statistical data were starting to lose their mystery. As the century progressed, chance came to be seen as an autonomous aspect of the world which could be handled by mathematical methods: 'Thus at the very moment that Cassirer's concept of determinism came into being, fully structured chance was becoming tamed. [...] the erosion of determinism was fully under way, and we were about to enter a "Universe of Chance".'¹⁷

Hacking is correct when he points to factors other than physics as important to the determinist argument. It seems, however, premature to dismiss determinism as early as he does. The interest in Paul Bourget's novel *Le Disciple* (1889) was largely due to continuing angst about freedom. In the book, the teaching of a determinist professor, Adrien Sixte (who reminded most readers of Hippolyte Taine), inspired a disciple to perform a despicable psychological experiment – the seduction of a young woman which led to her suicide. A great public debate ensued about the responsibility of science in this sad affair.¹⁸

¹⁶ Frederick Copleston, *A History of Philosophy*, vol. 6, part I, *The French Enlightenment to Kant* (New York: Image Books, 1964), p. 51.

¹⁷ Hacking, 'Nineteenth Century Cracks', pp. 474-5.

¹⁸ For an account of this book and some of the ensuing debates, see Paul, 'The Debate', pp. 301-3.

Another indication of the continued interest in determinism is the number of articles, books, and lectures devoted to the subject.¹⁹ The fascination was by no means limited to one country for there was much written and said in French, German, and English. Although some of this literature deals with psychological determinism, the physical sciences were seen to provide the strongest argument against human liberty. As the Abbé Merklen put it in his report on the works of the Society of Saint Thomas for the year 1887-8: 'De tous les arguments allégués pour soutenir la thèse de la nécessité, les arguments qui se tirent de considérations empruntées au déterminisme de plus en plus rigoureux de la physique moderne jouissent incontestablement d'une faveur qu'ils doivent aux résultats obtenus par cette science.'²⁰

The arguments for determinism arising out of physics continued to exert an influence for a long time. Although Paul Forman's thesis that the development of quantum mechanics in Germany after World War I was a reaction against the deterministic equations of classical physics is controversial, his evidence for the general desire to escape the iron laws of physics is not.²¹ The English-speaking world also felt the force of these arguments. In 1909, the Jesuit Michael Maher wrote for the Catholic Encyclopedia: 'Among the greatest objections raised by the progress of modern science against theism, the possibility of miracles, free-will, the immateriality of the human soul, its creation and immortality, are, according to many thoughtful men, those based on the Law of the Conservation of Energy.'

¹⁹ See, for example, Ernest Naville, *La libre arbitre* (Paris: Alcan, 1898). In the Preface, Naville gives indications that determinism was still an influential doctrine.

²⁰ *SéancesSSTA*, Annual Meeting in June 1888, *AnnPhilChr*, 116 (1888), 475-512 (p. 497).

²¹ Paul Forman, 'Weimar Culture, Causality and Quantum Theory 1918-1927: Adaptation by German Physicists and Mathematicians to a Hostile Intellectual Environment', *Historical Studies in the Physical Sciences*, 3 (1971), 1-115.

Whether or not Merkle and Maher were overstating the importance of experimental science to the debate about freedom, the discussion in this chapter will necessarily restrict itself to the influence of physics. Yet there is one further digression that needs to be made which will help to specify the discussion about the influence of physics on free-will: the meaning of freedom needs to be defined.

Christians insist that God's knowledge of the future does not rob man of his freedom to choose. While this may strike most people as counter-intuitive and even paradoxical, it arguably does no less violence to the common notion of freedom than does Spinoza's idea that to be free means to know that one is determined. These examples show that notions of freedom can be intricate. Fortunately, the people debating the interaction of physics and freedom understood human freedom fairly unproblematically – at least in the context of the debate. Man was said to be free, if his action at time $t + d$ could not be predicted with certainty on the basis of a full knowledge of the state of the material universe at time t . Thus Laplace's demon was seen as threat to freedom because his prediction of the future was based on knowledge of the past and present. God's knowledge of the future, on the other hand, is an aspect of his deeper view of the universe from outside of time. (This distinction does not pretend to solve the problem of human freedom in light of divine predestination, only to illustrate the terms of the debate about the bearing of physics on human freedom.) In what follows, 'freedom', 'free-will', and 'free-choice' will be used interchangeably in opposition to determinism.

B. First law of thermodynamics: the shackles of freedom

The first law of thermodynamics was the immediate context for the debate about determinism and free-will in the light of physics. The first law of thermodynamics by itself does not impose much of a constraint on human freedom. Gasoline rationing, for example, may restrict a person from driving beyond a certain radius but it leaves everything else to the choice of the individual. This is true for all other conservation laws. They place restrictions on the sum totals of the conserved quantity but say nothing else about the terms. *The argument for determinism needs a further premise about the behaviour of the constituents of matter.* In the late nineteenth century, every approach to physics, be it the kinetic theory, atomic dynamism, mechanical model making, or energetics, translated the physical problem into differential equations which were understood to provide determinate answers. Hence, most people could not easily avoid the determinist conclusion.

It may be somewhat puzzling that the first law of thermodynamics, rather than a particular version of physical theory, was cited as the basis for determinism, but there are several good reasons for the attribution. First, the law of the conservation of energy was not restricted to the inorganic realm. Thus it provided a means of transferring the determinism believed to exist in the inorganic order into the apparently free and spontaneous realm of life. Secondly, the first law of thermodynamics was an empirical law, a result of positive science. The various mechanical explanations of the universe were often irreconcilable hypotheses. To base the determinist argument on a particular mechanical system was to court refutation by physicists arguing for a rival system. The one fact that almost everyone could agree on was the conservation of energy. This law inspired various theories about the unity of force which, because they were all framed in differential

equations, could be used to argue for determinism.

Materialists welcomed the law of the conservation of energy for obvious reasons. Physicists, however, tended to be more skeptical of the law. At the time of its development, the law had been tested quantitatively only for isolated systems of inanimate matter. And even there the results were far from convincing. No one has yet managed to reproduce Joule's experiments to provide data that could possibly substantiate the law.²² The eagerness with which people accepted the law can best be explained by a generally prevalent belief in causality. In arguing for the conservation of energy, Mayer quoted the adage *ex nihilo nil fit*; and Joule wrote that 'it is manifestly absurd to suppose that the power with which God has endowed matter can be destroyed'.²³

Helmholtz was the first to apply the law to the universe as a whole, clearly going beyond the realm of empirical science. Other scientists were more cautious. For example, neither Kelvin nor Maxwell claimed that the law was applicable beyond closed systems. However, in France, especially as the scientific agenda gained momentum, the law was widely believed to hold universally. The advance of thermodynamics in the latter part of the nineteenth century too was responsible for the increased confidence in the conservation of energy. But after the discovery of radioactive energy, physicists once again became more circumspect regarding the law.²⁴ Henri Poincaré understood the law to mean that *something* remains constant.²⁵ His cousin, Lucien Poincaré, too, warned against overextending the law: 'It behooves

²² See Heinz Otto Sibus, 'Reworking the Mechanical Equivalent of Heat: Instruments of Precision and Gestures of Accuracy in Early Victorian England', *Studies in History and Philosophy of Science*, 26 (1995), 73-106.

²³ Maher, 'Energy', p. 424.

²⁴ Henri Poincaré, *La Valeur de la Science* (Paris: Flammarion, 1970), pp. 139-40.

²⁵ Poincaré, *Science and Hypothesis* (New York: Dover, 1952), p. 127: see Maher, 'Energy', p. 424.

us not to receive without a certain distrust the extension by certain philosophers to the whole Universe of a property demonstrated for those restricted systems which observation alone can reach. We know nothing of the Universe as a whole and every generalization of this kind outruns in a singular fashion the limit of experiment.²⁶ Eventually Einstein's famous $E=mc^2$ combined the two great conservation laws, which showed the danger in attributing absolute truth to physical theories. The physicists' skepticism was thus justified, but, beginning in the 1860s, the law of the conservation of energy was treated as an absolute result by the majority of those who sought to reconcile it with the possibility of human free will.

The belief in the law, however, did not stop experiments to determine how well it applied to living beings. In 1895, Max Rubner published results on heat production in dogs. The discrepancy between the observed results and the theoretical values was about 1% – accurate enough to verify the law in general but hardly good enough to verify that every every one of the animal's brain functions was physically determined.²⁷ A decade before Rubner's experiments, Moritz Schiff investigated temperature changes associated with the brain activity of chickens. He found that pain, vision, and hearing were all accompanied by a rise in temperature. It was enough to pass a paper of a different colour in front of the bird in order for the brain to get slightly warmer. These results were the basis of an argument which pitted Armand Gautier (1837-1920), professor of biological chemistry at the faculty of medicine in Paris, against Charles Richet (1850-1935), professor of physiology at the same faculty. Gautier argued that sensation was not a form of energy, for, if it were, the brain should have got colder rather than warmer. Richet, who was arguing

²⁶ Lucien Poincaré, quoted in Maher, 'Energy', p. 424.

²⁷ M.S. Pembrey, 'Animal Heat', in *Text-book of Physiology*, ed. by E.A. Sharpey-Schäfer, 2 vols (London: Young J. Pentland, 1898), I, pp. 785-867 (p. 833).

the materialist position, showed up the falsehood of Gautier's reasoning by pointing out that muscles, which exert mechanical forces, get hotter in the process. After much debate, Gautier conceded that 'mon honorable contradicteur affirme avec quelque raison qu'on ne saurait aborder à cette heure la démonstration de cette proposition par des preuves expérimentales directes'.²⁸

Désiré Mercier thought that both Gautier and Richet were misguided in their arguments. Both had wanted a direct experimental proof of something that could not be proved by external observations: 'Le jour où M. Gautier tenterait de fournir la preuve qu'on lui demande, il nierait ce qu'il a prétention d'établir.'²⁹ Richet too could not prove his position in the laboratory because instruments could only register physico-chemical changes. To say that thought was equivalent to these observable processes was to approach the subject with a materialistic prejudice.

Yet, according to Mercier, there was a way out of the impasse created by Gautier and Richet, because man had a direct access to his own thoughts. Every external experiment, he said, presupposes the validity of this internal functioning of the sense and intellect. If both internal and external experiences of man were taken into account, it would be found that, although every mental process is accompanied by physico-chemical manifestations, the intellect is nevertheless a spiritual faculty. This neo-Thomist conclusion was a faithful restatement of Thomas's teaching.³⁰ But before it could be established, it was necessary to show how an immaterial faculty could act in a material world without violating physical laws. There were several

²⁸ A. Gautier, 'L'origine de l'énergie chez les êtres vivants', *Revue scientifique*, 38 (1886), 737-42 and 'La pensée n'est pas une forme de l'énergie', *Revue scientifique*, 39 (1887), 14-8; Ch. Richet, 'La pensée et le travail chimique', *Revue scientifique*, 39 (1887), 83-5; see Mercier, 'La pensée et la loi de la conservation de l'énergie', *Le muséon*, 6 (1887), 215-23.

²⁹ Mercier, 'La pensée', p. 221.

³⁰ Thomas Aquinas, *Summa Theologiae*, I, q. 75, art. 1.

attempts to reconcile this apparent contradiction which were the subject of fairly extensive debate.

C. *Libertas ex machina*

One approach to the problem was to appeal to the concept of a pre-established harmony: God created the material world with a foreknowledge of all the choices that human beings would make, so that when the time came for the choice to be made no physical laws would have to be broken. This was the basis of Carbonnelle's solution to the problem. He noted that slight changes in initial condition could have a great influence on the solution of problems in mechanics. The human soul could exert forces on matter which were below the threshold of experimental detection but which could have profound influence on the development of physical activity.³¹ The forces could sometimes add to the total energy of the universe and sometimes subtract from it so that the slight deviations from the law of the conservation of energy could never be contradicted by experiment.

Carbonnelle's solution did not gain widespread acceptance. The atheists could hardly believe in God's providence; but Carbonnelle's co-religionists also tended to shy away from the explanation because it explicitly violated the first law of thermodynamics. To question the validity of the law was considered bad tactics given the popular belief that it was one of the greatest achievements of physics. Also, it could hardly appeal to the neo-Thomists who, like their master, were fond of quoting the biblical text 'she [divine Wisdom] orders all things well'.³² Carbonnelle's solution demanded a real, albeit undetectable, suspension of the laws of physics in order for humans to be able to function freely. Thus man's freedom would demand

³¹ Carbonnelle, *Confins*, pp. 361-5.

³² Wisdom 8.1.

a continuous miracle. Such a universe could hardly be said to be naturally suited to man.

Another early attempt at reconciling man's freedom with the conservation of energy appealed to forces which act perpendicularly to a body's trajectory. Such forces add no energy to the body although they can direct its path. An obvious example is the effect of the sun on the planets. The sun is responsible for their elliptical orbits although it does not alter the total kinetic energy of the solar system. Balfour Stewart (1828-87) and Peter Guthrie Tait (1831-1901), in *The Unseen Universe*, cite a passage from a *North British Review* article published in 1868 that proposed that the will acts in this way on atoms.³³ However, they distanced themselves from this solution because they thought that such a capricious force would make physics impossible. Regularity and repeatability, they said, were the essence of science. Yet other philosophers and scientists were not troubled by this scruple. Free will had to be explained somehow; and by its very nature it had to escape the determinism of mathematical equations. The idea of the will's acting as a perpendicular force continued to be cited favourably in the debate, although more as a springboard for introducing a concept than as a final solution.³⁴

A more sophisticated solution was devised by Joseph Boussinesq, who was at the time a professor of rational mechanics at the University of Lille. Boussinesq developed a discovery which had earlier puzzled Poisson. As Poisson put it in 1806:

Le mouvement dans l'espace d'un corps soumis à l'action d'une force donnée, et partant d'une position et d'une vitesse aussi données, doit être absolument déterminé. C'est donc un sort de *paradoxe*, que les équations différentielles dont le mouvement dépend puissent être satisfaites par

³³ Balfour Stewart and Peter Guthrie Tait, *The Unseen Universe*, Seventh edition (London: MacMillan, 1878), pp. 234-5.

³⁴ For example, see Guillaume Hahn, 'L'âme, la matière et la conservation de l'énergie', *RevQuestSci*, 45 (1899), 345-79 (p. 368).

plusieurs équations.³⁵

The multiple equations are called *singular solutions* and the initial conditions that give rise to them are called *bifurcation points*. Poisson noted that this strange result might have a bearing on the doctrine of absolute determinism, but he did not develop it further; and he did not even speculate as to its applicability to living creatures.

Boussinesq's contribution was to propose this puzzling mathematical result as an opportunity for the will to exercise its freedom. To be sure, only some restricted physical problems, with specially chosen initial conditions, give rise to these multiple solutions. Boussinesq gave three mathematical examples to illustrate his article for Moigno's journal *Les Mondes*. But, then as now, it was possible to give less technical illustrations of the kind of situations that give rise to the indetermination. For example, a ball bearing set at rest on the very apex of a hemisphere could in theory remain forever in that position. In practice, the ball bearing will begin to roll down from its highly unstable equilibrium position. But in which direction will it roll? An infinity of solutions is possible as the bearing is equally likely to begin its descent at any angle. The mathematics cannot determine the behaviour of the ball bearing at this critical juncture. Perhaps such bifurcation points were an opportunity for the will to exercise its freedom and choose one of the mathematically possible options.

Boussinesq was aware that bifurcation points in the inanimate realm might be rare if not altogether absent: repeatability was after all one of the salient features of experiments in physics. Yet living beings might prove to be different. In fact, Boussinesq proposed that the spatial and temporal frequency of bifurcation points

³⁵ Poisson, *Journal de l'Ecole Polytechnique*, 6 (1806), p. 106, as quoted in Paul Janet, 'Rapport sur le mémoire de M. Boussinesq intitulé Conciliation du véritable déterminisme mécanique avec l'existence de la vie et de la liberté morale', in *Séances et travaux de l'Académie des sciences morales et politiques*, 109 (1878), pp. 696-720.

might be the distinguishing factor between the animate and inanimate realm:

Un être animé serait par conséquent celui dont les équations de mouvement admettraient des intégrales singulières, provoquant à des intervalles très rapprochés, ou même d'une manière continue, par l'indétermination qu'elles feraient naître, l'intervention d'un principe directeur spécial. Ce principe, bien différent du principe vital des anciennes écoles, n'aurait à son service aucune force mécanique qui lui permît de lutter contre celles qu'il trouverait dans le monde: il profiterait seulement de leur insuffisance, dans les cas singulières considérés ici, pour influencer sur la suite des phénomènes.³⁶

It is clear that Boussinesq was not a vitalist. He thought that life had its basis in physico-chemical processes, but it was not determined by them because they themselves were not determined. The equations arising out of the Boscovichean cosmology, which Boussinesq had adopted as his own, were not violated but completed by the directive forces of life.³⁷

Boussinesq's speculations gained a wide hearing. His patron, de Saint-Venant, presented them to the Académie des Sciences in February 1877.³⁸ Boussinesq also published them in the journal of the Société des sciences de Lille, in the *Revue des Cours scientifiques*, and in *Les Mondes*. The philosopher Paul Janet summarized them favourably for the Académie des sciences morales et politiques in 1878, noting that Boussinesq's proposal is 'd'une nature très sérieuse et n'a rien de commun avec la métaphysique de fantaisie'.³⁹ But not everyone agreed. Joseph Bertrand (1822-1900), the perpetual secretary of the Académie des Sciences, criticized Boussinesq in terms that went beyond the bounds of good taste. Nevertheless, as Guillaume Hahn

³⁶ Boussinesq, quoted in Janet, 'Rapport', p. 712.

³⁷ Joseph Boussinesq, 'Extraits du mémoire sur la conciliation du véritable déterminisme mécanique avec l'existence de la vie et de la liberté morale', in *Séances et travaux de l'Académie des sciences morales et politiques*, 109 (1878), pp. 721-57 (p. 735).

³⁸ Boussinesq, 'Sur la conciliation de la liberté morale avec le déterminisme scientifique', *Comptes rendus hebdomadaires des séances de l'Académie des Sciences*, 84 (1877), 362-4.

³⁹ Janet, *Séances*, p. 696.

pointed out, this criticism from on high stopped neither Boussinesq's promotion to the Sorbonne nor his election to the Académie des Sciences.⁴⁰

De Saint-Venant, several weeks after presenting Boussinesq's paper, submitted his own musings on the subject of free will and physical determinism to the Académie des Sciences.⁴¹ De Saint-Venant's solution had in fact been suggested by Antoine Augustine Cournot (1801-77) as early as 1861.⁴² Examples abound, he said, to show how man's ingenuity can multiply forces. A slight push on the brake lever can stop a locomotive; and a minuscule spark can set off an explosion. In the limit, the amount of work needed to control or release prodigious amounts of energy tends towards zero. De Saint-Venant was not prepared to say whether the interaction between the thinking subject, the mind, with its organ, the brain, was mechanical or otherwise, but because vanishingly small control energies can have great effects 'rien n'empêche donc de supposer que l'union toute mystérieuse du sujet à son organe ait été établie telle, qu'elle puisse, sans travail mécanique, y déterminer le commencement de pareils échanges'.⁴³

Although Boussinesq and de Saint-Venant were invariably cited in contemporary discussions of the subject, especially in France and Belgium, their combined solution was anticipated by Maxwell in England in a paper given to a philosophical society in Cambridge in 1873. Arguments for determinism, he said, depended on the stability of physical laws. Such stability was manifest in simple

⁴⁰ Hahn, 'L'âme', pp. 352-3.

⁴¹ Adhémar de Saint-Venant, 'Accord des lois de la Mécanique avec la liberté de l'homme dans son action sur la matière', *Comptes rendus hebdomadaires des séances de l'Académie des sciences*, 84 (1877), 419-23.

⁴² Antoine Augustine Cournot, *Traité de l'enchaînement des idées fondamentales dans les sciences et dans l'histoire* (Paris: Hachette, 1911), pp. 273-5.

⁴³ De Saint-Venant, 'Accord des lois', p. 422.

systems such as the motion of planets. But it was not evident in more complex systems:

For example, the rock loosed by frost and balanced on a singular point on the mountain side, the little spark which kindles the great forest, the little word which sets the world a fighting, [...] , the little gemmule which makes us philosophers or idiots: the higher the rank, the more of them. At these points, influences whose physical magnitude is too small to be taken account of by a finite being, may produce results of the greatest importance. All great results produced by human endeavour depend on taking advantage of these singular states when they do occur.⁴⁴

Although the technical details of Boussinesq's paper are lacking in Maxwell's solution, the idea is the same. When Maxwell later learned of the work of Boussinesq and de Saint-Venant's solution, he wrote that it was 'epoch making' on account of its being 'the great solution of the problem of Freewill'.⁴⁵

The Belgian philosopher and psychologist Joseph Delboeuf (1831-1896) proposed yet another argument in favour of free will in an article whose subtitle was 'La liberté démontrée par la mécanique'.⁴⁶ Delboeuf hoped to use time as the ingredient which allowed the will to get its way. The will had at its disposal a certain amount of potential energy stored in the chemicals of the body; it could choose the best opportunities to release it. Thus freedom would not violate the law of the conservation of energy. Delboeuf was aware that this solution was lacking the most difficult step: 'Il y aurait donc à rechercher quel pourrait être le mécanisme d'un semblable arrêt. Cette question n'est pas de mon ressort ni de ma compétence'.⁴⁷ Yet Delboeuf speculated that the mechanism functions like the brake on a

⁴⁴ Maxwell, in Lewis Campbell and William Garnett, *The Life of James Clerk Maxwell* (London: MacMillan and Co., 1882), 434-44 (p. 443).

⁴⁵ See Karl Pearson, *The History of Statistics in the 17th and 18th Centuries*, ed. by E.S. Pearson (London, 1978), p. 360: see Hacking, 'Nineteenth Century', p. 465.

⁴⁶ Joseph Delboeuf, 'Déterminisme et liberté: La liberté démontrée par la mécanique', *Revue philosophique de la France et de l'étranger*, 13 (1882), 453-80, 608-38, and 14 (1882), 156-89.

⁴⁷ Delboeuf, 'Déterminisme et liberté', p. 163.

locomotive or the switch on a factory conveyor belt.

The French philosopher Alfred Fouillée (1838-1912) was often ranked with the determinists on account of his criticisms of arguments against attempts to reconcile physics and liberty. Frederick Copleston notes that Fouillée's position was in fact much more nuanced because he wanted to make room for freedom using psychological concepts.⁴⁸ Whether or not he succeeded is not of present concern. It remains true, however, that in *La liberté et le déterminisme* (1872), Fouillée argued against Cournot's solution. And in 1882, a few months after Delboeuf had published his essay in the *Revue philosophique*, Fouillée published a refutation in the same journal of some of the more recent efforts to reconcile human freedom and physics, including those of Cournot, Boussinesq, de Saint-Venant and Delboeuf. Fouillée concluded: 'Il nous semble que chercher la démonstration de la liberté dans la mécanique, c'est poursuivre l'impossible, et qu'il faut, dans cette question, s'élever au point de vue psychologique et métaphysique.'⁴⁹

Nevertheless, after Fouillée's article, there was one further attempt to reconcile mechanical laws with free will that gained approval in several circles. In 1887, de Tilly added a short note on the subject to his presidential address to the Académie des Sciences de Belgique. The note so impressed Hahn, that in an article in the *Revue des questions scientifiques* (1900), he wrote: 'Si on l'avait étudié, comme elle mérite de l'être, il y a bien longtemps que les difficultés tirées du principe de la conservation de l'énergie se seraient évanouies'.⁵⁰ De Tilly's solution is a development of the notion, cited above, that the soul acting on a single molecule in a

⁴⁸ See Copleston, *A History of Philosophy*, vol. 9, p. 173.

⁴⁹ Alfred Fouillée, 'Les nouveaux expédients en faveur du libre arbitre', *Revue philosophique de la France et de l'étranger*, 14 (1882), 585-617 (p. 617).

⁵⁰ Hahn, 'L'âme', p. 370.

direction perpendicular to its trajectory alters its course without altering the energy of the universe. De Tilly proposed that were the soul supposed to act on two molecules simultaneously, it could slow one down while speeding up the other so as to keep the total energy of the system the same. Were it allowed to act on three molecules, it could alter the system without altering its energy, nor displacing its center of mass, nor violating conditions on its total momentum. Acting on four or five or more molecules would then permit the soul to satisfy as many conditions as contemporary physics might devise. De Tilly's solution conserves the total of whatever quantities the macroscopic laws of mechanics decree must be conserved, which means that the soul's action on the body would escape experimental detection. But an observer with lynx-like eyes would no doubt wonder at the changes in the predicted trajectories of individual molecules, caused by the soul's intervention, which could in no way be explained by *mechanics*.

D. Neo-Thomist reconciliations of physics and freedom

The first neo-Thomist effort to address the threat to freedom arising from physics was a paper by the young Desiré Mercier published in the *Revue Catholique* in several instalments in 1883 and 1884. In the first article, Mercier distinguished between absolute determinism of the kind attributed to Laplace and recently popularized by Du Bois-Reymond and what he called the mitigated determinism of Bernard. This latter kind of determinism affirms, in the words of Bernard, that 'les manifestations des corps vivants aussi bien que celles des corps bruts sont rattachées à des conditions d'ordre physico-chimique'.⁵¹ Yet the physico-chemical conditions were not sufficient to determine absolutely the actions of animals and men. Mercier

⁵¹ Bernard, quoted in Mercier, 'Le déterminisme mécanique', p. 690.

thought that this kind of determinism was eminently plausible and in fact went on to quote a text of Thomas to support it.⁵² It would form the basis of his own solution. Nevertheless, he knew that he had to deal with claims of absolute determinism based on the mechanical interpretations of the first law of thermodynamics.

Mercier's next article reviewed the various solutions to the problem. He did not like the solution cited by Tait and Stewart – that the will exerts a force on particles in a direction normal to their trajectories – fundamentally because he thought that the will was not the immediate source of mechanical effects. Besides, even if the will were given the power to act directly on particles, it would indeed be a marvel for it to get its way and to preserve the law of conservation of energy.⁵³

Mercier next examined the combined efforts of Cournot, Boussinesq, and de Saint-Venant. Once again, he objected to the will's being assimilated to a mechanical agent. More particularly, he thought that Cournot's and de Saint-Venant's appeal to vanishingly small directive forces was illogical: the magnitude of the force might indeed approach zero, but if a force is going to be able to do something, it cannot be null. It was a category mistake to apply the mathematical concept of limit to the study of physics. Against Boussinesq, Mercier asked rhetorically: 'Est-il vraisemblable que chaque fois que je veux librement effectuer tel ou tel mouvement, de préférence à vingt autres, j'aie toujours la chance de me trouver sur un terrain de bifurcation, en présence de vingt et une routes indifférentes?'⁵⁴ He then went on to quote Carbonnelle whose opposition to Boussinesq's solution was well known in Catholic circles: 'aucune solution singulière

⁵² Thomas Aquinas, *De Potentia*, q. 3, art. 13.

⁵³ Mercier, 'Le déterminisme', pp. 837-8.

⁵⁴ Mercier, 'Le déterminisme', p. 843.

trouvée théoriquement, n'est jamais réalisable dans la nature.⁵⁵

Yet Mercier also found fault with Carbonnelle's solution, at least insofar as it admitted that the will could cause fluctuations, albeit insignificant, in the total energy of the universe. Mercier admitted that such an argument had its logic. The law of conservation of energy, such defenders of free will noted, was not an *a priori* truth, but an empirical result. But the freedom of the will was also an empirical fact, and one that is more immediate to human consciousness. If the two results are incompatible, then it is the first law of thermodynamics that will have to give way. Mercier agreed with the conclusion: 'si réellement il fallait opter entre la liberté et l'universalité de la loi de conservation de l'énergie, il serait rationnel et vraiment scientifique d'opter sans hésitation pour la liberté.'⁵⁶ Nevertheless, he thought that the hypothesis of variations in the first law of thermodynamics, although practically unfalsifiable, was gratuitous and unnecessary to the preservation of human freedom.

All the attempts at reconciliation considered thus far, Mercier noted, assumed that the will was an immediate principle of mechanical actions. Scholastic philosophy, on the other hand, 'affirme que le rôle de notre volonté spirituelle et libre est essentiellement distinct de celui qui revient à une puissance dynamique. Or si la philosophie moderne s'est montrée impuissante dans les diverses tentatives qu'elle a suggérées, n'y a-t-il pas lieu de soupçonner que son impuissance est le juste châtement de sa rupture avec la sagesse traditionnelle?'⁵⁷

In the final two articles, Mercier went on to explain how scholastic philosophy envisaged the interaction between the will and the body. First of all, the will was not

⁵⁵ Carbonnelle, quoted in Mercier, 'Le déterminisme', p. 843.

⁵⁶ Mercier, 'Le déterminisme', p. 846.

⁵⁷ Mercier, 'Le déterminisme', p. 848.

the immediate power of the soul that produces motion. Mercier provided a syllogistic proof of this assertion:

Des actes spécifiquement différents ne peuvent être produits que par des facultés réellement distinctes.

Or, un acte de volition et un acte d'impulsion mécanique sont des actes spécifiquement différents.

Donc ces actes ne peuvent être produits que par des facultés réellement distinctes, et conséquemment la volonté, qui produit la volition, ne peut pas produire immédiatement, et par elle-même, une impulsion mécanique.⁵⁸

In order to make this intelligible to the non-specialized reader, Mercier had to give a short lesson in the scholastic doctrine of the soul. According to this theory, the soul is the substantial form of an organized body or, equivalently, a living organism's principle of life. (Aristotle and the scholastics taught that plants, animals, and men all have souls, albeit of different kinds; but for the sake of simplicity, the present discussion will be restricted to the rational soul, that is, the human soul.) The soul is one, but it has many powers or faculties which are diversified according to their proper objects and actions. Thus vision is distinguished from hearing because colour differs from sound. And the will is distinguished from the intellect because the will seeks an object under the aspect of good, while the intellect abstracts the universal from a particular object and so is concerned with truth. The will and the intellect are the two faculties which reside in the soul, which is to say, they do not depend on an organ for their operation. (The brain is necessary insofar as it provides images from the senses as data for abstraction and reasoning, but the power of abstraction and reasoning does not arise out of biological matter but from the soul which in man is immaterial.) Other faculties in man, however, have as their subject both the soul and the organ – such as hearing, seeing, and tasting –, and sometimes even the soul

⁵⁸ Mercier, 'Le déterminisme', p. 52.

and the whole body, as in the case of nutrition and locomotion.

Having distinguished the powers of the soul, Mercier concluded that the will did not cause motion; it merely moved the faculty of locomotion to execute its decision. The question remained how this was possible. The answer lay in the scholastic teaching on the unity of man, who was at once a corporeal and spiritual being. According to this doctrine, it was wrong to see man as merely an aggregate of chemical substances. In man, chemicals ceased to exist as individual substances. Instead, they took on a virtual existence as part of the unity which properly belongs to the individual person. It was wrong, then, to suppose that the person was restricted in his choices and movements by the equations, deterministic though they be, of the staggering number of atoms which were virtually present in him. In view of the new unity, the equations did not adequately capture the behaviour of the virtual parts. The material aspect of man was thus at the service of the higher faculties.

The medieval debate between Avicenna and Averoes and the more contemporary disputes at the Roman College thus resurfaced in the debate about man's moral freedom. Mercier got rid of the problem caused by physical reductionism by denying the legitimacy of reductionism. Restated in the terms of scholastic psychology, the problem caused by the law of conservation of energy disappeared. Some of Mercier's philosophical language was criticized in the late 1890s by another neo-Thomist – de Munynck; but the basis of the solution eventually gained approval in scholastic circles. The acceptance, however, was not immediate.

The first discussion of the question of free-will and physics at the Société de Saint Thomas d'Aquin took place in December 1886. It was inspired by a paper

which Domet de Vorges had presented at an earlier meeting on 'Les rapports de la vie et de la sensation', in which he touched upon the legitimacy of applying mathematical physics to the processes of life. Domet de Vorges was critical of Boussinesq's solution because it granted too much to mechanics and because it was too convoluted. All that was necessary to preserve the law of the conservation of energy, according to Domet de Vorges, was a directive force that did not change the speed of individual molecules. Vicaire thought that Domet de Vorges was perhaps too quick to dismiss Boussinesq's efforts, especially since an appeal to directive forces was still too mechanical. Such forces, Vicaire pointed out, were always between material objects. One would have to invoke an imponderable 'ensouled molecule' that would escape the laws of mechanics in order to produce such forces. As it stands, Vicaire's argument is not clear, but presumably he had in mind Newton's third law of motion – equal action and reaction. Vicaire's own solution was along the lines favoured by Cournot and de Saint-Venant, that the soul is like the operator of a large machine whose contribution of energy is so small that it could never be experimentally detected. The Abbé Hébert warned that, detectable or not, such an energy would still not be strictly null, which is what disturbed the modern mind. And Chareyre noted that the scholastic mind should be prepared to accept that the soul can exert physical energy according to the adage: 'The higher [aspect] of the lower order always reaches to the lowest [aspect] of the higher order'.⁵⁹

Albert Farges introduced two further related distinctions which became part of the ultimate scholastic conciliation of free-will and physics: potency and act, and quantity and quality. These distinctions did not exist for those who believed that all energy was kinetic energy. Those, on the other hand, who maintained that there was

⁵⁹ 'Semper supremum infimi ordinis attingit infirmum supremi.' *SéancesSSTA*, 15 December 1886, *AnnPhilChr*, 113 (1886/7), 487-96 (p. 494).

a difference in kind between kinetic and potential energy could appeal to this qualitative difference to introduce a degree of freedom into a world whose total quantity of energy was constant. Hylomorphism, because it admitted the double principle of potency and act, could thus safeguard human freedom naturally, in distinction to the convoluted attempts necessary to preserve it in a purely mechanical world view. The meeting of the Society ended with calls for further discussions of the subject of free-will.

It seems the Society could never tire of discussing the possibility of freedom. Guieu read a note on Georges Lechalas's notion of liberty and physical determinism at the January 1888 meeting; in May and June 1888, Ackermann presented a paper on liberty and determinism; in April and May of 1889, Joseph Gardair read his paper on free-will; and as if that was not enough, members at the June 1889 meeting suggested that free-will be a special topic for the next academic year. The suggestion was taken seriously. At the annual assembly in November 1889, members were treated to a debate on the subject between Gardair and Ackermann, then to a paper by Ackermann in December 1889 and further discussions of Ackermann's work in January 1890, only to be followed by the Abbé Clodius Piat's paper 'Sommes-nous libres?' in February of the same year. To be sure, most of the time the focus was not on problems arising from physics. The topic of freedom, after all, had a rich history long before the advent of modern science, as the notoriety of Buridan's ass should make clear.⁶⁰ But at least one of Ackermann's papers addressed the problems of physics directly.

Auguste Ackermann (1846-1930) joined the faculty of the Institut catholique in Paris in the 1890-91 academic year as a lecturer in the history of philosophy. A

⁶⁰ The hypothetical donkey, named after the medieval philosopher, Jean Buridan, who starves between two identical bales of hay for want of reason to start eating from one rather than the other.

priest of the Paris diocese, he was also an ‘*agregé de l’Université*’. His interventions in questions of philosophy of science were particularly illuminating; and although there is no record of his ever having corresponded with Duhem, the two men’s ideas were often similar. Addressing the question of human liberty, Ackermann insisted that there was no conflict as long as the law of conservation of energy was treated as a result of positive science.⁶¹ The conflict arose only when the law was interpreted in the framework of mechanical theories. In this context, the law of the conservation of energy appeared as a corollary of the laws of mechanics and became inseparable from them. Ackermann thought that all attempts to reconcile human freedom and universal mechanism were doomed to failure. A much better strategy to defend human freedom was to question the validity of the laws of mechanics themselves.

Ackermann pointed out that although mechanical theories pretend to explain, their first principles are not only inexplicable but even contradictory. On the dynamicist hypothesis, there was action at a distance in the void. Scholastics would have immediately grasped Ackermann’s point that a true void could not have extension. He himself called attention to the problem of a physical force’s calculating its intensity as though it were intelligent. This, he thought, was a logical consequence of dynamism because the void was not a field which could influence the point atom and recourse could not be had to collisions of extended particles. The point atom, then, could not have any physical means of determining how much force it should experience at a particular place apart from calculations based on its distance from every other point atom in the universe – quite a feat for mindless matter to do. The kinetic theory had different but equally serious problems – infinite forces in collisions and the elasticity of hard atoms.

⁶¹ *SéancesSSTA*, Annual Meeting June 1888, *AnnPhilChr*, 116 (1888), 475-512 (p. 498).

These were standard scholastic criticisms of the kinetic theory and dynamicism but Ackermann went further. He pointed out that, as new effects were discovered, the hypothetical framework of mechanics had to be enlarged. Physicists, for example, spoke of an imponderable ether of zero viscosity. The image was clearly an analogy from sense experience. No doubt, there were good reasons for adopting the particular image, but perhaps other possibilities could also be justified. This open-ended development of theory had led, in Ackermann's estimation, to a new understanding of the truth claims of physics:

Le désarroi des hypothèses physiques est tel que les purs savants ne songent même plus à les accorder entre elles et ne les regardent que comme des symboles commodes pour l'enseignement: 'masses, forces, mouvement, repos, autant d'entités mystérieuses; la vraie science ne connaît que des nombres.' C'est-à-dire qu'après avoir prétendu à être métaphysique, explicative, la science elle-même renonce à toute explication. Après avoir prétendu atteindre le fond de la réalité physique, la mécanique confesse qu'elle reste à la surface des choses dans un formalisme abstrait.⁶²

Written in 1888, this description of physical science predates both Poincaré's commodism and Duhem's holism. Ackermann clearly restricts the philosophical import of physical theory to the level of description.

It might be objected, however, that determinism at the level of description was still determinism. Although mechanical theories were only hypothetically true, if their predictions were constantly confirmed by experiment, it might be argued that liberty was only an illusion. Not so, replied Ackermann: 'Il y a quelque chose de déterminé en tout, même dans notre âme, même en Dieu, la liberté a son point d'appui dans les natures données, c'est-à-dire déterminées.'⁶³ The methodology of physical science was powerless to observe liberty because liberty is something that

⁶² *SéancesSSTA*, 6 June 1888, *AnnPhilChr*, 116 (1888), 392-9 (p. 393). It is not clear whether the quotation marks indicate Ackermann's exact words or that he was quoting from an unspecified source.

⁶³ *SéancesSSTA*, 6 June 1888, *AnnPhilChr*, 116 (1888), p. 393.

can only be experienced from within. The physicist could only observe from without. Furthermore, he searches for constant and universal aspects of the material world, amid the varied details of particular circumstances, much as a statistician ignores the individual in his quest for averages. The laws which the physicist formulates will thus deal with a restricted aspect of nature – the part that yields to quantification. 'Bref, nous ne trouvons le déterministe [sic] universel dans la science que parce que nous l'y avons introduit nous-mêmes.'⁶⁴ According to Gardair, 'les conclusions de M. Ackermann sont, en somme, celles de tous les membres présents.'⁶⁵

The question of human liberty continued to be debated throughout the 1890s, but the next major Thomist contribution dates from the end of the decade. Beginning in 1897, the Dominican Marc Marie de Munnynck began to write articles on the subject in the *Revue thomiste*. Then, in 1900, he set forth his mature views in *La Conservation de l'énergie et la liberté morale*, which appeared as part of the popular series of 64-page pamphlets entitled *Science et Religion*. (By 1901, the series had 186 volumes.) In the meanwhile, however, the Jesuit Marius Couailhac (1856-1904) published his doctoral thesis *La liberté et la conservation de l'énergie* (1898) which de Munnynck addressed in his pamphlet. Thus it makes sense to look first at Couailhac's contribution.

Couailhac was not the first to introduce the distinction between quantity and quality into the debate, but he did it more thoroughly and clearly than it had previously been done. Another Jesuit, Eugène Portalié, described Couailhac's thesis defence at the Sorbonne in 1898:

La liberté et la conservation de l'énergie! Est-il sujet plus actuel en philosophie et qui ait suscité plus de travaux en ces derniers temps? Un

⁶⁴ *SéancesSSTA*, 6 June 1888, *AnnPhilChr*, 116 (1888), p. 394.

⁶⁵ *SéancesSSTA*, 6 June 1888, *AnnPhilChr*, 116 (1888), p. 397.

des membres du jury, M. Boutroux, l'avait lui même traité dans sa thèse sur la *Contingence des lois de la nature*, et son étude récente *l'Idée de loi naturelle* n'avait pas d'autre objet. En fallait-il davantage pour exciter l'intérêt?⁶⁶

Couailhac's strategy was to show that quantity was inseparable from quality. In local motion, he said, there was not only speed – a quantity – but also a direction – a quality. Each force also had both a magnitude and a direction. Hence, the principles of mechanics were unintelligible in terms of quantity alone. The equations might give the impression that only quantities were at issue, Couailhac maintained, but they could not be understood apart from qualities.

Couailhac developed his theme further in a chapter on reversibility. Nothing in the equations of mechanics prevented processes from *running backwards in time*. Yet in the real world, pears which have ripened and fallen to the ground do not jump back to the branch and revert to green fruit, flower, and bud. And even in the much simpler world of the laboratory, the second law of thermodynamics had never been contradicted. This, he believed, showed the insufficiency of mechanics.⁶⁷

Portalié remarked that Couailhac's arguments for the importance of quality to the proper understanding of the universe was the philosophical complement to Duhem's more scientific reasons for admitting qualities into physical theory.⁶⁸ There is, no doubt, a similarity between Couailhac's and Duhem's positions, but there is also a difference which Portalié did not understand. Portalié thought that the qualitative aspect of the world could not be quantified: 'rien de tout cela n'est soumis au nombre et à la mesure'.⁶⁹ Duhem, on the other hand, thought that some

⁶⁶ Eugène Portalié, 'La liberté et la conservation de l'énergie', *Études*, 76 (1898), 745-66 (p.745).

⁶⁷ Portalié, 'La liberté', p. 760.

⁶⁸ Portalié, 'La liberté', pp. 760-1.

⁶⁹ Portalié, 'La liberté', p. 760.

qualities could and should be quantified and incorporated into physical theory. His version of physical theory could then predict that reversible processes do not happen in nature; but it could not reveal directly the causal links which scholastic philosophy sought to understand.

De Munnynck's *La conservation de l'énergie et la liberté morale* was highly praised by other Catholic writers.⁷⁰ He accepted fully the legitimacy of the law of the conservation of energy, which, he stressed, was an *observed fact, not an a priori* truth. At the same time, however, he insisted that the freedom of the will too was an observed fact, not of external observation but of internal experience: 'ainsi la réalité du libre-arbitre est placée au-dessus des conceptions les plus ingénieuses, les mieux enchaînées'.⁷¹ Convinced that there was no contradiction, de Munnynck sought to explain how freedom of the will did not violate the first law of thermodynamics. Reviewing previous attempted solutions, he found them all wanting. Carbonnelle's hypothesis of minute additions and subtractions of psychic energy had no experimental basis. Boussinesq's solution failed on two counts: first, the singular points might not exist in nature; and, secondly, it pandered too much to the mechanical conception of the universe. De Saint-Venant (and Cournot) made the mistake of equating 'vanishingly small' and zero. De Munnynck preferred de Tilly's solution of a directive force with many degrees of freedom which had been endorsed previously by Hahn, because he believed that it destroyed the tenets of physical determinism. And he appreciated Couailhac's efforts for the same reason. Yet he thought that neither of these approaches specified how the will operated, and in particular how potential energy stored in the chemistry of the body could be

⁷⁰ See, for example, a review of the pamphlet by L.S. in *RevQuestSci*, 48 (1900), 638-42.

⁷¹ Marc de Munnynck, *La conservation de l'énergie et la liberté morale*, Sciences et Religion - Études pour le temps présent (Paris: Bloud et Barral, 1900), p. 14.

actuated. He thought that only Aristotelian hylomorphism could explain the process.

De Munnynck thought that potential energy 'n'est pas autre chose que l'effet neutralisé d'une force actuellement agissante'.⁷² A billiard ball, for example, at rest between two cues exerting equal and opposite forces on it was in a different dynamic state from a ball just resting on the table with a cue touching it. In the first case, the removal of one cue would result in the motion of the ball; in the second, the ball would remain at rest. De Munnynck called the neutralizing force *force prohibante*; and the force that in turn overcomes the *force prohibante* he called the *force décrochante*, the triggering force. He turned to chemistry to illustrate these concepts further.

Citing the authority of the chemist Louis Henry, de Munnynck said: 'Si quelque chose est certain, c'est que la molécule n'est pas une simple juxtaposition d'atomes.' The molecule enjoyed an individuality. It acted as a unified whole and not as a collection of independent atoms. The principle of its unity was at the same time the *force prohibante* which did not let the chemical energy of the molecule dissipate:

Dans chaque molécule, une forme, une réalité quelconque maintient les atomes dans une indivision spéciale, donnant à leur ensemble tous les caractères d'une portion de matière individualisé. Dès que cette réalité vient à disparaître, l'énergie accumulée s'actualise, apparaît sous forme de chaleur, d'électricité, de mouvement cinétique, ou s'emmagasine en quantité déterminée dans une nouvelle espèce.⁷³

The *force prohibante* was thus nothing less than the substantial form.

De Munnynck believed that 'l'énergie vitale est, au point de vue qui nous occupe, absolument assimilable à l'énergie chimique'.⁷⁴ Although there was more to

⁷² De Munnynck, *La conservation*, p. 37.

⁷³ De Munnynck, *La conservation*, pp. 40-1.

⁷⁴ De Munnynck, *La conservation*, p. 43.

human life than chemistry, he maintained that all energy used by human beings is to be accounted for by chemistry. In man, the substantial form was the soul. Hence the soul was also the *force prohibante*. But what actuated the chemical energy in the body to carry out the will of the individual? In inorganic molecules, it was the surroundings that determined whether the *force prohibante* would be overcome – heat, presence of other chemicals, electricity, shock, etc. The *force décrochante* came from the outside. The human soul, on the other hand, because it was immaterial, could act on itself to actuate the body to obey the commands of the will:

La volonté comme *force décrochante* puisse neutraliser la *force prohibante* de la molécule nerveuse, c'est-à-dire qu'elle puisse agir sur la substance qui en est le principe; et cela sans produire du travail. Or cette *force prohibante* n'est autre chose que *l'âme humaine elle-même*. Il est donc manifeste que, par son côté matériel, l'acte volontaire n'est que l'action de l'âme sur elle-même, de l'âme comme principe d'activité libre sur l'âme comme *force prohibante* d'énergie chimique, ou en langage scolastique, comme forme substantielle du corps humain.⁷⁵

From a neo-scholastic point of view, de Munnynck's solution made sense, but apart from introducing a technical vocabulary, it did not go beyond Couailhac's analysis. All that de Munnynck said was that the quantity of energy stayed the same while the soul was free to use it as it saw fit. By starting from chemistry and proceeding to human life, he seemed to be following the same route as the physical reductionists who would construct man from simple atoms and their laws of interaction; in fact, he gave himself an unfair advantage in solving the problem. First, de Munnynck's basic blocks, the molecules, had a much richer nature than any which the various schools of mechanism were willing to grant. (It should be remembered that chemical hylomorphism was established among the scholastics by pointing to the insufficiencies of every merely mechanical explanation of physical and

⁷⁵ De Munnynck, *La conservation*, p. 50.

chemical phenomena.)

The second advantage that de Munnynck had was that, according to scholastic theory, the molecules in a human body were present not as individuals but as virtual parts of a much more complex entity – man. Hence, the already rich substantial forms of the chemical molecules were given a much greater opportunity to escape from physical reductionism. They could now be altered by the spiritual soul of man which was the substantial form of the body.

The scholastic view was consistent, but it succeeded in resolving the perceived contradiction between freedom of the will and mechanistic physics by denying the legitimacy of the mechanical conception of the universe right from the beginning. This was arguably the best strategy for all who wanted to maintain human freedom and beyond that to account for every aspect of what it was to be human: a self-conscious, rational animal, who was intimately linked to the inorganic world and its regularities. Mercier had warned that there are many pitfalls in discussing man:

La coexistence de la multiplicité et de l'unité dans l'épanouissement de notre vie, a toujours paru un difficile problème et quiconque se préoccupe exclusivement, pour la résoudre, soit de l'unité, soit de la diversité, se condamne d'avance à un échec certain.⁷⁶

He believed that only the peripatetic school could do justice to all aspects of the problem. But if that were so, it could not confront specialized approaches to the problem on their own terms. De Munnynck could effect a synthesis between modern physical science and freedom of the will only because he imposed a peripatetic understanding onto physics and chemistry. Thus tamed, these sciences ceased to be problematic.

One might suspect that de Munnynck's invocation of chemical hylomorphism in

⁷⁶ Mercier, 'Le déterminisme', p. 52.

his solution to the problem of freedom and his use of terms such as *force prohibante* and *force décrochante* was just a cynical appeal to scientific authority in a scientific age. But this need not be so. Although he himself was primarily a philosopher, he studied chemistry under Henry, who was primarily a scientist. If Henry thought that the facts supported hylomorphism, then de Munnynck could be excused for appealing to chemistry at the outset of his argument before proceeding to the more complex case of man. Mercier did not use such technical language in his own essay on freedom of the will, but he was writing before Nys completed his *Cosmologie* in 1888 and thus before the general acceptance of chemical hylomorphism among scholastics. No doubt, the larger question of the essence of man was in the back of people's minds as they worked on developing chemical hylomorphism, but the architects of the doctrine – Nys, Bulliot, de Munnynck – sincerely thought that the scholastic theory best fit the established facts of science. If hylomorphism also happened to safeguard human freedom, so much the better.

There was yet another way to break the mechanistic straightjacket without embracing chemical hylomorphism and without appealing to highly questionable *ad hoc* hypotheses. In 1874, Émile Boutroux published his doctoral thesis *Contingency of the Laws of Nature* in which he argued that 'life, feeling, and liberty are true and profound realities, whereas the relatively invariable and general forms apprehended by science are but the inadequate manifestation of these realities'.⁷⁷ It took some time for Boutroux's ideas to penetrate beyond a small circle of intimates which included the brothers Jules and Paul Tannery and Henri Poincaré.⁷⁸ A major reason

⁷⁷ Émile Boutroux, *Contingency of the Laws of Nature*, trans. by Fred Rothwell (Chicago: Open Court, 1920), p. vi.

⁷⁸ Mary Jo Nye, 'The Boutroux Circle and Poincaré's Conventionalism', *Journal of the History of Ideas*, 40 (1979), 107-20 (p. 108).

for the slow dissemination of Boutroux's philosophy was that it was perceived to threaten the truth of science. Portalié, for example, cited the *Contingency* in his survey of arguments for freedom of the will, but thought it extreme: 'Elle [la réaction de Boutroux] délie peut-être la liberté des entraves qu'on voulait lui imposer, mais elle ruine les fondements de la science.'⁷⁹ Yet eventually Boutroux's ideas gained acceptance. As Mary Jo Nye has argued, they gave rise to Poincaré's conventionalism. And their similarity to Duhem's conception of physics is evident. Eventually these ideas gained a wider hearing. In 1900, for example, at the International Congress of Philosophy, Wilbois argued for human freedom by borrowing heavily from Poincaré and Duhem. In particular, he argued that (1) physical laws were symbolic, (2) experimental measurements were approximate, and (3) every experiment presupposed the whole of physics.⁸⁰ All three points are Duhemian themes.

E. Duhem on physical determinism

Duhem addressed the question of free-will and physics in his *Physique de Croyant*, not for its own sake, but as a means of illustrating the difference between his conceptions of physical theory and of metaphysics. The apparent contradiction between human freedom and the conservation of energy, he maintained, arose from a false understanding of physical theory. It presented a problem for all those who derived their physics from metaphysical principles, be they Cartesians or atomists, for all such thinkers presupposed that deterministic mathematical laws governed the behaviour of their chosen building blocks. Human freedom, Duhem continued, could

⁷⁹ Portalié, 'La liberté', p. 751.

⁸⁰ J. Wilbois, 'Sur un argument tiré du déterminisme physique en faveur de la liberté humaine', *Bibliothèque du Congrès International de Philosophie*, vol. 3, *Logique et Histoire des Sciences* (Paris: Armand Collin, 1901), 633-86 (p. 637).

also be threatened by the Newtonian understanding of physical theory. Even if the physicist restrained himself from making hypotheses about the essences of things, he believed on the basis of a broad induction that he had discovered the unchanging laws which govern the phenomena. Once again, these laws were expressed in the unbending language of mathematics. *Human freedom becomes a casualty.*

Duhem, on the other hand, denied that there was any contradiction between the law of conservation of energy and the possibility of human freedom, because *physical theory did not directly attain to objective reality:*

What indeed is a principle of theoretical physics? It is a mathematical form suited to summarize and classify laws established by experiment. By itself this principle is neither true nor false; it merely gives a more or less satisfactory picture of the laws it intends to represent. It is these laws which make affirmations concerning objective reality, and which may, therefore, be in agreement or disagreement with some proposition of metaphysics or theology. However, the systematic classification that theory gives them does not add or take away anything concerning their truth, their certainty, or their objective scope. [...] *In itself and by its essence, any principle of theoretical physics has no part to play in metaphysical or theological discussions.*⁶¹

Duhem's position is reminiscent of Ackermann's analysis of human freedom at the meetings of the Society of Saint Thomas. Physical theory describes in its deterministic framework an aspect of nature which follows regular laws. But it does not account for these regularities; nor does it claim to explain all objective reality in terms of a few laws. Moreover, it is always provisional.

Duhem gave a concrete example of what physical theory cannot do:

For us the principle of the conservation of energy is by no means a certain and general affirmation involving really existent objects. It is a mathematical formula set up by a free decree of our understanding in order that this formula, combined with other formulas postulated analogously, may permit us to deduce a series of consequences furnishing us a satisfactory representation of the laws noted in our laboratories.⁶²

⁶¹ Duhem, 'Physics of a Believer', p. 285.

⁶² Duhem, 'Physics of a Believer', pp. 285-6.

Such a law then was neither true nor false but only more or less accurate. In order to argue against human freedom based on the first law of thermodynamics, one would first have to assume that it was true and to combine it with other laws, stated in the form of differential equations, which were also assumed to be true. The result would be a system of differential equations which would leave *no room for freedom*.

Duhem dismissed such an argument as worthless:

We selected our differential equations or, what comes to the same thing, the principles they translate, because we wished to construct a mathematical representation of a group of phenomena; in seeking to represent these phenomena with the aid of a system of differential equations, we were presupposing from the very start that they were subject to a strict determinism; we were well aware, in fact, that a phenomenon whose peculiarities did not in the least result from the initial data would rebel at any representation by such a system of equations. We were therefore certain in advance that no place was reserved for free actions in the classification we had arranged. When we note afterwards that a free action cannot be included in our classification, we should be very naive to be astonished by it and very foolish to conclude that free will is impossible.⁸³

Duhem's eschewing of all mechanical analogies in his work as a physicist no doubt made it easier to avoid thinking that the world was as clearly understandable and predictable as a clock. The terms which energetics chose for its equations – energy, entropy, temperature, chemical potential, enthalpy, etc. – could not readily be visualized in terms of mechanical models whose causal interactions were as 'unproblematic' as collisions. And many of the terms were quantified 'qualities' (see chapter 5.4). No doubt, it is true that qualities can be said to be causes, but they are more resistant to the notion of determinism than quantities.

First, unlike the limited number of quantities at the basis of mechanics, there is a potential infinity of qualities. The physicist is not likely to think that he has

⁸³ Duhem, 'Physics of a Believer', p. 286.

captured every aspect of the world by isolating a few commonly recurrent qualities. Hence, the temptation towards reductionism, a necessary presupposition of physical determinism, is diminished. Secondly, the human mind tends to think that the causality of qualities is relatively obscure when compared to the collisions of atoms or the contortions of the ether. The efforts, such as Lesage's, to understand gravitation in terms of pushes rather than of pulls may come to mind in this context. And the causality of the colour red – very real in bullfighting – is more mysterious still.

Duhem knew that physics was simplifying the world in order to understand it. Hence, physics for him could not shake his faith in the common sense belief in human freedom. In particular, physical theory did not directly bear upon metaphysical doctrines. Duhem's separation of physics from metaphysics was problematic for some of the neo-Thomists, but there were similarities in his and their arguments for human freedom.

The neo-scholastic case for chemical hylomorphism rested on the insufficiency of mechanical theories to account for the phenomena. Nature, the neo-Thomists argued, was richer than extension and movement. And the substances of the laboratory became richer yet when incorporated into the human person. There was more to man than could be described by mere equations. He obeyed the laws of the physical world, but he was free. Some of the neo-Thomists believed that physical science itself could be used to demonstrate this freedom. Duhem, on the other hand, thought that physics had nothing to say about the matter. This difference of outlook will be discussed further in the next chapter.

2. Physics and the eternity of the world

In Maher's estimation, the first law of thermodynamics was the basis of some of 'the gravest objections raised by the progress of modern science against theism' and all it entailed. The second law of thermodynamics, on the other hand, suggested an argument against the eternity of the universe, which some neo-scholastics took up. Their enthusiasm, however, was somewhat restrained, in part perhaps because Thomas had taught that apart from Divine revelation, it was impossible for man to know with certainty whether the world was eternal or created in time. The debate about the eternity of the universe was thus not as widespread as the debate about human freedom. Seldom were its conclusions seen as anything more than fitting arguments for the Christian dogma of creation in time. Nevertheless, an examination of another topic where physical theory could potentially influence a metaphysical discussion will provide a better understanding of how the neo-scholastics and Duhem understood the relationship between physics and metaphysics.

It should be emphasized at the outset that the question here is about the eternity of the universe and not about any specific age of the solar system or of other known physical features. Thus discussions of the age of the earth, as interesting as they may have been to geologists and those debating the theory of evolution, do not enter into the more general question. If Farges is to be believed, Catholics had no problems with various theories about the origin of the solar system from nebula. And the popularity of de Lapparent's books outside of France and outside of Catholic circles testify to the willingness of Catholics to treat geological questions based on the available scientific evidence. But neither solar physics nor geology were thought to have a direct bearing on whether the universe is eternal or not.

A. Creation *ex nihilo*: a dogma of the Christian Faith

A brief history of the Christian dogma on creation will help to situate the late-nineteenth-century debate. The opening words of the Bible speak of a beginning: 'In the beginning, God created the heavens and the earth'. Although the text goes on to speak of primordial waters over which the Spirit of God hovered, the early Christians understood the passage, and other texts as well, to mean that the universe is not eternal; and some Fathers of the Church, such as Basil (ca.330-ca.379), thought that an eternal world is inherently impossible. In 1215, the Fourth Lateran Council met to defend the Faith against the teachings of various sects who believed that there were two eternal principles – the material and the spiritual. The Council proclaimed that Catholics must believe in one God 'who by His own omnipotent power at once from the beginning of time created each creature from nothing'.⁸⁴

At about the time of the Council, the teachings of Aristotle began to be disseminated in the Christian West. The Stagirite believed the world to be eternal. Some of the scholastic doctors, most notably Saint Bonaventure, thought they could maintain the Christian position against Aristotle by reason alone. Thomas, on the other hand, thought that neither the arguments for eternity nor those against it could be conclusive. God's ontological priority over the universe, and hence the contingency of the universe, does not imply that the universe had a beginning in time. The Christian could know that the world had a temporal beginning only because God had revealed it.⁸⁵ The Catholic dogma was reinforced in 1277, when the eternity of the universe was condemned by the Archbishop of Paris along with over two hundred other teachings, many of which were attributed to Aristotle. In the

⁸⁴ Denzinger, paragraph 1783.

⁸⁵ Thomas Aquinas, *Summa Theologiae*, I, q. 46, a. 2.

nineteenth century, with the spread of pantheism and naturalism, which maintained that man and the universe must be understood apart from God, the First Vatican Council reaffirmed the teaching of Lateran IV that the world was created by God at the beginning of time.⁶⁶

B. Carbonnelle and the newly developed arguments from science

Despite Thomas's argument to the contrary, there were some Catholic thinkers in the nineteenth century who thought that it was possible to provide a conclusive proof for the Christian dogma without reference to Revelation. Carbonnelle thought that he could prove it in two ways. The first way involved an analysis of what was meant by an 'infinite number', which he thought was a contradiction in terms. Carbonnelle found the scholastic distinctions between actual and potential infinities wanting. His argument for a universe of finite duration can be summarized as follows. An 'infinite number', he said, was essentially indeterminate. Now, any past event must have taken place at a determinate time, if the event were to have an objective reality. Therefore, no real event could have taken place infinitely long ago; and, hence, the universe is not eternal. It is difficult to believe that anyone could accept the argument, for, apart from any problems with the concept of absolute time, it proves only that each event must have taken place at a determinate time in the past, but not that there was a first event. The argument is mentioned here only to show Carbonnelle's faith in the power of abstract concepts, in this case numbers, to attain ontological truths.⁶⁷

Carbonnelle's second argument for a temporally finite universe was based on the laws of physics. He believed that it was possible to reduce the whole of the

⁶⁶ Denzinger, paragraph 1783.

⁶⁷ Carbonnelle, *Confins*, Chapter 4, pp.227-94.

inanimate universe to a problem of rational mechanics as envisaged by Boscovich. Although Carbonnelle conceded that many of the details of rational mechanics were unknown, he thought that a few were beyond dispute: the conservation of mass, the conservation of energy, and the second law of thermodynamics, which he stated as 'la quantité d'énergie vibratoire augmente sans cesse aux dépens de l'énergie visible'.⁸⁸

Rudolf Clausius (1822-88), who had coined the word 'entropy' and applied the second law of thermodynamics to the universe as a whole, spelled out its meaning in a speech to the Congress of German Natural Philosophers and Physicians: 'a natural law has been found which permits us to conclude with certainty that, in the universe, everything did not run in circles, but that modifications took place in a determined sense, and thus they will tend to bring about a final state.'⁸⁹ The final state envisaged by Clausius became commonly known as the 'heat death' of the universe. It was popularized with dramatic illustrations of people dying of cold in Camille Flammarion's *La fin du monde* (1893).

In the meantime, however, Carbonnelle used the notion of an end to argue for a beginning:

Si l'univers n'avait pas eu de commencement, il ne pourrait pas être aujourd'hui en marche vers un état limite, il y serait arrivé depuis longtemps. L'énergie universelle serait toute transformée et distribuée comme elle doit être dans un lointain avenir. Si le monde était éternel, le monde serait mort aujourd'hui. Donc chaque transformation nous démontre qu'il n'est pas éternel et qu'il a eu un commencement. Pour se soustraire à cette conséquence, pour rejeter la création, il faut, tout en parlant au nom de la science moderne, ignorer ou repousser aveuglément l'une de ses plus belles découvertes.⁹⁰

It is not likely that Carbonnelle was the originator of the argument. Yet he was

⁸⁸ Carbonnelle, *Confins*, p. 329.

⁸⁹ Clausius, *Revue des cours scientifiques* (February 1868), quoted in Carbonnelle, *Confins*, p. 330.

⁹⁰ Carbonnelle, *Confins*, p. 332.

undoubtedly an authority on science in Catholic circles; and his *Confins de la science et de la philosophie*, the source of the above quotation, predated most publications on the subject. The argument became well known. It is reproduced, for example, in Farges's *L'idée de Dieu après la science moderne*. Eventually, it was cited as simply the argument for a temporally finite universe based on entropy, with no further details given.⁹¹ Yet, although all neo-scholastics knew the argument, none of them thought that it had the conclusive force attributed to it by Carbonnelle.

C. Sertillanges and the prudence of Thomas

In 1897, the Dominican Antoine-Dalmace Sertillanges (1863-1948) delivered a paper entitled 'La preuve de l'existence de Dieu et l'éternité du monde' at the International Catholic Scientific Congress in Fribourg. Sertillanges's objective was to show that the traditional scholastic proofs for the existence of God were in no way logically dependent on creation in time. After reviewing these proofs, he focused on contemporary arguments purporting to show that an eternal universe was impossible. Convinced of Thomas's position, he was critical of all of the arguments, and especially of Carbonnelle's clumsy attempts at dealing with 'infinite numbers': 'Si l'auteur avait essayé de mettre [l'argument] *en forme*, [...], l'inanité en fut devenue si manifeste qu'il ne fût point allé jusqu'au bout, sa plume eût refusé le service.'⁹²

Having disposed of arguments based on mathematical notions, Sertillanges turned to arguments for creation in time based on physical science, and principally on the second law of thermodynamics. Sertillanges thought that there was something to be said for the proof from entropy, which he also called the law of degradation of

⁹¹ See, for example, Mercier et al., *A Manual of Modern Scholastic Philosophy*, I, p. 54.

⁹² A.-D. Sertillanges, 'La preuve de l'existence de Dieu et l'éternité du monde', *RevThom*, 5 (1897), 453-68, 609-25, 746-62 (p. 617).

energy:

La validité de ce raisonnement est admise par beaucoup de bons esprits, et ce serait assez pour nous faire croire qu'il n'est pas dénué de toute valeur. Comme argument probable, *ad hominem*, il a sa place dans l'arsenal apologétique. Au point de vue de certains savants et moyennants quelques hypothèses assez généralement admises, il peut amener la conviction.⁹³

In itself, however, the argument was not conclusive. First, there was the question of specifying what was meant by 'universe'. Was the universe a closed system? Was it finite in extent? Was the energy within the universe finite? Secondly, no one knew the cause of degradation of energy. Was the empirical law statistical in nature? If so, then perhaps, as Poincaré had suggested, the universe might wake up after a protracted but finite sleep.⁹⁴ Macquorn Rankine (1820-72) thought that degraded energy travelling to the ends of the universe might be reflected and reconcentrated.⁹⁵ And Mouret thought that a general law might preside over the universe and impose an eternal oscillation upon it:

L'éternité serait donc l'infini d'une série d'oscillations grandioses entre le chaos et l'équilibre, entre le mouvement et la chaleur, l'infini d'un rythme à longue période, scandé par les abaissements et les relèvements de la chaleur, par le flux et le reflux de la marée thermique immense, dont l'entropie mesure les insensibles progrès.⁹⁶

Sertillanges thought that although this suggestion was arbitrary, it was nevertheless possible. Science was incapable of contradicting it.

Sertillange cited the proposals of Poincaré, Rankine, and Mouret to illustrate his general thesis against Carbonnelle, who thought that the law of entropy was not merely based on experiment but on the 'nature of things'. Sertillanges was more

⁹³ Sertillanges, 'La preuve', p. 751.

⁹⁴ Poincaré, 'Le mécanisme et l'expérience', *Revue de métaphysique et de morale*, 1 (1893), 534-7 (p. 536): see Sertillanges, 'La preuve', p. 756.

⁹⁵ Sertillanges, 'La preuve', p. 758.

⁹⁶ Mouret, quoted in Sertillanges, 'La preuve', p. 758.

skeptical:

Au fond, 'la nature des choses' nous est inconnue, il faut très humblement le reconnaître, et il en résulte, quant à la loi de la dégradation de l'énergie, que, ne pouvant savoir avec certitude ni quelle est la cause, ni si elle n'est pas comprise dans une loi plus haute, qui en réglerait et en contiendrait les effets, nous ne pouvons prétendre non plus à déterminer l'étendue de son application, soit dans l'espace, soit dans le temps.⁹⁷

The second law of thermodynamics could neither prove nor disprove the Christian dogma of creation in time.

D. Duhem: physics and the Great Year

Duhem's analysis of the import of entropy on the eternity of the world is remarkably similar to Sertillanges's. In 'Physique de croyant', he wrote:

First of all, [the argument] implicitly assumes the assimilation of the universe to a finite collection of bodies isolated in a space absolutely void of matter; and this assimilation exposes one to many doubts. Once this assimilation is admitted, it is true that the entropy of the universe has to increase endlessly, but it does not impose any lower or upper limit on this entropy; nothing then would stop this magnitude from varying from $-\infty$ to $+\infty$ while the time itself varied from $-\infty$ to $+\infty$; then the allegedly demonstrated impossibilities regarding the eternal life of the universe would vanish.⁹⁸

The assumptions that the results of a small-scale laboratory experiment apply strictly to the universe as a whole and that the entropy of the universe must be finite were sufficient to render the argument for the finite age of the universe inconclusive.

Yet, even if the universe could be assimilated to the conditions of the laboratory and the laws of thermodynamics were capable of accounting for all the phenomena, Duhem maintained that science still could not furnish a proof of creation in time. He argued that other physical theories could save the phenomena equally well:

⁹⁷ Sertillanges, 'La preuve', p. 756.

⁹⁸ Duhem, 'Physics of a Believer', p. 288.

[If two or more theories save the phenomena equally well,] which shall we believe? The one, no doubt, which will best fit our extra-scientific preoccupations and predilections; but certainly the logic of the physical sciences will not provide us with any fully convincing argument to defend our choice against an attacking party and impose it on him.

So it goes with any long-term prediction. We possess a thermodynamics which represents very well a multitude of experimental laws, and it tells us that the entropy of an isolated system increases eternally. We could without difficulty construct a new thermodynamics which would represent as well as the old thermodynamics the experimental laws known until now, and whose predictions would go along in agreement with those of the old thermodynamics for ten thousand years; and yet, this new thermodynamics might tell us that the entropy of the universe after increasing for a period of 100 million years will decrease over a new period of 100 million years in order to increase again in an eternal cycle.

By its very essence experimental science is incapable of predicting the end of the world as well as of asserting its perpetual activity. Only a gross misconception of its scope could have claimed for it the proof of a dogma affirmed by our faith.⁹⁹

It is clear that there was no difference between Duhem and most neo-Thomists on the question of using physics to prove creation in time. This is not surprising. Christians understand creation to be the result of God's free action. Hence, it is easy for them to comprehend that observations of the actual universe cannot establish any necessary reasons for its mode of creation. Furthermore, the uncertainties of infinity – temporal, spatial, energetic, or entropic – were enough to discourage most people from projecting onto the universe the results of the laboratory. All but the least imaginative mind could think of many loopholes to render a conclusive proof of creation in time impossible. This is apparent both to those who think that physical theory is a causal explanation and to those who maintain that it is only a means of saving the phenomena. One can maintain that man is capable of knowing the nature of things as they are, and at the same time acknowledge that he cannot provide reasons why they must be so.

The acknowledgement by the neo-scholastics of the limitation of the argument

⁹⁹ Duhem, 'Physics of a Believer', p. 290.

contrasts well with the dogmatic statements of some scientific popularizers. The eternity of matter was a materialist dogma. *Ex nihilo nihil fit* was an oft-repeated argument against creation. Although the maxim goes back to ancient Greece, in the nineteenth century the first law of thermodynamics was seen as a further corroboration of this empirical statement. The argument can be found in the writings of Émile Littré, Ernst Haeckel, Clémence Royer, Svante Arrhenius, and many others too numerous to mention. The second law of thermodynamics, on the other hand, seemed to favour the theistic vision of the universe. Haeckel therefore decided that the law must be wrong: 'La seconde proposition de la théorie de la chaleur contredit la première et doit être sacrifiée.'¹⁰⁰ More ingenious specific ways of avoiding the Christian dogma have already been mentioned. To these may also be added Arrhenius's suggestion that the encounter of two extinct stars could produce a new and energetic celestial body. Poincaré developed the idea that exchange of matter between cold nebula and hot stars could prevent the heat death of the universe in an article entitled 'Le démon d'Arrhénius' (1911).¹⁰¹ In this scenario, a star's radiation pressure would overcome its force of gravity to drive away small molecules into distant nebula. The trick was to devise a discerning natural mechanism – a demon – to make sure that only sufficiently cold molecules got away.

Materialists preferred to view the development of the universe as an eternal cycle rather than accept the Judaeo-Christian belief in a beginning and a linear progression towards an end. This is particularly evident in the work of Friedrich

¹⁰⁰ Haeckel, quoted in René Hedde, 'Les deux principes de la thermodynamique', *RevThom*, 12 (1904) 706-27, 13 (1905), 69-91 (p. 70). Hedde gives no references.

¹⁰¹ Henri Poincaré, 'Le démon d'Arrhénius', in *Dernières pensées*, (Paris: Flammarion, 1963), pp. 212-8; see Pierre Thullier, 'Qui a peur de la thermodynamique?', *La recherche*, 6 (1975), 885-8 (p. 888).

Nietzsche (1844-1900), who conceived his doctrine of eternal returns in 1881, and of Friedrich Engels (1820-95), who was working on his *Dialectics of Nature* at the time of his death in 1895. But the theory of eternal returns is much older than the nineteenth century. The ancient Greeks believed that the heavens governed the earth. The tides and the seasons provided daily, monthly, and yearly examples of cyclical causal dependencies. The slowest of the cycles was the *Great Year*, a period of about 26,000 solar years which measures the revolution of the fixed stars with respect to the equinoxes. Duhem believed the concept of eternal returns to be destructive of science, for it locked the universe into a necessary fatality from which Christian dogma would later free it. In the *Système du monde*, he wrote:

Finally, we hear stated that the very slow changes on earth are tied to the almost imperceptibly slow motion of the fixed stars whose revolution measures the *Great Year*.

To that system all the disciples of Greek philosophy – Peripatetics, Stoics, Neoplatonists – have contributed. To that system Abu Masar offered the homage of the Arabs. The most illustrious rabbis, from Philo of Alexandria to Maimonides accepted that system.

Christianity was needed to condemn that system as a monstrous superstition and to throw it overboard. [...]

Also, and above all, the Church Fathers hit, and did so in the name of the Christian Creed, the pagan philosophers on points which today, we consider more metaphysical than physical but where actually lie the cornerstones of the physics of Antiquity: such are the theory of an eternal *prime matter*, the belief in the stars' domination over sublunary things and in the periodic life of a cosmos subject to the rhythm of the *Great Year*. By destroying through these attacks the cosmologies of peripateticism, of Stoicism, and of Neoplatonism, the Fathers of the Church clearly prepare the way for modern science.¹⁰²

The Church Fathers whom Duhem cites here attacked the 'monstrous superstition' by condemning astrology. But how did the condemnation of the *Great Year* clear the road for modern science? Duhem provides an answer in the sixth volume of the *Système du monde*. The eternity of the world was condemned along

¹⁰² Duhem, in Jaki, *Scientist and Catholic*, pp. 256-7.

with other Aristotelian teachings in 1277 by Archbishop Étienne Tempier of Paris. Duhem interpreted this condemnation as an affirmation of God's liberty to create the universe as it pleased Him and not according to the dictates of Aristotle's physics. The Archbishop's decree stimulated the creation of alternate physical theories. Thus modern science, Duhem said, 'was born, so to speak, on March 7, 1277 from the decree issued by Monseigneur Étienne, bishop of Paris'.¹⁰³

Needless to say, the thesis is controversial. Jaki has defended it and has added reasons of his own for why the Church is, as Duhem put it, the 'midwife of science'. Other historians, especially those who focus on the seventeenth-century scientific 'revolution', do not even bother to address the claim. Whatever one might choose to make of the thesis, it does provide an example of the interaction of physics and metaphysics in the mind of Duhem. There is no direct passage between the two. Physics must not be constructed from metaphysical principles. And metaphysical propositions cannot be proved by physical reasoning. Yet the development of physics is guided by the desire to know the universe, even though physics can only give an analogical glimpse of the only contingent universe known to man.

3. Physics and the existence of God – the Prime Mover argument

Saint Thomas taught that God's existence is not a self-evident proposition but that it could nevertheless be proved without recourse to Divine Revelation.¹⁰⁴ This was not a radical teaching, for the possibility of proving the existence of God from the created order is explicitly taught in the book of Wisdom and by the Apostle Paul. In the nineteenth century, the First Vatican Council, reacting against both fideists and rationalists, made it a heresy to deny that the existence of God could be proved by

¹⁰³ Duhem, in Jaki, *Scientist and Catholic*, p. 262.

¹⁰⁴ Thomas Aquinas, *Summa Theologiae*, I, q.2.

unaided human reason. Thus Catholics had to believe by faith that it was possible to demonstrate the existence of God by reason alone.

The Vatican declaration thus authenticated a branch of philosophy which was commonly called 'theodicy' at the time but which has since come to be called – at least in theological circles – 'natural theology'. The term 'theodicy' was coined by Leibnitz and meant the justification (diké) of God in the face of a world permeated by evil. Because the existence of evil has always proved to be the biggest stumbling block to belief, 'theodicy' came to include all philosophical study of God. Natural theology is 'natural' in the sense that it does not admit the data of supernatural Revelation into its discussions. The efforts to establish God's existence through amazingly adapted animal organs, sometimes called 'physical theology' or 'natural theology', are a species within the genus of natural theology conceived broadly. It is the broader meaning that will henceforth be retained.

A. Many ways to the Creator

Within the Church, there has been a variety of attitudes towards natural theology and various approaches to proving the existence of God. Cardinal Newman, for example, did not think that arguments for God's existence based on the physical world were likely to instill belief, although he thought that natural theology was essential to a balanced liberal arts education.¹⁰⁵ Such an apparently contradictory attitude arose from two concerns. The first was the recognition that none of the proofs came close to proving the existence of the God of Abraham. The thought of an 'unmoved mover' could hardly smite the sinner's heart with compunction. On the

¹⁰⁵ See Michael G. Carbery, *Assent to God: A discussion of the nature of natural theology according to John Henry Newman* (Centro di Studi Ecumenici Giovanni XXIII: Bergamo, [1969?]), 75-87. Newman discusses his attitudes towards 'physical theology' and 'natural theology' explicitly in his *Idea of a University*.

other hand, if God exists and guides creation by his providence, it would be a disaster to keep him out of an educated person's world view. Whatever one might think of the proofs for God's existence, it is clear that they are the necessary logical foundation of any natural theology. The Vatican I declaration of their possibility was thus a defense of the enterprise, which had the authority of both Scripture and Tradition behind it. But in upholding the power of reason to demonstrate the existence of God, the Council Fathers did not specify how reason was supposed to achieve the goal.

Historically, there were several different approaches to proving God's existence which each had their representatives in the Church. Saint Anselm is usually credited with the formulation of the ontological proof of God's existence which argued that, if God is 'that greater than which nothing can be conceived', then He must exist not only as a concept in the mind but as a distinct reality. Descartes found the argument valid. Kant rejected it because he believed that existence was not a predicate. The argument continues to attract attention today.¹⁰⁶

The teleological argument – the argument from order – has always been popular. The Psalms and the Church Fathers praise the Creator by recalling the beauties of creation; and Thomas included the argument as the fifth of his ways. In more recent history, it has been dubbed the watchmaker argument, and made famous through William Paley's *Evidences*. Catholics in Duhem's era also found the argument appealing. By 1910, Murat's *L'idée de Dieu dans les sciences contemporaines: Le firmament, l'atome, le monde végétal* was in its third edition. In 1915, D.L. de Saint-Ellier published the second edition of *L'ordre du monde physique*

¹⁰⁶ See Roger Scruton, *Modern Philosophy: An Introduction and Survey* (New York: Penguin, 1994), pp. 135-7. He mentions Norman Malcolm and Alvin Plantinga as modern supporters of the argument.

et sa cause première d'après la science moderne in which he spoke of the vastness of the universe, the intricacies of insects, the circulation of blood, and the currents in the ocean. Farges presented the teleological argument in his various scholastic publications. And de Lapparent too returned to the theme on many occasions.

Several new arguments for the existence of God were developed in the nineteenth century. In the aftermath of the French Revolution, Louis de Bonald argued that human society was constituted by a primitive divine revelation. He maintained that man could not think without language; but the development of language presupposed the ability to think. Only God could have broken this vicious circle.¹⁰⁷ Towards the end of the century, Auguste Gratry (1805-72) of the French Oratory, thought that calculus could show the existence of God. In the limit, one divided by zero approaches infinity, he said, which means that zero multiplied by infinity is one. Thus a finite contingent universe ('one') has been created out of nothing ('zero') by an infinite power.

Neo-Thomists had nothing but scorn for Gratry's argument and other attempts which claimed to establish God's existence with mathematical certainty.¹⁰⁸ They favoured Thomas's arguments which are all *a posteriori*: they argue from the world – the effect – to its cause. The ontological argument, on the other hand, is considered to be an *a priori* proof, because it tries to establish God's existence from a definition of his essence. Thomas believed that such a proof was impossible because he thought it was illegitimate to jump from the ideal to the ontological order.¹⁰⁹ The neo-scholastics in Duhem's era, following Thomas, focused their hopes of proving

¹⁰⁷ On de Bonald, see Foucher, *La philosophie catholique*, pp. 22-7.

¹⁰⁸ See, for example, Farges, *Cours de philosophie scolastique*, I, pp. 478-80.

¹⁰⁹ *Summa Theologiae*, I, q. 2, art. 1, ad 2; for nineteenth-century discussions of this point, see, for example, Farges, *Cours de philosophie scolastique*, I, pp. 253-5.

God's existence on the five ways, which all argue from effect to cause.

The problem with this strategy was that the first and, according to Thomas, the 'more manifest' way was based on motion, and depended on the principle that 'everything that is moved is moved by another'. Some explanation or reworking would be necessary if the proof were to be convincing in an age when most people unquestionably accepted the law of inertia. The fate of the *prima via* offers another insight into the relationship between physics and metaphysics.

B. The Prime Mover and inertia

The development of the *prima via* could be traced back to Aristotle's proofs for the unmoved mover in his *Physics*, which moderns would unhesitatingly call *metaphysics*.¹¹⁰ (Duhem did so explicitly.¹¹¹) Nevertheless, the common appellation 'physics' established a connection between the peripatetic and the modern enterprise that was difficult to overcome. The question that exercised the minds of Duhem's contemporaries was how to view the *prima via* in light of the principle of inertia.

In the *Summa Theologiae*, Thomas presents the proof from motion as follows:

It is certain and apparent to the senses that some things in this world are in motion. Everything that is in motion is moved by something else. Nothing is in motion unless it is in potency to that toward which it is moving; for something causes motion insofar as it is in act. For to cause motion is nothing else than to lead (*educere*) something from potency to act; but something which is in potency cannot be led (*reduci*) into act except by something which is in act; thus something hot which is actually hot, such as fire, makes wood, which is potentially hot, to be actually hot, and in this way moves and changes it. Now, it is not possible that the same thing be at the same time both in potency and in act with respect to the same thing, but only towards different things; for what is hot in act, cannot be at the same time hot in potency, but only cold in potency. It is therefore impossible that something should be causing motion and being moved according to the same aspect and the same way, or (in other words) that it should move itself. Therefore it is necessary that everything that is

¹¹⁰ Aristotle, *Physics*, Books VII and VIII.

¹¹¹ Duhem, 'Physics and Metaphysics', pp. 31-2.

in motion is moved by another. And here one cannot proceed backwards to infinity, because thus there would not be some first mover and consequently any other mover, because secondary movers cannot cause motion unless they are moved by the first mover, just as a stick cannot cause motion unless it is moved by a hand. Therefore it is necessary to come to some prime mover that is not itself moved; and this mover is what all men understand to be God.¹¹²

Whether or not all men understand God to be the Prime Mover, the proof is contentious because terms such as potency and act can be problematic. Thomas's illustrations are deceptively simple. A hot fire can heat a log because fire is actually hot. But Thomas must have been aware that heat can be produced from apparently cold substances such as flints and the ingredients of Greek fire. Whatever explanations contemporary science may have provided for these more difficult examples, the basis of the argument in the *prima via* could still be saved by saying that the flint or the apparently cold chemicals were in some way actually hot. And, if it proved too difficult (or impossible) to specify how a particular cold object could actually possess the perfection of heat, recourse could always be made directly to the Prime Mover in whom all perfections were unified and whose essence was admittedly beyond human comprehension. That was the point of the proof. God was pure actuality. Although it was possible in some instances to specify unproblematic secondary causes, such as fire heating wood, the secondary causes in turn needed to

¹¹² 'Certum est enim et sensu constat aliqua moveri in hoc mundo. Omne autem quod movetur, ab alio movetur. Nihil enim movetur, nisi secundum quod est in potentia ad illud ad quod movetur; movet autem aliquid secundum quod est actu. *Movere enim nihil aliud est quam educere aliquid de potentia in actum; de potentia autem non potest aliquid reduci in actum, nisi per quod aliquod ens in actu; sicut calidum in actu, ut ignis, facit lignum, quod est calidum in potentia, esse actu calidum, et per hoc movet et alterat ipsum. Non autem est possibile ut idem sit simul in actu et potentia secundum idem, sed solum secundum diversa; quod enim est calidum in actu, non potest simul esse calidum in potentia, sed est simul frigidum in potentia. Impossibile est ergo quod secundum idem et eodem modo aliquid sit movens et motum, vel quod moveat seipsum. Omne ergo quod movetur, oportet ab alio moveri. Si ergo id a quo movetur, moveatur, oportet et ipsum ab alio moveri, et illud ab alio. Hic autem non est procedere in infinitum, quia sic non esset aliquod primum movens; et per consequens nec aliquod aliud movens, quia moventia secunda non movent nisi per hoc quod sunt mota a primo movente, sicut baculus non movet nisi per hoc quod est motus a manu. Ergo necesse est devenire ad aliquod primum movens, quod a nullo movetur, et hoc omnes intelligunt Deum.'*

Thomas Aquinas, *Summa Theologiae*, I, q.2, art. 3, response (Pianine edition); my translation.

be grounded in a first cause. Some causal chains could be long; others, short. But they all needed to be grounded. Here it is essential to recognize that 'first' does not refer to priority in time but priority in being. The first cause does not just start a process and then become superfluous, like the god of the deists. Thomas is talking about a simultaneous chain of causality that sees every event as grounded in God. Without the first cause, fire would not exist with its ability to heat wood, (nor, for that matter, would the wood). Every change is a manifestation of God's continuing activity in the universe, and hence a proof of his existence.

The change in vocabulary in the previous paragraph from 'mover' to 'cause' was a deliberate attempt to make the argument of the *prima via* more understandable to the reader unfamiliar with scholastic language. It also provides an opportunity to emphasize that the *prima via* is about causation. Motion, as Aristotle understood it, needed an explanation, for it was 'the actuality of that which exists potentially when it is in *actuality not qua itself but qua movable*'.¹¹³ Admittedly, the definition is obscure. However, it has the twofold advantage of (1) defining change in general, not just local motion, and of (2) not being circular, at least not in an obvious way. Its meaning can be illustrated briefly by the following example. A cold brick has the potential of becoming hot. After an hour in a hot oven, it will have become as hot as its surroundings, and a steady state will have been reached. An actualization of a potential will have taken place but change will no longer be taking place. Change happens as long as there is a possibility for further actualization of a potency, as long as the brick is somewhat colder than its surroundings, hence the

¹¹³ Aristotle, *Physics*, Book III, Chapter 1, 201A 10-11, the translation is from, *Aristotle: Selected Works*, trans. by Hippocrates G. Apostle and Lloyd P. Gerson, 3rd edition (Grinnell, IA: Peripatetic Press, 1991); another translation (R.P. Hardie and R.K. Gaye) reads, 'the fulfilment of what exists potentially, in so far as it exists potentially, is motion'; Thomas Aquinas commented on the Latin text 'potentia existentis entelechia secundum quod huiusmodi est, motus est' in *In Octo Libros Physicorum Aristotelis Expositio, Liber III, lectio 2* (Marietti edition).

necessity for the '*not qua itself bu qua movable*' in the definition of change. Because motion is an actuality or actualization, it needs a cause that has the perfection towards which motion is leading in act. The object itself cannot have in act that towards which it is heading. To think that an act could arise just by itself, so it is claimed, is to contradict the basic principle of causality.

This analysis of movement has been criticized even by favourably disposed neo-Thomists on accounts of discontinuities at the end-points of motion. But such details are trifling.¹¹⁴ A much more fundamental criticism can be made and has been made at a different level. Potency and act are concepts that divide being. They presuppose that change needs to be explained in terms of being. But is that so? As Ackermann put it at a meeting of the Society of Saint Thomas:

Le devenir a-t-il une cause? Faut-il, avec Platon et Aristote, chercher la raison du devenir dans l'Immuable, ou, avec Héraclite, Fichte ou Hégel, dire qu'il est à lui-même sa raison? L'absolu est-il acte ou action? repos ou mouvement? transcendance ou immanence?¹¹⁵

The difficulty in presenting an argument for one or the other of these basic views is the lack of common principles. But that did not stop eminent neo-Thomists from trying. Réginald Garrigou-Lagrange (1877-1964) was perhaps the most persistent opponent of the doctrine that motion was its own explanation because he thought that it violated the principle of non-contradiction. He carried on a correspondence with Duhem about the bearing of the law of inertia on the *prima via* in which he made the connection explicit:

In fact, to say that change of position is a successive union of diverse elements (of position A and position B) or that the unconditional union of diverse elements is possible, is to say that elements by themselves diverse can of themselves (unconditionally) be really one (at least by a unity of union) which is the denial of the principle of identity, and consequently of

¹¹⁴ See, for example, *SéancesSSTA*, 13 June 1895, *AnnPhilChr*, 131 (1895/6), 404-8.

¹¹⁵ *SéancesSSTA*, 16 March 1892, *AnnPhilChr*, 124 (1892), 190-2 (p. 192).

the principle of non-contradiction.¹¹⁶

The problem can be restated as follows. A body X cannot both be and not be at point A at a particular time, t_2 . To view its inertial motion which passes through points A and B as a state is to join in a unity elements that are contradictory – namely X being at A and X being at B. To object that the principle of non-contradiction is saved because the motion takes place over a finite time, so that X is at A at t_2 and at B at t_1 , would not satisfy Garrigou-Lagrange who would respond that motion then cannot be a state – the very point that he is trying to make. Jaki, who analyzed the correspondence between Duhem and Garrigou-Lagrange, points out that ‘this abandonment of the principle of contradiction and identity was the basis of the claim of Hegel and all pantheists, and of evolutionists such as Bergson, that “becoming was its own reason”, in which case reality becomes a “realized contradiction”’. This was unacceptable to Thomists, who had an unshakeable confidence in human reason, as can be seen from a passage of the same letter of Garrigou-Lagrange to Duhem:

the principle of identity and of non-contradiction is not only a law of abstract thought but a basic law of reality, therefore the becoming cannot be its own reason, but must have in the final account its reason in that reality which is identical with itself, absolutely simple and unmovable, and is, with respect to being, as A is to A, *ipsum esse subsistens*, and consequently essentially distinct from a multiple and changing world.¹¹⁷

Garrigou-Lagrange understood the *prima via* to be a metaphysical demonstration of permanent validity. He was aware, however, that the law of inertia might compromise the proof in the eyes of his contemporaries; so he sought Duhem’s authority to justify dismissing the law of inertia as metaphysical nonsense. Duhem’s

¹¹⁶ Letter from Garrigou-Lagrange to Duhem, 10 July 1909, quoted in Stanley Jaki, ‘The Physicist and the Metaphysician’, p. 189.

¹¹⁷ Letter from Garrigou-Lagrange to Duhem, 10 July 1909, quoted in Jaki, ‘The Physicist and the Metaphysician’, pp. 189-90.

response will be considered shortly. But first it will be instructive to look at other neo-Thomist attempts to deal with the *prima via*.

It is clear from the example that Thomas gave in the formulation of the proof, that motion was not to be understood in the restricted sense of local motion. But local motion is the one that lends itself most easily to physical analysis. Neo-Thomists focused on this aspect of the proof, especially since the demonstration is billed as the 'manifestior via', which suggests that it should be based on the 'manifestior motus'.

Albert Farges thought that the *prima via* was the clearest approach to the existence of God but he gave it a new formulation. He emphasized the importance of local motion, because modern physics, except for energetics, considered qualitative changes such as variations in temperature to be essentially linked to variations in the motion of atoms. Quantitative changes such as thermal expansion could also be understood in terms of local motion. Hence of the four types of change enumerated by Aristotle – substantial, quantitative, qualitative, and local – the last three could be reduced to one – local motion.¹¹⁸

Farges presented his ideas at the International Catholic Scientific Congress in Brussels (1894) and in several books on scholastic philosophy. The present discussion follows his presentation of the subject in *L'idée de Dieu d'après la raison et la science* (1900) on account of its detail. The cause of all physical movement, Farges began, was universal attraction. Newton had discovered the law in pondering the motion of planets and large scale motions on earth such as falling apples and the tides of the sea. Laplace then applied the law of universal attraction to capillary

¹¹⁸ Albert Farges, *L'idée de Dieu: existence de Dieu, nature de Dieu, rapports de Dieu et du monde*, 4th edition, Études philosophiques pour vulgariser les théories d'Aristote et de S. Thomas et leur accord avec les sciences, no. 8 (Paris: Berche et Tralin, 1900), p. 63.

motion; and other natural philosophers – Farges gave no names – delighted in comparing the motion of atoms to the motion of planets. This vision of physics was to become the starting place for the new *prima via*:

Les lois newtonniennes de l'attraction dominant donc toutes les sciences astronomiques et physico-chimiques. C'est là un fait capital dans la nature, qui nous permet d'asseoir sur une base large et solide notre première preuve de l'existence de Dieu.¹¹⁹

Universal attraction, he said, was an undeniable fact, but its cause remained controversial. Dynamism endowed matter with an inherent active force; whereas the kinetic theory, (which Farges called the mechanist hypothesis), denied that matter had anything but a potency to receive motion through collisions. Farges's strategy was to show that 'dans l'une et l'autre de ces deux hypothèses, ces mouvements d'attraction prouvent l'existence du Premier Moteur'.¹²⁰

Turning first to the mechanist hypothesis, Farges noted with satisfaction that anyone who held the law of inertia must agree with the scholastic principle that 'rien ne change tout seul; tout ce qui est mû l'est par un autre; *quidquid movetur ab alio movetur*'.¹²¹ The examples he gave to illustrate the principle – design of machinery, calculation of perturbations in planetary orbits – make it clear that he understood movement to be what Newtonian mechanics would call acceleration. The whole basis of the *prima via* was thus transformed. Acceleration, on the mechanist hypothesis, was caused solely by collisions. Thus, Farges argued, for atom A to be set in motion, it must have been hit by atom B; atom B must have in turn been hit by atom C and so forth. 'Nous épuiserons tous les atomes de la nature sans avoir trouvé dans la nature un premier moteur qui ait donné la première impulsion.' The

¹¹⁹ Farges, *L'idée de Dieu*, 4th ed., p. 65.

¹²⁰ Farges, *L'idée de Dieu*, 4th ed., p. 65.

¹²¹ Farges, *L'idée de Dieu*, 4th ed., p. 66.

first mover must therefore be outside of nature. 'C'est lui que nous appelons Dieu et qui l'est réellement'. He is no mere ultimate celestial sphere or demiurge, Farges continued, because such movers were moved movers and part of the series which needed to be grounded in an unmoved mover who was at the same time an uncaused cause.¹²²

Having presented his proof, Farges went on to defend it against the argument, made by Pierre-Auguste Bertauld in his *Étude critique des preuves de l'existence de Dieu*, that motion is eternal and hence necessary and in no need of explanation. Farges tried to meet this argument in two ways. First, Farges agreed that there was one eternal reality which was necessary and needed no further explanation. But this reality was God and not motion. Motion, even if eternal, needed explanation, for all those who held the law of inertia to be true agreed that *quidquid movetur ab alio movetur*. Motion was thus a contingent reality in need of explanation.

In his second argument against Bertauld, Farges broke with the ultimate scholastic authorities – Aristotle and Thomas – for he believed that motion could not be eternal. Experimental science, in his opinion, provided many reasons to suppose a beginning. Biologists believed that there was a beginning to life. Physicists believed in the heat death of the universe – an end which points to a beginning. And reason itself, Farges continued, made it clear that motion could not be eternal because 'une série de mouvements dont chaque terme a un commencement et dont la totalité serait sans commencement est une contradiction manifeste'.¹²³

Farges's arguments invite criticism, but it will be more useful first to present

¹²² Farges, *L'idée de Dieu*, 4th ed., p. 68.

¹²³ Farges, *L'idée de Dieu*, 4th ed., p. 73.

his version of the *prima via* based on the dynamicist hypothesis. Farges favoured this hypothesis over the mechanistic alternative because dynamism endowed matter with a principle of action and was thus more in line with Aristotle's definition of nature as the principle of motion and rest. Yet Farges pointed to three 'deficiencies' in the dynamicist hypothesis, gaps that needed to be filled by an unmoved mover. First, objects could attract one another only if they were separated, or, in scholastic language, force could exist in act only between separated objects. Thus, something that is pure act was responsible for the separation. Secondly, there would be no motion in an infinite space homogeneously filled with matter, because forces would cancel out. Thus some intelligence had to set up the initial conditions in such a way that the universe as man experienced it would eventually come into being. Thirdly, the initial conditions not only required a judicious choice of starting points for each molecule of matter, but also of speeds to account for the angular momenta of the planets. Here, Farges cited two astronomers who were members of the Académie des Sciences, Hervé Faye (1814-1902) and Charles Wolf (1827-1918), and who dismissed Kant's cosmogony as false on account of its beginning with matter in a state of rest.¹²⁴ It should be clear that the three 'deficiencies' could be reduced to one, for they were just three conditions on a possible initial state of the universe.

Farges's *prima via* is very different from Thomas's version. Beginning from mechanics, Farges proceeded to metaphysics. Admittedly, it can be argued that mechanics were a form of metaphysics, but that is not what Farges really believed. Like most scholastics, he thought that the mechanist hypothesis was fundamentally flawed, but he used it as the basis of one form of the *prima via*. Thomas, on the

¹²⁴ Faye, *L'origine du monde*, 2nd ed., p. 152; Wolf, *Hypothèses cosmogoniques: examen des théories scientifiques modernes sur l'origine des mondes* (Paris: Gauthier-Villars, 1886), p. 9 and p. 19: both quoted in Farges, *L'idée de Dieu*, 4th ed., pp. 80-1.

other hand, used metaphysical principles which he believed. If Farges's approach through dynamism resembled Thomas's way more closely, there remained a profound difference. Farges's Prime Mover was very much like the god of the deists – a watchmaker who could have died or stopped caring about the universe eons ago. He was not the metaphysical basis which continued to make change possible in the here and now. Farges's argument is a god-of-the-gaps approach, which he implicitly admitted in citing Faye for support against those who accused him of being anti-scientific by looking for explanations outside of nature. The astronomer had said: 'L'esprit de la science est d'expliquer les choses par les lois naturelles *tant qu'on peut*, et de ne recourir à l'intervention divine, que là où l'on ne peut plus faire autrement.'¹²⁵

Farges was not the only one who tried to reformulate the *prima via* for a modern audience. Bulliot read 'La preuve du premier moteur' to the Société de Saint Thomas in March and April 1892. The paper engendered much debate among the members. Bulliot, like Farges, restricted the *prima via* to local motion and developed two versions of the proof to correspond to the mechanist and dynamicist hypotheses. On the mechanist supposition, Bulliot began, motion is a positive attribute of matter – 'un acte par conséquent'.¹²⁶ Yet, motion was not an essential property of matter. It was a simple accident whose origin had to be sought outside of matter:

La source de ce mouvement qui anime tout l'univers suppose une source première et incorporelle d'énergie, une source immuable qui puisse donner toujours sans jamais s'appauvrir.
Cette source immuable, ce moteur immobile, c'est l'être premier, c'est

¹²⁵ Faye, *De l'origine du Monde*, p. 7, quoted in Farges, *L'idée de Dieu*, 4th ed., p. 85.

¹²⁶ *SéancesSSTA*, 16 March 1892, *AnnPhilChr*, 124 (1892), 190-2 (p. 190).

celui que les hommes appellent Dieu.¹²⁷

This argument inspired several criticisms. First there were questions about Bulliot's understanding of the mechanist hypothesis. The Vincentian priest Victor Ermoni noted that the kinetic theory did not usually separate movement from matter, nor did its principles necessitate such a separation which had been the basis of Bulliot's argumentation. Bulliot replied that he had presented the theory as he had found it in textbooks, where motion was treated as a reality that is passed on from one object to another. The Abbé Pierre Alfred Merklen then replied that both matter and motion as presented in textbooks on mechanics were abstract concepts. At best, they could be used to prove the existence of an abstract first mover. Domet de Vorges confirmed Merklen's point: 'On ne trouverait pas un mécaniste admettant que le mouvement ait une entité réelle.' To this Bulliot replied that Tait thought that energy was as real as mass, which was clearly not very helpful.¹²⁸

Besides these questions about Bulliot's understanding of the kinetic questions, there were more penetrating criticisms. Gardair noted that the *prima via* was a metaphysical proof based on a very elementary concept of causality – 'il faut une raison à la réalisation du contingent'. Distraction with the phenomenal order of things tends to destroy the habit of metaphysical thought. The Abbé Vallet thought that Bulliot would have done better to restate Thomas's proof instead of reworking it. Yet Bulliot was convinced that Thomas's proof needed correction, 'vu que S. Thomas faisait du repos le terme ultime du mouvement alors la science moderne voit dans le mouvement continué, non pas un changement, mais une énergie, un état

¹²⁷ *SéancesSSTA*, 16 March 1892, *AnnPhilChr*, 124 (1892), 190-2 (p. 191).

¹²⁸ *SéancesSSTA*, 16 March 1892, *AnnPhilChr*, 124 (1892), 190-2 (p. 191).

durable'.¹²⁹ But such a point of view, Ackermann argued, destroyed the very basis of the *prima via*, for if motion were a stable state it needed no more explanation than did rest. At this point, Ackermann interjected, with words cited earlier, that the real debate was far beyond the competence of physical theories: 'Le devenir a-t-il une cause?' The debate was between Plato and Aristotle on one side against Heraclitus, Hegel, and Fichte on the other.

At the next meeting of the Société de Saint Thomas, Bulliot presented the *prima via* adapted to the dynamicist hypothesis. On this supposition, it was not necessary to go outside of nature to search for the cause of movement, because of the mutual attraction of matter. But this did not destroy the *prima via* for 'ce que l'on perdait du côté de l'origine du mouvement, on le retrouvait du côté de sa direction'.¹³⁰ Bulliot explained this more indirect way to the prime mover as follows:

Le corps, en tombant, marchaient nécessairement les uns vers les autres; la marche de l'univers, sous l'influence de l'attraction, consistait dans une concentration progressive des atomes et des masses secondaires en une masse central et unique. L'évolution du monde avait une fin, elle avait donc eu un commencement.¹³¹

In Bulliot's hands, as in Farges's, the *prima via* was transformed into a proof for the watchmaker of the deists. To be sure, Bulliot tried to remedy this deficiency by appealing to hylomorphism. The duality of matter, he insisted, proved its contingency. 'La preuve de l'existence de Dieu par le mouvement touche de si près à celle de la contingence qu'elles semblent n'en faire qu'une'.¹³² But he did not develop the thought further.

Bulliot's presentations inspired two written responses at the next meeting from

¹²⁹ *SéancesSSTA*, 16 March 1892, *AnnPhilChr*, 124 (1892), 190-2 (p. 192).

¹³⁰ *SéancesSSTA*, 27 April 1892, *AnnPhilChr*, 124 (1892), 382-4 (p. 383).

¹³¹ *SéancesSSTA*, 27 April 1892, *AnnPhilChr*, 124 (1892), 382-4 (p. 383).

¹³² *SéancesSSTA*, 27 April 1892, *AnnPhilChr*, 124 (1892), 382-4 (p. 384).

Fr Vallet and Fr Derennes. Although using slightly different arguments, they both thought that Thomas's *prima via* was broader and more metaphysical than Bulliot's reformulations.¹³³ Farges and Bulliot each presented their proofs at the 1894 Congress in Brussels. But only Farges had the courage to publish his paper in the proceedings. Duhem was present at the session and did not hesitate to make his views known on the efforts of Farges and Bulliot, as the following record of his interjection makes clear:

M. P. Duhem, sans vouloir aborder le côté métaphysique de la question, ni contester la valeur de l'argument à ce point de vue, ne peut s'empêcher de remarquer que les défenseurs de l'argument [du premier moteur] le maintiennent contre les mécanistes, tandis que, vis-à-vis des dynamistes, ils l'abandonnent, en réalité, pour se rabattre sur la *contingence* du mouvement.

Dans ces matières surtout, il serait désirable que les discussions philosophiques ne s'appuient que sur une doctrine parfaitement assise et adoptée par les sommités de la science. Il faut se défier non seulement de la vulgarisation, ce qui est évident, mais encore des aperçus plus ou moins osés que les savants les plus autorisés se permettent parfois, et qui, n'étant présentés par eux que comme de simples aperçus, peuvent aller au delà de ce que comporte une logique vraiment démonstratif.¹³⁴

C. Duhem and the *prima via*

Duhem did not try to reformulate the *prima via* but his clarifications for Garrigou-Lagrange of the status of the law of inertia have turned out to be his most often published work. Garrigou-Lagrange, unlike Farges and Bulliot, did not think that the *prima via* needed reworking. It was rather the modern mind that needed to be healed from denying the law of non-contradiction, which it did, according to Garrigou-Lagrange, by accepting the law of inertia. According to Jaki, Garrigou-Lagrange probably encountered Duhem for the first time at the 1894 Congress in

¹³³ *SéancesSSTA*, 18 May 1892, *AnnPhilChr*, 125 (1892/3), 97-112.

¹³⁴ *Compte rendu du troisième congrès scientifique international des catholiques. Troisième section -- Sciences philosophiques* (Bruxelles: Société belge de librairie, 1895), p. 315.

Brussels. On at least one occasion, Garrigou-Lagrange took up Duhem's invitation to visit him in Bordeaux, probably in the spring or summer of 1904.¹³⁵ This acquaintance emboldened Garrigou-Lagrange to ask Duhem to look over his presentation of the *prima via* and to write an article on the principle of inertia. Garrigou-Lagrange's reasons for thinking that the law of inertia entailed the denial of the law of non-contradiction have been cited earlier in the chapter. His own explanation of projectile motion made use of the notion of *impetus*. He cited the work of the Thomist Antoine Goudin (1639-1695) to introduce the concept: 'the projectile that received the impulse is not at the same time in potency and in act under the same respect; it has in act that impetus, but it is in potency with respect to the position to which it tends.' Garrigou-Lagrange explained further:

In other words, the projectile is in act as to its dynamic quality and in potency as to its local positions. All contradiction is thereby avoided. This notion of *impetus* that finds in the notion of *live-force* energy its mathematical representation, seems destined to play an essential role in the metaphysics of local motion; this will show how the principle of inertia, whatever truth it contains experimentally, is subordinate to the rational principle of 'no change without a cause'.¹³⁶

Garrigou-Lagrange was anxious to deny that the law of inertia contained ontological truth. To this end, in *Dieu: Son existence et sa nature: Solution thomiste des antinomies agnostiques*, he cited Boutroux's *Contingency of the Laws of Nature*. He appealed to Poincaré in support of the statement that no one has ever proved experimentally that an object moving in a vacuum would not eventually slow down and stop. Finally, he mentioned Duhem's name two pages into an appendix as an introduction to the physicist's letter on inertia. (Jaki emphasizes this slighting of Duhem. There does not seem to be any reason for it except an uneasiness among

¹³⁵ Jaki, 'The Physicist and the Metaphysician', p. 187.

¹³⁶ Letter from Garrigou-Lagrange to Duhem, quoted by Jaki, 'The Physicist and the Metaphysician', p. 198.

Thomists with Duhem's ideas.) Yet Duhem gave Garrigou-Lagrange all that he could possibly ask for:

I consider, therefore, the principle of inertia only as it is for the physicist.

One may say of it, then, what may be said of all principles of the mechanical and physical theories. These fundamental principles or *hypotheses* (in the etymological sense of the word) are not *axioms*, self-evident truths. Nor are they *laws*, that is, general propositions reached directly by induction from the teachings of experience.

This is in line with Duhem's holism. He then went on to give further explanations which should by now be familiar. A theory's ability to predict experimental results endowed it with a probability that it might be true but not with certitude. Nothing could rule out the possibility that phenomena would eventually come to light that would show the theory to have been false or inadequate:

From these considerations two consequences follow: (1) *We shall never have the right to affirm categorically of any one of the principles of the mechanical and physical theory that it is true.* (2) *We are not allowed to affirm of any one of the principles on which the mechanical and physical theory rests that it is false, so long as there has been no discovery of phenomena that disagree with the consequences of the deduction of which this principle constitutes one of the premises.*

What I have just said applies particularly to the principle of inertia. *The physicist has not the right to say that it is certainly true*; but still less has he the right to say that it is false, since we have so far met with no phenomenon (if we leave out of consideration the circumstances in which the *free will* of man intervenes) that compels us to construe a physical theory from which this principle would be excluded.

All of this is said without going beyond the domain of the *physicist*, for whom the principles are not affirmations of real properties of the bodies, but premises of deductions the consequences of which must be in agreement with the phenomena every time that a free will does not intervene to disarrange the determinism of the latter.

To these principles of physics, can we and must we make certain propositions correspond which would affirm certain real properties of bodies? To the law of inertia, for instance, must we make the affirmation correspond that there is, in every body in motion, a certain reality, an *impetus*, endowed with such or such characteristics? Do these propositions apply or not to other beings endowed with free-will? These are problems that the method of the physicist is incapable of grappling with and it leaves

them to the free discussion of the metaphysicians.¹³⁷

Only if the metaphysician were to formulate a proposition which would either directly or indirectly violate the phenomena could the physicist legitimately object. 'Now you have, Reverend Father, the summary of what I would say if I were ever to write, concerning the principle of inertia, the article that you so kindly wish me to write.' Duhem never wrote the article, but this short letter became his most frequently printed work, on account of the many translations and editions of Garrigou-Lagrange's *Dieu*.

Garrigou-Lagrange's efforts to prove the existence of God were legitimized by the Magisterium of the Church. The anti-modernist oath which was promulgated in 1910 stipulated that God's existence could be proved as a cause through its effects.¹³⁸ Among the attempted demonstrations, the *prima via* continued to enjoy prominence. But, as should be clear by now, it took on different forms depending on how much weight its reformers put on the teachings of modern physics about motion. Farges and Bulliot transformed the proof into an argument for an initial pusher. Garrigou-Lagrange sought and received Duhem's assurance that he was free to retain the traditional metaphysical framework of instrumental causality grounded in a Prime Mover.

An important historical reason for the primacy of the *prima via* is its early development by Aristotle. His metaphysical analysis of change has undoubtedly been immensely influential and is arguably brilliant. His analysis of local motion, at least in its quantitative aspect, on the other hand, was seriously flawed. It is thus curious to see adaptations of the *prima via* to make it consonant with the science that

¹³⁷ Duhem, in Jaki, 'The Physicist and the Metaphysician', pp. 200-1.

¹³⁸ Denzinger, paragraph 2145.

describes with stunning accuracy the motions of planets and the trajectories of projectiles. But it is hardly credible that these motions point more strongly to God's existence than do other aspects of the material universe. In Farges's and Bulliot's estimation, albeit implicit, the *prima via* as it was understood in the Middle Ages was sheer nonsense, hardly the objective basis for knowledge of God.

Garrigou-Lagrange was much more logical. Yet he too worried about what the mechanical concept of inertia would do to the proof. He was happy to hear a physicist tell him that modern physics was nearly irrelevant to metaphysical musings. This must, in fact, be the case if a further statement from Garrigou-Lagrange's *Dieu accessible à tous*, is correct: 'Il n'est pas défini que ce pouvoir qu'a la droite raison de démontrer avec une ferme certitude l'existence de Dieu passe facilement à l'acte; mais cette doctrine, communément admise par les théologiens, est proche de la foi, "proxima fidei".'¹³⁹ Modern physics could thus hardly have a bearing on the existence of God.

There is no record of Duhem's devising proofs for the existence of God or pondering whether such proofs were possible. But his belief in common sense as the foundation of scientific, philosophical, and religious certitude suggests that he thought that reason was an important component to his act of religious faith.¹⁴⁰ Further evidence for this view comes from Duhem's fondness for citing Pascal: 'We have an impotence to prove invincible by any dogmatism, and we have an idea of truth invincible by any Pyrrhonian skepticism.'¹⁴¹ The importance of reason to theism has been recently re-affirmed by the *Catechism of the Catholic Church*: 'These [ways of

¹³⁹ Garrigou-Lagrange, *Dieu accessible à tous* (Paris: [n. pub.], 1941), p. 2.

¹⁴⁰ Émile Picard, *La vie et l'oeuvre de Pierre Duhem*, pp. 52-3

¹⁴¹ Duhem, *AimSPT*, p. 27; also 'The Value of Physical Theory', p. 335; also *German Science*, tr. by John Lyon (La Salle, IL: Open Court, 1991), p. 16; Pascal, *Pensée* no. 406.

coming to know God] are also called proofs for the existence of God, not in the sense of proofs in the natural sciences, but rather in the sense of "converging and convincing arguments," which allow us to attain certainty about truth.¹⁴² Although the statement betrays a wonderful naiveté about the certainty of natural sciences, it shows that the Magisterium has come to recognize that a single proof will never suffice to convince the minds of most people. Certainly such a proof would not come from physics.

More recent Thomist writings also corroborate the view that physics cannot provide a direct proof of God's existence. Jacques Maritain, for example, writing in 1962, believed that Thomas's five ways remained valid insofar as they were understood metaphysically. However, the various images which Thomas borrowed from medieval physics to illustrate the metaphysical ideas have been rendered counterproductive by developments in science. Particular physical laws have nothing to say about the existence of God, but, according to Maritain, modern science as a whole can provide perennially valid variations on Thomas's fifth and fourth ways.

The teleological argument – the fifth way – is suggested by the success of science to understand nature, even if only obliquely rather than in its essence:

En premier lieu: si la nature n'était pas intelligible, il n'y aurait pas de science [...] l'intelligibilité de la nature est le fondement même de ces constances relationnelles que sont les "lois" – y compris cette catégorie de lois qui ne concernent que des probabilités – auxquelles la science voit les phénomènes soumis [...] Or comment les choses seraient-elles intelligibles si elles ne procédaient point d'une intelligence? En dernière analyse, une Intelligence Première doit exister, qui est elle-même Intellection et Intelligibilité en acte pur [...]¹⁴³

Thomas's fourth way is based on the gradations in created beings – their truth,

¹⁴² *Catechism of the Catholic Church* (San Francisco: Ignatius, 1999), paragraph 31.

¹⁴³ Jacques Maritain, 'Dieu et Science' (1962), in *Oeuvres Complètes*, 12 vols (Paris: Saint-Paul, 1982-95), XII, pp. 1181-1203 (p. 1198-9).

goodness, beauty – which point to an ultimate Truth which must at the same time be the ultimate Goodness and Beauty. Maritain saw in the systematization of the sciences – the approach towards a natural classification as Duhem would put it – a suggestion of the ordering principle upon which the metaphysical argument is based. ‘Or l’intelligence humaine – imparfaite comme elle est, et obligée d’employer une irréductible multiplicité de types et de perspectives de connaissance – est une activité spirituelle qui ne peut ni procéder de la matière ni subsister par soi et être ainsi sans limites et omniconnaissante.’¹⁴⁴ Again, a transcendent First Intelligence was necessary to explain the success of human science.

Thus, in Maritain’s mind, if physics did anything to prove the existence of God, it did so by providing empirical evidence for the confidence man naturally has in his power of reasoning. Much of this evidence was missing to the medievals for, apart from astronomy, the physico-mathematical sciences had yet to be developed; but they were aware of the mystery of knowledge. *If modern science could rob the world of mystery as Berthelot believed – ‘aujourd’hui le monde est sans mystère’ – Maritain has shown that science itself could engender the sense of wonder that is at the root of speculative thinking. The development of modern physics forced a re-evaluation of the *prima via*, but it did not destroy it. The status of the metaphysical proof, which can be grasped even by the scientifically illiterate, has been left unchanged.*

4. Conclusion – the independence of physics and metaphysics

The three debates analyzed in this chapter correspond to the three main topics of metaphysics – the soul, the universe, and God. These have been of central importance to philosophy from the beginning of recorded history, especially among

¹⁴⁴ Maritain, ‘Dieu et Science’, p. 1200.

the peoples who came into contact with Biblical Revelation. The development of modern physics added new aspects to the perennial debates. It challenged human freedom and the *prima via*; but it provided hope for proving the dogma of creation in time. Physics was thus neither an unmitigated evil nor the pearl of great price for the Christian faith. The more philosophical Christians, who were not prepared to countenance the possibility of a contradiction between faith and reason, were forced to work out how the results of physics fit in with their faith, especially in the scientific climate of Duhem's era.

As should be clear, the traditional teachings emerged intact from the discussion. Man was free; the temporal status of the universe was beyond the reach of unaided reason; and man could be pointed towards an unchanging cause of motion via a consideration of change. Physics, on the other hand, emerged from the discussion with its pretensions circumscribed. The descriptive and predictive success of physics was no match for the intimate experience of human freedom. The unbending laws governing the motion of molecules were relegated to a vague virtual existence in the substantial unity of the human body. Oscillating universes, for which there was no empirical evidence, were considered theoretically possible by both Christians and their adversaries as means of avoiding the metaphysical consequences of the experimentally developed second law of thermodynamics. And inertia was no match for the deeply ingrained belief that nothing happens without a cause.

But if the metaphysical positions could weather major developments in physics, some separation of the two bodies of knowledge must be possible. Duhem insisted on this from the start when he wrote that physical theory was not a metaphysical explanation. He then brought the general teaching to bear on the particular questions discussed in this chapter in 'Physique de croyant' (1906) and in his letters

to Garrigou-Lagrange. At the time, his separation of physics and metaphysics was still a bit too radical for most neo-Thomists to countenance, but already they were beginning to see some wisdom in it. It is my contention that Duhem's ideas eventually won out. But in order to see this, one has to examine the distinction of physics and metaphysics at a more theoretical level.

CHAPTER 5

Towards a Neo-Thomist Philosophy of Physics

It is also an illusion to believe that by appealing to scientific facts without first illuminating them by a higher light, any philosophical debate – the debate about hylomorphism, for instance – may be settled. Of themselves, they have nothing to say on that score. Let them not be tortured in order to wring a pseudo-confession from them! – *Jacques Maritain, Distinguish in Order to Unite.*¹

The ultimate aim of this thesis is to describe the relationship between the physical sciences and philosophy as it was understood by Duhem and the neo-Thomists. In chapter 3, the focus was on the interpretation of empirical laws. Could the phenomena be explained by reductionist systems such as mechanism or dynamism, or did empirical science demand a broader explanatory framework such as hylomorphism? In chapter 4, three case studies – human freedom, the duration of the universe, and the existence of God – illustrated diverse conceptions of the relation of physics to metaphysics. In this chapter, the focus will be on the philosophy of physics. The topic is not new, for it could not help but permeate the previous chapters. But in this chapter, the philosophy of physics will be examined more explicitly. This chapter, in particular, will bring out the differences among people who styled themselves as, or were universally acknowledged to be, neo-Thomists. But Duhem's relation to the neo-Thomists is the prime focus of the thesis. The organization of the present chapter reflects this fact, for most sections discuss the reactions to Duhem's views among neo-Thomists.

1. Reactions to Duhem's early papers in the Revue des questions scientifiques

Duhem published his first essay in the philosophy of physics in 1892: 'Quelques réflexions au sujet des théories physiques'. The article, which appeared in the *Revue*

¹ Maritain, *Distinguish*, p. 58.

des questions scientifiques drew severe criticism from Vicaire who applied Gratry's condemnation of Hegel's philosophical writings to Duhem's efforts: 'Ils sont admirables, très instructifs, mais à condition de les lire à rebours et d'en prendre en toute chose le contre-pied.'² In particular, Vicaire cited Duhem's skepticism as dangerous to the aims of the Brussels Scientific Society. Lacombe took up Duhem's defense in the first volume of the *Revue thomiste*. Vicaire, he admitted, 'connaît beaucoup de choses, tout, si l'on veut, sauf la philosophie catholique'.³ Right from the start, Duhem had his detractors and his defenders among neo-Thomists.

The main point at issue was causality: Was physical theory a causal explanation or not? All Thomists were agreed that the human mind could know essences and their causal relationships. Following Thomas, they defined science, meaning any organized body of knowledge, as *cognitio per causas*. And they distinguished philosophy from the other sciences as *cognitio per ultimas causas*. Thus to many neo-Thomists, Duhem's denial that modern physics provided causal explanations was a cause for alarm.

Even in the thirteenth century, however, Thomas recognized that astronomy could not claim to provide causal knowledge. In his commentary on Aristotle's *de Caelo et Mundo*, he wrote:

It is not necessary that the hypotheses (*suppositiones*) which astronomers discover be true: for although such hypotheses appear to solve [the problem], it is not necessary to say that these hypotheses are true, because perhaps the phenomena pertaining to the stars can be saved in some other way, which is not yet understood by man.⁴

² Vicaire, 'De la valeur', p. 452.

³ Bernard Lacombe, 'Théories physiques: à propos d'une discussion entre savants', *RevThom*, 1 (1893), 676-92, 2 (1894), 94-105 (p. 677).

⁴ 'Illorum (astrologorum) suppositiones quas invenerunt non est necessarium esse veras: licet enim talibus suppositionibus factis appareant solvere, non tamen oportet dicere has suppositiones esse veras, quia forte secundum aliquem alium modum, nondum ab hominibus comprehensum, apparentia circa stellas salvatur.' Thomas Aquinas, Commentary on Aristotle's *de Caelo et Mundo*, Liber II, Lectio 17;

Thomas also cited the astronomer's incertitude in the *Summa Theologiae* to illustrate his argument that God's triune nature could not be known apart from Revelation.⁵ Both passages were well known to neo-Thomists, perhaps on account of Duhem. He cited the passage from Thomas's commentary on *de Caelo et Mundo* in his 'Physique et Métaphysique', which stimulated a discussion at the Société de Saint Thomas;⁶ and later, in the *Théorie physique*, he cited the passage in the *Summa* in support of his instrumentalism.⁷

It might appear then that there was hardly any room for debate. Modern physics, the descendant of medieval astronomy, could at best save the phenomena. *Thomas dixit; causa finita est.* Yet Thomas did not speak as clearly as Duhem might have wanted. Thomas distinguished the inability of the astronomer to provide causal explanations from man's ability to prove that the heavens move with a uniform velocity. Evidently, he thought that some aspects of astronomy – in fact its first principles – escaped the uncertainty of the details. Duhem's opponents did not cite this further passage, but they instinctively felt that his skepticism was too far-reaching. It is unfortunate that they did not in fact study the extended text more closely, for none of them would have accepted Thomas example of irrefutable knowledge: the uniform motion of the heavens.

Many of the neo-Thomist fears about Duhem were raised by Vicaire in 'De la valeur objective des hypothèses physiques': 'Expliquer, trouver la cause; voilà le mot essentiel que M. Duhem et les savants de la même école évitent soigneusement'.

the text is as quoted by Duhem, 'Physique et métaphysique', in *Prémices philosophiques*, pp. 84-112 (p.101), probably the Vives edition.

⁵ Thomas Aquinas, *Summa Theologiae*, I, q. 32, a. 1, *ad secundum*.

⁶ SéancesSSTA, 29 November 1893, *AnnPhilChr*, 127 (1893/4), 401-4.

⁷ Duhem, *AimSPT*, p. 41.

Throughout the article, Vicaire insisted that science is about knowledge of causes. Just about all scientists (and natural philosophers before them), he said, thought that they were striving to understand nature as it was.⁸ The mere co-ordination of experimental laws and symbols could hardly inspire human beings to devote themselves to science. Moreover, Vicaire maintained that even Duhem, Poincaré, and Kirchoff – whom he grouped together as proponents of commodism – had a secret pining for knowledge of causes.⁹

Vicaire did not doubt the importance of establishing quantitative relations among experimental data, but he thought that science did not end there. It must proceed ‘des phénomènes à leurs relations, des relations aux causes’.¹⁰ Vicaire recognized some of the difficulties with the last step but did not think that they were insurmountable. There was, first of all, the problem of indetermination, popularized by Poincaré: if a mathematical solution to a particular problem of mechanics could be found, it was possible to find an infinity of other solutions that could also account for the given phenomena. Yet Poincaré himself had admitted that everyone would reject many of these solutions as too bizarre and prefer others on account of their simplicity.¹¹

Admittedly, it was difficult to define ‘simplicity’, but Vicaire believed that common intuition could eliminate all but one or two alternatives.¹² He thought that indetermination could be overcome completely by the potential infinity of experimental data. Problems such as Poincaré’s, he said, arose only when a limited

⁸ Vicaire, ‘De la valeur’, p. 464.

⁹ Vicaire, ‘De la valeur’, pp. 472-4.

¹⁰ Vicaire, ‘De la valeur’, p. 462.

¹¹ Poincaré, *Electricité et optique*, Introduction, xv.

¹² Vicaire, ‘De la valeur’, pp. 468-9.

number of phenomena had to be explained. But by a judicious choice of experiment, it was possible to eliminate all but one solution. In this context, Vicaire cited an *experimentum crucis*, performed by Otto Heinrich Wiener (1862-1927), to determine whether, in a beam of light, the vibrations are parallel to the plane of polarization, as Neumann thought, or perpendicular to the plane of polarization, as Fresnel thought. Vicaire was aware that Poincaré did not think that the experiment was decisive, but he pointed out that most physicists were convinced by it. And Poincaré himself admitted that, even if the experiment did not prove Fresnel's theory, it nevertheless changed the terms of the debate. Thus, Vicaire argued, it was at least a positive if not definitive step on the road to knowledge.¹³

A second difficulty in attaining to or verifying knowledge of causes in physics was that entities such as atoms could not be directly perceived by the senses. The importance of sense knowledge is captured by sayings such as 'seeing is believing' and the scholastic adage *nihil in intellectu nisi prior in sensu*. But this did not deter the medieval scholastics from reasoning upon the human soul and God. In the nineteenth century, Vicaire believed that it was possible to pass beyond sense experience to the knowledge of atoms by reasoning. He thought that Duhem's article on 'Notation atomique et hypothèses atomistiques' was too skeptical about the existence of atoms. It is true, Vicaire said, that it was impossible to see and measure individual atoms, but that *did not mean that they did not exist*. The giants in *Gulliver's Travels* also could not discern individual coins in men's pockets, but human beings could easily describe them and measure them. Vicaire expressed the hope

¹³ Vicaire, 'De la valeur', pp. 470-1. He quotes Poincaré, but gives no reference. Duhem also used the experiment to argue against the possibility of a crucial experiment in 'Some Reflections on the Subject of Experimental Physics', p. 83. Gaston Milhaud then discussed the experiment again, citing Duhem favourably, in 'La science rationnelle', *Revue de métaphysique et de morale*, 4 (1896), 280-302 (pp. 296-7).

that some day a powerful enough microscope might be developed which would dispel any hesitation about atoms. He should have known enough about optics to recognize the inherent limitations of using light to see atoms. But the hypothetically acute instrument suited his argument too well to cause any scruples. In any case, the hypothesis of atoms could enjoy a fairly high level of certitude. The difference in scale, he maintained, did not lead to a difference in the nature of certitude but only to a difference of degree.¹⁴

Vicaire's failure to distinguish what he meant by 'nature of certitude' and 'degree of certitude' is indicative of his being oblivious to philosophical subtleties. He assumed that common sense was sufficient to distinguish the terms, just as he believed that common sense dictated that the concepts from the macroscopic world continue to be valid on microscopic scales. Science itself, he believed, had justified this intuition, for from the notion of attraction, articulated by Newton, 'on arrive à la notion de l'attraction moléculaire, et la théorie de la capillarité devient pour Laplace un chapitre de la mécanique céleste'.¹⁵

Vicaire was convinced that physical theory was something more than a mnemonic device for experimental laws. The connections it provided between the laws revealed something real about nature. He argued to this point by analogy. An experimental law, he said, was derived from discrete observation points, yet it was expressed as a continuous function. The resulting function provided more information about the physical world than the discrete points which suggested it: 'Il me paraît aussi impossible de formuler une hypothèse physique strictement équivalente à un ensemble d'observations ou de trouver une courbe équivalente à un

¹⁴ Vicaire, 'De la valeur', pp. 466-8.

¹⁵ Vicaire, 'De la valeur', p. 479.

ystème de points isolés.¹⁶

Vicaire emphasized the triumphs of science as an argument for explanatory theories. Copernicus, he said, was not in fact the cautious instrumentalist that Osiander had made him out to be; he was convinced that the earth moved around the sun. And in the late nineteenth century, the power of atomic theory to suggest new chemical syntheses manifested its truth. Vicaire ended his article with a plea for a metaphysical understanding of physical theory:

Restons donc fidèles aux vieux principes, éternellement vrais. Proposons-nous, non pas d'élaborer des symboles plus ou moins utiles, mais de connaître la nature. Dût-on nous trouver 'vieux jeu', ou même nous accuser de faire de la métaphysique, avouons cette noble ambition. Là est la vérité, là est la science.¹⁷

It is ironic that Vicaire should have turned to history and spoken of eternally true principles, for, then as now, the obvious problem with explanatory theories was that history has seen many 'unshakeable' metaphysical theories crumble. Duhem, for example, illustrated this basic truth by citing one of Descartes's letters: 'To my mind, it [the instantaneous velocity of light] is so certain that if, by some impossibility, it were found guilty of being erroneous, I should be ready to acknowledge to you immediately that I know nothing in philosophy.'¹⁸ (Despite the fact that Olaus Römer (1644-1710) determined the speed of light to be finite from astronomical observations made between 1672 and 1676, the influence of Descartes's philosophy continues to be felt today.)

The historical vicissitudes of explanatory theories was the first point that Lacombe made against Vicaire: 'Devant ces hécatombes de théories, dont rien ne fait

¹⁶ Vicaire, 'De la valeur', p. 485.

¹⁷ Vicaire, 'De la valeur', p. 510.

¹⁸ Descartes, quoted by Duhem, *AimSPT*, p. 33.

prévoir le terme, la science, en prenant de l'âge, se fait réservée, – quoi de plus naturel? Elle se fait prudente, de cette prudence que certains, restés jeunes malgré tout, confondent avec le scepticisme.¹⁹ Lacombe thought that in the time of Descartes, there was an excuse for thinking that physics was a branch of metaphysics, 'la crédulité et un certain orgueil s'excusent chez les enfants précoces. Mais conserver, à l'heure actuelle, le même enthousiasme [...] voilà qui serait puéril et sans excuse.'²⁰ (The choice of words was calculated to infuriate Vicaire who had begun his paper with the condescending hope that 'le jeune et savant auteur [Duhem] me permettre de lui dire avec la sympathie que méritent et que m'inspirent son talent précoce et sa remarquable activité: la thèse fondamentale [...] en est faux'.²¹)

Yet Vicaire could be refuted even without reference to the history of science. Lacombe pointed out that contemporary physicists differed in their choice of theories. Sometimes even the same physicist – Maxwell was the prime example – would adopt different explanatory schemes in research. And the willingness of physicists to accept unreal concepts such as perfectly elastic bodies and point masses further showed that physical theories could not be causal explanations but only tools of research.²²

Lacombe spoke about 'la liaison contre nature, d'assez longue durée [...] entre la philosophie et la science'.²³ He was sure that this connection was 'toujours au détriment de la philosophie'. Philosophers since Descartes should have clearly

¹⁹ Lacombe, 'Théories physiques', p. 678.

²⁰ Lacombe, 'Théories physiques', p. 679.

²¹ Vicaire, 'De la valeur', p. 452.

²² Lacombe, 'Théories physiques', p. 680.

²³ Lacombe, 'Théories physiques', p. 685.

defined and separated the domains of science and philosophy. 'De fait, ils n'ont pas eu de plus vive préoccupation que de rattacher coûte que coûte et vaille qui vaille la science à la philosophie, d'en faire le second chapitre de leur cosmologie.' Duhem was to be praised for untangling this mess. 'Courageusement, il a tenté de trier les préjugés et les vérités, de rejeter les premiers et de recommencer avec le petit lot des vérités restant l'oeuvre scientifique.'²⁴ Duhem had taken the only possible approach: 'Et si on ne veut pas s'en tenir au juste milieu de M. Duhem, on en est réduit ou à fermer les yeux et tout nier avec M. Vicaire, ou à lâcher tout et ne rien sauver, selon le parti auquel depuis quelque temps déjà s'est rangé M. Poincaré.'²⁵

Lacome also noted that it was hardly instructive to lump, as Vicaire had done, Duhem with Poincaré and Kirchoff: 'M. Duhem est en religion un croyant, en philosophie un dogmatique; M. Poincaré est un sceptique, que toute idée métaphysique fait doucement sourire; Kirchoff pose toujours pour le savant agnostique.'²⁶ These quotations show that a neo-Thomist found nothing offensive in Duhem's ideas and that he even considered Duhem one of the school.

There is one more point in Lacome's article that is worth mentioning – Lacome's recognition of the importance of language: 'Comment, en effet, s'exprimer ou même penser sur ces matières sans des mots? et comment s'entendre, si ces mots ne sont pas nettement définis?'²⁷ The difficulty became especially acute when abstract terms were involved: force, motion, matter are obvious examples. Although the problem of language was hardly mentioned by contemporaries, the difficulty was not new: 'Pascal a bien dit de la notion du mouvement – et cette remarque

²⁴ Lacome, 'Théories physiques', p. 682.

²⁵ Lacome, 'Théories physiques', p. 683.

²⁶ Lacome, 'Théories physiques', p. 684.

²⁷ Lacome, 'Théories physiques', p. 687.

s'applique à toutes les notions universelles – qu'elle s'impose par son évidence, quoique la définition en soit difficile à trouver.²⁸ Science and philosophy both needed to hone the meaning of words, for the common day-to-day use of words would otherwise lead inevitably to equivocation and contradiction. This was one of the points that Duhem would make at the 1894 Congress in Brussels.

Duhem published several articles in quick succession, all in the *Revue des questions scientifiques*, after 'Quelques réflexions' appeared in January 1892. 'Une nouvelle théorie du monde inorganique' (January 1893) was a review of the cosmology of Leray. It appeared just in time for Vicaire to cite it with approval as evidence that Duhem was not against metaphysics as such.²⁹ Mansion referred to Duhem's next article, 'Physique et métaphysique' (July 1893), as his reply to Vicaire. In it, Duhem carefully defined the meaning of terms such as 'physics', 'metaphysics', and 'cosmology' as he used them, and pointed out that his use – the modern use – differed from the Aristotelian usage. Perhaps the most important section of the paper is his defense of the separation of physics and metaphysics. It was not because he was a skeptic that he wanted to separate the disciplines, but precisely in order not to become a skeptic about all knowledge, for progress in physics inevitably disproved long-cherished 'truths'. The next paper, 'L'école anglaise et les théories physiques' (October 1893), could be seen as an answer to Vicaire's concern that physicists need to be motivated by the prospect of real knowledge rather than merely co-ordinating experimental laws in clever patterns. Here, Duhem introduced the notion of natural classification (see chapter 3.1): physical theory provided a glimpse of reality, but only an analogical glimpse. In 'Quelques réflexions au sujet de la physique

²⁸ Lacome, 'Théories physiques', pp. 687-8.

²⁹ Vicaire, 'De la valeur', p. 482.

expérimentale' (July 1894), Duhem argued against the possibility of an *experimentum crucis*. And in 'L'évolution des théories physiques du XVII^e siècle jusqu'à nos jours' (October 1896), he showed that explanatory theories did not withstand the test of time. The last four papers can thus be seen as an extended reply to Vicaire.

The Société de Saint Thomas took a great interest in the debate between Duhem and Vicaire. The *Annales de philosophie chrétienne* reprinted Duhem's 'Physique et métaphysique'; and the members of the society discussed the relation of physics and metaphysics at several meetings, in November 1893, and in January, April, and May 1894. At the November meeting, Domet de Vorges presented a verbal summary of a paper on the validity of physical theories, written specifically to address Duhem's positions.³⁰ The main point of issue was the distinction between physics and metaphysics. Duhem wanted to divest physics of the burden of explanation: physics describes; metaphysics explains. Domet de Vorges, as zealous as he was for the rights of metaphysics, thought that it was the duty of every discipline (*science*) to provide explanations of reality. According to him, physics should explain phenomena which can be observed, whereas metaphysics transcends the sphere of direct observation. Thus it was the task of metaphysics to speak of the nature and fundamental properties of substances as such. Physics, on the other hand, had the more mundane task of proposing hypotheses to explain phenomena in such a way as to make any discrepancies between theory and experiment disappear. This task required specialized knowledge which the metaphysician could not be expected to have. In fact, the very nature of metaphysics – to deal with matters which transcend direct observation – deprived it of that recourse to the laboratory which was an essential element of the experimental sciences. According to Domet de

³⁰ *SéancesSSTA*, 29 November 1893, *AnnPhilChr*, 127 (1893/4), 401-3 (p. 401).

Vorges, Duhem's concept of physical theory reduced physics from the level of science to a mere utilitarian enterprise: 'Si ces idées se répandent, nous aurons peut-être encore de bons ingénieurs, mais nous n'aurons plus de grands savants.'³¹

The obvious problem was how to decide when the hypotheses proposed by the physicist were true. Domet de Vorges was content with the logical fallacy known as the hypothetico-deductive method: if H implies R, and R happens, then H must be correct. Admittedly, he spoke of 'une très grande probabilité que l'hypothèse était conforme à la réalité', but he was implicitly confident that the very high probability was in fact equivalent to certainty. Domet de Vorges maintained that Duhem was not justified in quoting Thomas as support for an instrumentalist understanding of physics. He thought that the passage from the *de Caelo et Mundo* pertained only to difficulties in explaining retrograde motions of planets, where the lack of data made alternative hypotheses likely.³² As the minutes of the meeting put it:

M. de Vorges est convaincu que, si les scolastiques eussent été consultés sur une controverse de ce genre [la controverse actuelle], ils auraient répondu sans hésiter qu'une hypothèse ne vaut dans la science qu'autant que l'on a de justes raisons de croire qu'elle répond à la réalité et que des hypothèses arbitraires, créées uniquement pour lier artificiellement les faits, n'ont aucun caractère scientifique.³³

This passage could only have been written by a philosopher, for it assumes that physicists are capable of producing any number of theories which will each account for the phenomena equally well, whereas they would be ecstatic if they could come up with even one that fits all the phenomena. Furthermore, it betrays an ignorance of both the history of physics and the contemporary debates among physicists. The various naive realists, past and present, might have agreed that a scientific hypothesis

³¹ *SéancesSSTA*, 29 November 1893, *AnnPhilChr*, 127 (1893/4), 401-3 (p. 402).

³² Thomas Aquinas, *De Caelo et Mundo*, Liber II, Lectio 17.

³³ *SéancesSSTA*, 29 November 1893, *AnnPhilChr*, 127 (1893/4), 401-3 (p. 403).

could only be justified by good reasons, but opposing schools each thought that they had good reasons for their positions. Neither the Ptolemians nor the Copernicans thought that they were defending a perverse mental construct, nor, in Domet de Vorges's day, did the proponents of the kinetic theory and the dynamicists. Both thought they had good reasons for their respective views.

No one at the November meeting objected to Domet de Vorges's criticism of Duhem. But a comment by Vicaire that metaphysics and physics must co-penetrate one another, because metaphysics could not ignore empirical results any less than physics could dispense with reasoning in interpreting experiments, made the members aware that the distinction of the two disciplines would warrant further discussion.³⁴

At the January meeting, Bulliot commented upon Domet de Vorges's paper which by then had appeared in the *Annales de la philosophie chrétienne*. Although he generally approved of the work, he thought that Domet de Vorges had accepted too lightly some of Duhem's ideas for he had said that 'la cosmologie cherche à connaître la nature de la matière considérée comme cause des phénomènes' whereas 'la physique est l'étude des phénomènes dont la matière brute est le siège et des lois qui les régissent'. Bulliot claimed that Domet de Vorges could not really have meant to distinguish cosmology and physics in this way, especially since the rest of the paper contradicted this radical view which opened the way for positivism in physics. Bulliot acknowledged that cosmology and physics were distinct but he thought that the two merged in a common domain. Using scholastic language, he said that since both disciplines study the same objects, they cannot be distinguished by reason of *objectum formale quod*, but only by the light by which they study the object, that is to

³⁴ The distinction between physics and metaphysics continues to be debated among neo-Thomists. For a recent contribution to the debate, see Lawrence Dewan, 'St. Thomas, Physics, and the Principle of Metaphysics', *The Thomist*, 61 (1997), 549-66.

say, by reason of *objectum formale quo*.

According to Bulliot's reading of Aristotle, just about every science had to concern itself with substance, although only metaphysics studied substance *per se*. Sciences such as physics used the terms 'substance', 'quality', and 'motion' according to their common meaning. The conclusions of physics were tentative until they received the stamp of approval of metaphysics which reflects upon and hones the meaning of the commonly used terms. Metaphysics was thus the highest science which alone had the right 'de prononcer des arrêts que nulle autre science ne saurait réformer'. But both physics and metaphysics can provide an understanding of the same objects – material substances. It was impossible to distinguish physics from metaphysics as completely as geometry from metaphysics. In the latter case, the distinction is possible because geometry says nothing about the essence of quantity but concerns itself only with the properties of quantity. The link between physics and metaphysics was more intimate:

Au contraire, l'objet de la physique expérimentale et de la physique rationnelle reste la même, au moins en partie; et dès lors il ne peut donner lieu à la formation de deux sciences aussi complètement distinctes, mais seulement à la création de deux sciences solidaires, superposées l'une à l'autre, soudées ensemble par un anneau commun. Ces deux sciences ont partiellement le même champ d'étude, le même *objectum formale quod*. Elles ne diffèrent que par le but à atteindre, par la possession plus ou moins complète, plus ou moins réfléchie des notions et des termes métaphysiques qu'elles emploient, par le contrôle, ici plus expérimental, là plus métaphysique, auquel elles ont recours. Elle ne diffèrent, en un mot, que par leur objet *formale quo*.³⁵

Bulliot's analysis did not go unchallenged. Gardair and Derennes defended Duhem's understanding of physical theory:

La physique bornerait ses recherches à l'étude des phénomènes et de leurs lois, c'est à dire des raisons prochaines, sans jamais atteindre la substance comme son objet. La cosmologie, au contraire, prendrait son point de

³⁵ *SéancesSSTA*, 18 January 1894, *AnnPhilChr*, 127 (1893/4), 591-5 (pp. 594-5).

départ là où la physique s'arrête et, grâce aux données expérimentales de celle-ci, s'élèverait jusqu'à la substance ou raison dernière. La délimitation entre ces deux provinces du savoir ne serait pas une simple division du travail scientifique, rendue nécessaire par les progrès des sciences et les bornes de l'esprit humain; elle résulterait de la nature même des choses.³⁶

The discussion was lively, for the minutes note that 'la fin de la séance a pu seule clore la discussion' – a sure omen that it would be taken up in the future.

Three months later, in April 1894, the Abbé Gossard presented a paper entitled 'Recherche d'un critérium pour distinguer la Philosophie des autres sciences'. He said that the distinction between the various disciplines arose from the different ways in which human beings conceptualized reality. If the foundational concepts of a discipline were 'proper' concepts, that is, *proportioned to man's senses and imagination*, the discipline would not be metaphysical. Lines, shapes, rocks, and light were among the many examples of 'proper' concepts, for people's ideas of these things resembled their material instantiation. From among these proper concepts arose the disciplines of geometry, geology, and optics. Metaphysical sciences, on the other hand, were based on 'improper' concepts, that is to say, *concepts that could not be imagined but could only be grasped by reasoning*. Thus, substance, accident, cause, change and other such improper concepts were the elements of metaphysics. The difference between 'proper' and 'improper' concepts, according to Gossard, gave rise to different notions of causality in metaphysics and in the other sciences. Metaphysics could say that there must be a cause, but it could not specify the cause except in a tautological way, as in the dormitive power of opium. The other sciences could do better for their explanatory framework was more immediately proportioned to the human intellect.³⁷

³⁶ *SéancesSSTA*, 18 January 1894, *AnnPhilChr*, 127 (1893/4), 591-5 (p. 595).

³⁷ *SéancesSSTA*, 19 April 1894, *AnnPhilChr*, 128 (1894), 292-6.

Gossard's paper generated a lively discussion which continued into the May meeting. Much of it need not be resurrected from the pages of the *Annales de philosophie chrétienne*, for it dealt with details about 'proper' and 'improper' concepts, while assuming, as did Gossard, that experimental sciences should reveal causal connections. The members in general preferred to go back to the old definition of philosophy as knowledge through ultimate causes whereas physics provided knowledge of proximate causes. Even Derennes, who had previously argued for an instrumentalist understanding of physics, seemed to have made something of a retreat and found peace in an equivocation. According to the minutes of the April meeting, he said that 'la physique ne considère que les raisons prochaines qu'on appelle communément les lois'. If by 'raisons' he meant causes, he accepted the majority position. If, on the other hand, he meant 'an accounting within the context of a theory', he would have incurred the wrath of Bulliot, Farges, Vicaire, Domet de Vorges, and others. The members may have thought that they had come to an understanding of the relationship of physics to metaphysics. But they had yet to understand modern physics.

2. Duhem at the Congress in Brussels

In September 1894, the members of the Society of Saint Thomas turned out in large numbers at the third International Catholic Scientific Congress in Brussels, where their ignorance could no longer be hidden. On Tuesday, September 4, Duhem found himself beside Ambroise Gardeil, at the afternoon session of the philosophy section. Mercier presided, assisted by Domet de Vorges. Among the speakers were both Farges and Bulliot who each gave a talk on the proof of God's existence based on motion. As Farges was speaking, Duhem leaned over towards Gardeil and whispered: 'Si la philosophie a une valeur scientifique, à quoi bon ce flot

d' éloquence?³⁸ Duhem was at first impressed with Bulliot: 'A la bonne heure, voilà qui est net!'³⁹ But soon, Duhem could not restrain himself. This time, he got up and said in a loud voice that it was illegitimate to construct a metaphysics by pillaging physics for terms, such as force and energy, which appear to be metaphysical but which in physics are mere symbols for experimentally determined quantities:

Je veux bien que l'on me comprenne; je ne nie pas l'existence de la métaphysique: je ne lui refuse pas le droit d'analyser à sa manière les phénomènes expérimentaux qui nous servent de point de départ commun, ni d'arriver, à partir de ces phénomènes, à la connaissance des causes et des essences par des procédés à elle propres: je veux seulement que l'on n'emploie pas des théories controversées, qui n'ont même pas été bien exposées, qui n'ont été exposées que d'après des ouvrages de vulgarisation, à établir la métaphysique.⁴⁰

Gardeil happened to meet Duhem early the next day. 'Figurez-vous que depuis hier', Duhem began, 'j'ai des remords d'avoir troublé la quiétude de ces excellents métaphysiciens. Je viens me rassurer auprès de vous. Vous qui êtes de la confrérie, pensez-vous que j'ai dépassé les limites?'⁴¹ Gardeil agreed that Duhem spoke a little harshly but 'quant au fond de la discussion, loin d'avoir offensé la métaphysique, je pense au contraire que vous en avez bien mérité. Après vous avoir entendu, on regardera à deux fois à confondre Physique et Métaphysique.'

Encouraged by this remark, Duhem went on to elaborate on his understanding of the philosophy of science. He began by acknowledging that physicists, and especially Descartes, bear part of the responsibility for confusing physics and metaphysics:

Pour moi, c'est Descartes qui a lancé la Physique sur cette fausse piste. Descartes croyait être métaphysicien et n'était qu'un imaginaire. Il lui

³⁸ Gardeil, 'La philosophie au Congrès', p. 574.

³⁹ Gardeil, 'La philosophie au congrès', p. 574.

⁴⁰ Duhem, quoted in Gardeil, 'La philosophie au congrès', p. 579.

⁴¹ Gardeil, 'La philosophie au congrès', p. 583.

fallait se figurer les essences, comme, il se figurait un triangle ou une pyramide. Sans doute la révolution qu'il a provoqué a été utile, mais d'une utilité scientifique, d'un ordre tout pratique et non de l'ordre philosophique et spéculatif, comme il le pensait. Elle a permis de noter par des symboles mathématiques les phénomènes et les a soumis ainsi au calcul. Mais le calcul ne saurait rendre que ce qu'on lui a livré. Il excelle pour préciser, mais il n'invente pas. Il n'y a pas une plus grande somme de vérité physique au bout de la Thermodynamique que dans les sensations qui lui servent de point de départ.

The impressive predictive accuracy of physics did not insure that it could provide a clearer or deeper understanding of the world. Duhem continued:

Quand je voudrais savoir, avec vérité, ce qu'est la chaleur par exemple, j'oublierais toute ma thermodynamique et je tâcherais de me mettre dans l'état d'un enfant qui pour la première fois cherche à se rendre compte de la sensation de chaleur et de ce qui la cause. Quelle preuve a-t-on que dans le sulfure de carbone il y ait, conservées en nature, des molécules de soufre et des molécules de carbone, alors que tout tend à montrer que l'on a affaire à un corps nouveau et original? Toujours le besoin de se figurer, d'imaginer, de forger l'unité à coups d'imagination. Voilà les théories physiques au point de vue de leur valeur réelle. Tout autre est leur valeur symbolique. Dès lors qu'elles ne voient plus dans leurs hypothèses que des instruments de travail, sans valeur absolue, les théories commencent à faire avancer la science.

Duhem then turned to history to corroborate his instrumentalist understanding of physical theory:

L'histoire est là pour prouver que depuis trois siècles la science n'a progressé qu'en accumulant des ruines: Les théories les plus en faveur sont tombées dans l'oubli: elles ont cependant fait marcher la science. Il en est de même sans aucun doute des théories actuelles. A chaque instant la moindre expérience peut les renverser, car toutes sont intéressées dans l'expérimentation la plus banale. Quel péril pour la science suprême, pour la métaphysique, si elle devait faire reposer sur des bases aussi ruineuses les démonstrations si rigoureuses auxquelles elle prétend, et, par suite, les intérêts religieux et moraux qui en découlent.⁴²

The passage makes it abundantly clear that Duhem was not an enemy of metaphysics but rather its champion against poor reasoning. Also evident is Duhem's insistence on common sense as the true basis for philosophy. The physicist's avowals

⁴² Gardcil, 'La philosophie au congrès', p. 583-4.

struck a resonant chord in Gardeil:

Oserai vous dire ce que est depuis longtemps mon sentiment. Une chose m'a toujours étonné: je vois la plupart de nos néo-scolastiques admettre d'emblée et comme par esprit de corps les conclusions d'Aristote et de saint Thomas, puis dès lors qu'il s'agit de la preuve, ils déclarent qu'elle n'est pas encore faite, que les démonstrations que l'on en a données ont vieilli, que leurs base expérimentale surtout est tout entière à renouveler en la mettant au courant des sciences modernes. Voilà ce que je ne puis m'empêcher d'admirer: car si les bases des vieilles démonstrations sont ruineuses, comment d'avance pouvons-nous être assurés de trouver les conclusions anciennes au bout des démonstrations nouvelles?

Gardeil was challenging the ability of natural philosophy to provide metaphysical truths. But he was not questioning that it was important for metaphysicians to address science. He believed that it was necessary to know the sciences in order to appreciate the differences between metaphysics and physics. He elaborated:

Or, ce que vous venez de dire m'éclaire absolument. Sans doute, pour la question spéciale des rapports de la science moderne et de la philosophie, il faudra connaître l'une et l'autre: mais en métaphysique pure, et c'est là que sont les grandes questions, je puis me passer, non pas de l'expérience, mais des théories physiques. La raison en est que les théories physiques ne contiennent pas plus de vérité sur la nature de la réalité physique que ne leur en a transmis la sensation. Or la sensation est à tout le monde: elle était pour Aristote ce qu'elle est pour nous; elle appartient à l'homme avant d'appartenir au savant ou au métaphysicien. Il sera donc permis au savant d'imaginer dans l'objet que lui fournit la sensation tout un édifice d'atomes, toute une mécanique de vibrations, qui se prêteront au calcul avec exactitude, jusqu'à ce des failles se produisent dans l'édifice et des accrocs dans la marche de la machine: il sera permis au philosophe de chercher les conditions rationnelles des mêmes objets de la sensation.

Gardeil distinguished physics and metaphysics by their aims. The physicist was concerned with the exact description and prediction of phenomena. He was free to represent the world in terms that lent themselves to quantification. He should not be surprised that his categories were different from those of the philosopher, who wanted to understand the world in categories more immediately relevant to human beings. Gardeil illustrated the distinction by considering local motion:

Dans le mouvement local, le savant, qui veut tout voir en figures, trouvera masse et force; le métaphysicien y trouvera puissance et acte fondus

ensemble et pourtant distincts, et ultérieurement comme conditions extrinsèques, les causes efficientes et finales. Le second résultat n'est pas contraire au premier: il est d'un autre ordre. J'ose dire qu'il est d'un ordre supérieur puisque la métaphysique abstrait davantage de la matière que la physique mathématique, et qu'elle serre ainsi de plus près l'idée déposée au fond de toutes choses. Votre doctrine ne peut donc qu'être un bienfait pour la science et la métaphysique: elle assure l'indépendance de l'une et de l'autre – mais non pas cette indépendance qui suppose l'opposition et la contradiction, mais une indépendance harmonique, qui emporte une légitime subordination de la science à la philosophie.

Gardeil went on to give the Thomist criteria for the division of the sciences.

The scheme will be discussed at greater length later in the chapter. Here it will explain in what sense Thomists understand one system of knowledge to be superior or subordinate to another and why there need be no contradiction between philosophy and science:

Elles [la science et la philosophie] sont indépendantes puisqu'elles se placent à un degré d'abstraction différent et emploient des procédés spéciaux: elles restent subordonnées, car la science ne saurait défendre contre la critique les procédés rationnels qu'elle emploie, non plus que se prononcer sur l'existence réelle, et les conditions rationnelles de l'objet sensible qu'elle examine. Seule la métaphysique peut le défendre contre le sceptique, montrer sa cohérence et son intelligibilité, et le conserver ainsi à la science.⁴³

The term *philosophia perennis* is present in neither passage. Yet both Duhem and Gardeil pointed out what must be true of any philosophy that claims to be perennial – its basic facts must be accessible to people of all ages. Duhem returned to this theme in a letter he wrote to Gardeil to thank him for an offprint of the *Revue thomiste* article where this remarkable exchange was published. He first set the Dominican's mind at ease about the accuracy of the report: 'M. Duhem n'a nul besoin d'être indulgent pour son interprète qui a parfaitement rendu sa pensée et lui fait trop d'honneur par l'importance qu'il accorde à cette pensée.' Then he went on to elaborate:

⁴³ Gardeil, 'La philosophie au congrès', pp. 584-5.

Si ces quelques réflexions sur les théories physiques jetées par moi soit dans mes articles, soit au Congrès pouvaient amener les philosophes aux conséquences que vous indiquez; si elles pouvaient les convaincre que la métaphysique doit être fondée sur les données obvie, immédiates, de l'observation *non scientifique* et sur l'analyse de ces données, et non point sur les théories provisoires et symboliques de la physique, elles auraient, je crois, produit un effet utile. Ce que le P. Bulliot, l'Abbé Farges, ..., font pour resusciter la Scolastique au moyen de la Science moderne me paraît être l'inverse de la véritable méthode Aristotélicienne, dont le grand caractère me paraît être de faire reposer la philosophie tout entière sur l'analyse de ce qu'il y a dans les choses de plus simple, de plus général, de *plus à la portée de tous*, à l'invers des sciences qui s'attaquent au compliqué, au détail.⁴⁴

Duhem probably mentioned Bulliot and Farges on account of the second intervention he had made at the Congress. On Thursday morning, Duhem was present at a session where Bulliot was scheduled to read a paper on 'Les concepts de matière et de masse'. Gardeil reported that the tension in the room could be felt as people from other sections slipped in to hear Bulliot. An earlier speaker was interrupted by the audience and told to summarize his paper. Finally, Bulliot's turn arrived. He first gave a definition of mass and then a definition of prime matter. Then he concluded: 'Pour obtenir la matière première et la masse, sur un même sujet, le corps physique, nous opérons les mêmes retranchements; donc la masse et la matière première sont identiques.' When the president of the session, Domet de Vorges, asked whether anyone wanted to speak, six or eight objectors immediately raised their hands. It was decided that the physicists should speak first. All eyes turned to Duhem. He declined to comment on whether mass had been properly defined – that would take a hundred pages. 'Encore une fois, ce n'est pas la métaphysique que j'attaque. Je ne la critique que lorsqu'elle a l'ambition de traiter la question toute spéciale des Confins de la science et de la philosophie.' To this end, he had two pieces of advice: (1) much circumspection was necessary given the

⁴⁴ Letter from Duhem to Gardeil, 29 November 1894, in ArchSaulchoir.

instability of physical theories; and (2) metaphysicians should have a knowledge of physical theories, acquired by ten to fifteen years of first-hand experience, rather than by reading prefaces to physics textbooks, before seeking to define the relation of physics to metaphysics: 'Si vous voulez faire la philosophie des sciences, soyez un Helmholtz ou un Poincaré!'⁴⁵

As might be expected 'l'effet de cette sortie, qui s'achève au milieu d'interruptions passionnées, d'applaudissements, de cris de réprobations, est immense'. The debate continued. More people from other sections continued to pour in. Even after the session was declared over, the discussions did not cease. As the crowd was finally pouring out of the room, 'M. Farges se retourne vers elle [la foule] et, du seuil de la porte, le bras tendu, il s'écrie avec véhémence: "Ce ne sont pas des savants, ce sont des obstructionnistes!"'

Bad feelings continued after the Congress. An article signed by 'un congressiste' appeared in the *Annales de philosophie chrétienne* which attacked both Duhem and Gardeil: 'Cette ignorance [de quelques métaphysiciens] des principes scientifiques les plus élémentaires, le R.P. Gardeil la réprovoque et la condamne, je n'en doute pas un instant; mais ne craint-il pas de lui donner quelque encouragement involontaire en empruntant à M. Duhem sa fameuse théorie sur la certitude, ou plutôt l'incertitude objective des sciences [...]'. The author left no question as to his own sympathies: 'le R.P. [Gardeil] nous reconstruirait aux côtés de savants et de philosophes tels que M. Vicaire, M. de Vorges, M. Farges, le P. Bulliot et bien d'autres.'⁴⁶

⁴⁵ Gardeil, 'La philosophie au congrès', pp. 753-4.

⁴⁶ Un Congressiste, 'Le Congrès de Bruxelles et l'argument du premier moteur', *AnnPhilChr*, 131 (1895/6), 58-70 (p. 68).

3. Jean Bulliot: 'un des braves gens'

It is tempting to lump together these heroes of the 'congressiste' as enemies of Duhem; and it is even possible to find evidence that Duhem at times linked them together. Niall Martin, for example, cites a letter to Blondel in which Duhem expressed his disgust with Domet de Vorges and the 'sales bêtes venimeuses' such as the 'congressiste' and condemned the hypocrisy of the 'monde catholique'. Yet, in the same letter, Duhem was willing to admit that there were some 'braves gens' in the Société de Saint Thomas.⁴⁷ Among these, Duhem would eventually recognize Bulliot who was of a different temperament from Farges or Domet de Vorges.

There are no letters between Farges or Domet de Vorges and Duhem. Duhem's intervention at the Brussels Congress seems to have made no impression on Farges's thinking. He published his paper on the existence of God in the proceedings and continued for many years to write scholastic manuals as though he had never heard of the problems which Duhem mentioned. Bulliot, on the other hand, seemed genuinely pleased by Duhem's interventions at the Congress.⁴⁸ He declined to publish his papers in the proceedings. And, despite being named a professor of scholastic philosophy at the Institut catholique, he nearly ceased to write on modern physics and scholasticism. But that is not to say that he lost all interest. He wrote several letters to Duhem on the subject in 1895, which, for reasons that will soon become apparent, Duhem thought were foolish and said so forcefully in his own letters to Pautonnier – 'ne me parlez pas du R.P. Bulliot et consorts; ces imbéciles là auront gâché une très belle oeuvre'⁴⁹ – and also to Gardeil.⁵⁰ But

⁴⁷ Letter from Duhem to Blondel, 12 January 1896, in the Blondel Archives in Louvain-la-Neuve: see Martin, *Pierre Duhem*, p. 54.

⁴⁸ Gardeil, 'La philosophie au congrès', p. 758.

⁴⁹ Letter from Duhem to Pautonnier, 25 April 1896, in Archives of the Archdiocese of Paris.

Bulliot became a life-long friend to Duhem, a collaborator in the foundation of the *Revue de philosophie*, and his indispensable agent in Paris with manuscript libraries and publishers. Duhem must have recognized in Bulliot true zeal for the cause of Catholicism and a desire to collaborate with professional physicists. Bulliot could not help but be impressed by Duhem's own devotion to the Catholic faith and by his intellectual powers, although he was disappointed that Duhem did not endorse hylomorphism in modern physical theory.

Bulliot wrote his first letter to Duhem on 1 January 1895, to thank him for an unspecified 'très intéressante brochure' and to warn him that he was praying 'pour votre parfaite conversion philosophique'.⁵⁰ Unlike Duhem, Bulliot was not content to regard physical laws as mere relations between symbols. 'Pour nous, la loi est la manière d'agir d'un être, d'un corps réel, plus ou moins complètement exprimée par l'équation.' Laws, Bulliot maintained, were absolute insofar as they were translations of reality. Equations, on the other hand, were not absolute for they did not adequately capture all the causal factors in a given situation. On this understanding, Newton's law of attraction was absolute. The fact that it did not adequately describe capillarity was not due to a breakdown of the law but to the presence of another force. This manner of viewing things, Bulliot argued, was more in line with scholastic thought and did not hurt experimental science. 'Pourquoi ne pas nous la laisser et pourquoi les savants, quand ils veulent bien converser avec nous, ne consenteraient-ils pas à parler ce langage?'

On 7 March 1895, Bulliot thanked Duhem for a long letter. He assured him that he was not aiming to restore thirteenth-century physics and that he was open-

⁵⁰ Letter from Duhem to Gardéil, 24 January 1895, in ArchSaulchoir.

⁵¹ Letter from Bulliot to Duhem, 1 January 1895, in the ArchAcSci, *fonds* Duhem.

minded enough to admit the positive aspects of Descartes's thought to his students as well as to point out where medieval scholastic philosophy suffered on account of bad physics. He even admitted that there was wisdom in Duhem's conception of a negative entente between physics and philosophy. But he thought that there was room for a more positive understanding. Metaphysics and physics, he began, both had need for hypotheses. Hypotheses tended to come from the specialized sciences such as physics. Metaphysics then considered them and tried to integrate them into a coherent whole. 'Voilà donc ce que j'entends par l'accord non plus seulement négatif mais positif de la philosophie et de science: discuter l'ensemble les hypothèses et les théories et se mettre d'accord sur le choix certain ou probable de celles qui satisfont le mieux aux besoins organiques de la physique et de la métaphysique.' He finished the letter with a hope for more collaboration: 'Nous arriverons d'autant plus vite à être d'accord que les savants feront plus de métaphysique et les philosophes plus de physique et de chimie.'⁵²

Duhem wrote a long reply which, as far as it can be reconstructed from Bulliot's letter of 25 March 1895, restated the case for a strictly negative entente between physics and metaphysics. Bulliot responded that he shared almost entirely Duhem's point of view. He deplored that materialists had made use of mechanism to argue for their metaphysical belief: 'Il importe donc de rebattre l'orgueil ou la sottise de tous ces grands faiseurs de systèmes.' No doubt, the negative tactic was necessary, but Bulliot thought that it was not sufficient. A more positive link was necessary because most people did not have the intellectual discipline to keep physics to its restricted domain:

On n'empêchera jamais un grand nombre d'esprits cultivés et spécialement

⁵² Letter from Bulliot to Duhem, 7 March 1895, in ArchAcSci, fonds Duhem.

la tribu des philosophes de chercher et de rêver, si vous voulez, une explication générale des choses, une synthèse des sciences, aussi hypothétique soit-elle. Si nous ne leur en fournissons pas une qui soit spiritualiste, ils continueront à embrasser et à prêcher à l'ennui une indigne synthèse matérialiste. On l'a dit souvent [qu']on ne réfute que ce qu'on remplace et les synthèses générales sont seules efficaces.'

These tactics might have been the best short-term solution to a propaganda war, but they could be disastrous to the long-range project of defending a *philosophia perennis*. Bulliot seemed to be oblivious to this more general problem. He spent several pages trying to prove to Duhem that man's knowledge of heat and optics had progressed much since Aristotle. Metaphysics, he said, would have to adapt itself to this progressive knowledge in its attempts to develop a consistent view of the whole universe. This, of course, is where the deeper problems in Bulliot's approach arose. His scheme would pose no danger to a permanently valid philosophy if progress in physical knowledge was merely cumulative. But he himself was aware that the historical record was different. The end of the letter reveals his confused state of mind:

Permettez moi encore un seul mot: voudriez-vous me dire pourquoi il serait absurde d'accorder une valeur objective *probable* aux théories de la lumière? – C'est ce que nous faisons, je l'avoue. Mais Newton, et Fresnel, et Cauchy le faisaient aussi. – Si vous voulez dire par là que aucune de ces théories n'est exempte de difficultés, cela est assurément vrai; mais l'avenir on les perfectionnera, ou les remplacera. Dès maintenant ces théories doivent contenir quelque vérité.⁵³

Duhem would have said that the 'truth' which they contained was a conformity between the quantitative aspects of theory and experimental results. Bulliot thought that he wanted it to mean more, but did not follow his logic to the end. Given his hatred of subjectivism, he could not have defined truth as a temporary and relative construct. But then again, he spoke of 'truth' as something that might have to be

⁵³ Letter from Bulliot to Duhem, 25 March 1895, in ArchAcSci, *fonds* Duhem.

replaced. Was it true then that in Aristotle's day heat was one of the elements, a material substance, whereas in the nineteenth century it became a mode of motion? Bulliot preferred to terminate his letter rather than to face the question squarely.

Bulliot wrote again to Duhem on 5 December 1896 to thank him profusely for his 'L'évolution des théories physiques'. Duhem had predicted to Gardeil that the article would be enthusiastically received by the neo-Thomists in Paris. What he did not foresee was that the article would not be published by the *Revue des deux mondes* but by the *Revue des questions scientifiques*:

J'ai remis à la Revue des Deux Mondes un manuscrit qui paraîtra, je pense, dans le courant de l'année prochaine et où je romps résolument un lance en faveur d'Aristote; j'y développe cette idée que les théories scientifiques modernes, issues d'une réaction violente contre les *qualités* scolastiques, ont évolué inconsciemment de manière à revenir exactement aux idées aristotéliennes – avec l'instrument mathématique en plus. – Je pense bien que toute la Société de St Thomas d'Aquin va m'écraser lorsque cet article paraîtra.⁵⁴

Bulliot was indeed enthusiastic about the article but nevertheless expressed his hope that Duhem would take 'un pas de plus dans cette enquête de philosophie scientifique, jusqu'à la théorie de la matière et forme, *essence* de la philosophie péripatéticienne'. He went on to explain that hylomorphism was compatible with the law of conservation of energy, and, because it admitted substantial change, it was a powerful bulwark against a materialism based on reducing everything, including life, to mere accidental change.

The next significant letter was written by Bulliot, on 28 March 1904, to thank Duhem for his manuscript of the *Théorie physique* which was being published in the *Revue de philosophie*. In the meantime, there had been long and informal discussions in and about Cabrespine between Bulliot and Duhem (and Peillaube) regarding the

⁵⁴ Letter from Duhem to Gardeil, 11 December 1895, in ArchSaulchoir.

foundation of the new journal, which must have clarified Duhem's position for Bulliot. Thus it is not surprising to read regarding the *Théorie physique*: 'Pour le fond, il n'y a pas entre nous de divergence essentielle. J'en étais convaincu d'avance *à priori*: je m'en félicite maintenant lecture faite.' Yet Bulliot displayed a certain uneasiness – 'scrupules de métaphysicien' – which he laid bare before Duhem in the hope that Duhem might add a sentence or two in favour of a more positive relation between physics and metaphysics. No doubt, he began, Duhem was right to heap scorn on metaphysical intrusions into physics. It was sheer madness to think that the universe had to conform to the straightjacket of Descartes's clear and distinct ideas about matter. Physics must be allowed to determine its own method of analysis. But was it not true that as physics progressed under Newton and then Gibbs, it broadened, and was thus able to eliminate all but a few metaphysical systems, and perhaps in the end even tended to a unique system? 'C'est la phase synthétique. Je regrette un peu à la fin de votre beau travail l'absence de cette grande idée qui aurait élargi et élevé le cadre de votre belle étude et qui lui aurait donné toute sa portée.' Bulliot's hesitation never went away completely.⁵⁵

4. The Fribourg Congress: André de la Barre, s.j.

Much to Gardeil's disappointment, Duhem did not attend the Fribourg Congress in 1897. Yet his ideas on physical theory were incorporated into a paper by the Jesuit André de la Barre, a professor at the Institut catholique, 'licencié ès sciences'.⁵⁶ De la Barre spoke on the 'Points de départ scientifiques et connexions logiques en physique et métaphysique'. It would be an unwarranted digression to describe the main thesis of the paper; the point of present interest is that de la Barre fully

⁵⁵ Letter from Duhem to Bulliot, 5 December 1896, in ArchAcSci, *fonds* Duhem.

⁵⁶ Schlincker, 'Les sciences philosophiques', p. 561.

accepted Duhem's analysis of experiments in physics: 'l'observation précise d'une groupe de phénomènes, accompagnée de l'interprétation de ces phénomènes; *cette interprétation substitue aux données concrètes réellement recueillies par l'observation des représentations abstraites et symboliques qui leur correspondent en vertu des théories physiques admises par l'observateur*'.⁵⁷ De la Barre noted that he did not want to get into a discussion of symbolism, but wanted only to show that a 'scientific fact' was not a simple matter of observing. Nevertheless, later in the article, he wrote:

On peut être scandalisé que nous semblions adopter la formule positiviste: 'Expliquer, c'est classifier.' Parce qu'elle paraît exclure la recherche des causes, à bon droit elle est suspecte à plusieurs. Nous ferons simplement remarquer qu'elle est légitime et indispensable dans la science physico-mathématique, parce que, *en tant que mathématique, elle considère la cause formelle*, et n'est déductive qu'en raison de cette cause formelle.⁵⁸

The fact that the reports of the Congress show no trace of a heated discussion of this point shows just how far Duhem's influence must have penetrated.

De la Barre used another of Duhem's ideas as a stepping stone to his metaphysical argument – the quantification of qualities. This was one facet of Duhem's theory of physics that a wide spectrum of neo-Thomists received with gratitude, for it was ammunition against mechanistic conceptions of the universe. Strangely enough, Duhem did not insist on the distinction between qualities in physics and qualities as commonly understood. He was no doubt aware that qualities no less than other terms of physical theory were restricted to an analogical approach to metaphysical reality. Hence, the qualities in energetics could hardly be the Aristotelian category of the same name. Nevertheless, he retained the common

⁵⁷ André de la Barre, 'Points de départs scientifiques et connexions logiques en physique et en métaphysique', in *Compte rendu du quatrième Congrès scientifique international des catholiques, troisième section, sciences philosophiques* (Fribourg: Saint Paul, 1898), pp. 59-71 (p.61).

⁵⁸ De la Barre, 'Points de départ', p. 62.

term.⁵⁹

There were more specific reasons why the quantified qualities of physics differed from their common sense counterparts. The qualities in physics were defined by the operations which measured them. Duhem's qualities differed from other quantitative measurements because they had to be intensities rather than extensions following simple rules of addition. Measurements of length, for example, are extensions because one meter plus one meter make two meters. Temperatures, on the other hand, do not work this way. A body at 300°K when put next to another body of 300°K does not produce a temperature of 600°K. Thus qualities in physics were measurements of properties that admitted of more or less but did not follow simple laws of addition.

Duhem thought that qualities were just as legitimate in physical theory as extension and motion. They were no more or no less explanatory than Descartes's elements. The obvious example of a Duhemian quality was temperature, which captured some of the common-sense understanding of heat. But there were others: conductivity, co-efficient of expansion, and chemical potential, to name just a few. As Duhem himself said, there was no *a priori* method of determining what qualities were to be admitted into physical theory, for primary qualities – the only ones he would countenance – were primary only because of the contingent fact that no one had yet figured out how to analyze them into simpler constructs. Thus there was no guarantee that the operationally defined 'qualities' would have any obvious common sense counterpart.

The suggestive relation between heat and temperature happened to be quite special. But even this relation was not as simple as might be imagined. First, the

⁵⁹ I am indebted to Stanley Jaki for pointing out to me this weakness in Duhem's philosophy of physics.

sensation of heat by human beings is restricted to a small range of temperatures. Moreover, ambient temperatures often do not correspond to perceived warmth – human beings find the wind-chill factor more informative than mere temperature. The instruments that are used to measure and define the temperature as it is understood by physical theory transform its meaning from the common-sense human perception of heat.

Duhem's insistence on 'qualities' impressed his neo-Thomist contemporaries. It was also part of his struggle to free physics from the shackles of mechanism. But ultimately, it was not consistent with his notion of physical theory and with his penetrating analysis of experiment.

5. *Duhem in Louvain: a much studied philosopher of science*

Désiré Nys found many good things to say about Duhem in his *Cosmology*, especially because Duhem had restored 'qualities' into physical theory (see chapter 3.4.B). Yet he felt uneasy about Duhem's denial that physical theory was a causal explanation. Nevertheless, judging from the theses he supervised, he must have been fascinated by Duhem's views. The titles of two pertinent works are *La valeur de l'expérience scientifique et les bases de la cosmologie* (1899-1900) by Joseph Lemaire, and *Mach et Duhem: Étude épistémologique comparée* (1910), by Constantin Michalski.

Lemaire reworked his thesis into an extended rebuttal of Édouard Leroy's commodism. The resulting article re-used the title of the thesis and was published in 1912 in the first volume of the *Annales de l'Institut supérieur de philosophie*. Following Nys, Lemaire defined cosmology as the philosophical study of the mineral realm; as such, it was a division of metaphysics. Lemaire acknowledged that general metaphysics hardly needed a detailed scientific basis. Concepts such as substance and accident, and action and passion could be derived from the crudest empirical

observations. But if these were to remain the sole bases of metaphysics, the metaphysician would forever be condemned to repeating the insights of Aristotle and the medieval scholastics. Fortunately, science had made the cosmologist's life more interesting:

*Entre les déterminants prochains des phénomènes et leurs déterminants derniers, il en est d'autres dont l'étude forme en quelque sorte la limite indécise qui sépare la science pure de la philosophie pure et dont seule une collaboration étroite de la science et de la philosophie peut permettre de fixer la nature. Qui pourrait, d'ailleurs, nier que ces nouvelles connaissances ne soient aptes à donner une compréhension plus large aux notions de la métaphysique pure, nécessairement très élémentaires, si elles ne sont dérivées que d'une expérience vulgaire?*⁶⁰

Lemaire situated cosmology as the middle link in a continuous chain of knowledge between experimental physics and metaphysics. The chain would be broken if experimental results and laws were shown to be merely commodious temporary constructs. Lemaire's article was chiefly aimed against Leroy, but he could not avoid Duhem.

Lemaire analyzed in some detail Duhem's 'Quelques réflexions au sujet de la physique expérimentale' (July 1894). In the article, Duhem had argued that experiments in physics demanded a specialized language. A physicist, to use his example, would speak of measuring resistance, whereas a layman would describe the procedure as watching a piece of iron swing against against a mirrored background. Duhem's point was that each experiment in physics was composed of two facets: (1) observation, which could be done by anyone and (2) interpretation, which could be done only by the trained physicist, using a technical language. Moreover, Duhem maintained that the technical language was not a mere abridgement of common language:

⁶⁰ J. Lemaire, 'La valeur de l'expérience scientifique et les bases de la cosmologie', *Annales de l'Institut supérieur de philosophie*, 1 (1912), 213-80 (p. 215).

This statement, we see, is not the repetition of certain observed facts made in an abbreviated and technical language. It is the transposition of these facts into the abstract and schematic world created by physical theories. [...] In this world a battery is no longer a vase of pottery or glass, filled with certain liquids, in which certain solids are immersed, but a conceptual artifact (*être de raison*) symbolized by certain chemical formulae, a certain electromotive force, and a certain resistance.⁶¹

It is easy to see the connection to Duhem's holism here. A simple experiment is never simple; its interpretation is tied to prior theoretical conceptions. The unproblematic access to the world which the senses usually provide is sacrificed in the case of physics for the sake of accuracy within a theoretical framework.

Lemaire had to get around this analysis to sustain his position. He appealed to the difference between arbitrary and natural symbols and suggested that physics used the natural variety and thus that experiments could reveal something about the nature of matter.⁶² This, of course, was begging the question. He also suggested, as had Bulliot in his letters to Duhem, that when theory was not borne out by experiment, the theory was not false but only missing a component.⁶³ In the conclusion to the article, Lemaire admitted that there was much to be said for Duhem's analysis, despite its skeptical excesses. The philosopher needed much warning not to borrow as fact from physics a merely assumed convention. In particular, 'les récentes idées philosophiques émises à propos des hypothèses des physiciens sur la variabilité de la masse, donnent un regain d'actualité à cette recommandation'.⁶⁴ But to say that one of the foundational ideas of Newton's mechanics – the invariability of mass – could be jettisoned in light of new evidence

⁶¹ Pierre Duhem, 'Some Reflections on the Subject of Experimental Physics', in *Pierre Duhem: Essays in the History and Philosophy of Science*, pp. 75-111 (pp. 89-90).

⁶² Lemaire, 'La valeur de l'expérience', p. 244.

⁶³ Lemaire, 'La valeur de l'expérience', pp. 247-8.

⁶⁴ Lemaire, 'La valeur de l'expérience', p. 277.

without compromising the ‘truth’ of the system would be to degrade the idea of truth to the merely pragmatic. Duhem had higher standards.

Constantin Michalski wrote his thesis on the comparison between Duhem’s and Mach’s philosophies of physics. To his credit, Michalski picked up on the importance of natural classification to Duhem’s notion of physical theory. Moreover, he noted that thermodynamics, via analogy, was consonant with the Aristotelian philosophy. He also correctly pointed out that ‘à part ce désaccord au point de vue métaphysique et à part la classification naturelle, il y a des ressemblances profondes entre Mach et Duhem’.⁶⁵ The similarities have already been noted in chapter 3.1. The metaphysical disagreements which Michalski cited were Mach’s relegation of substance to the realm of prejudice and his ensuing theoretical unification of philosophy and science with only the extent of their outlook – general and particular – to distinguish them in practice. Michalski’s thesis does not show the usual tension that accompanied analyses of Duhem’s work originating from Louvain. This is probably on account of its ostensibly historical approach. It is hard to imagine that one could get a philosophical thesis fully endorsing Duhem past Nys.

One must not underestimate the institutional resistance to accepting entirely Duhem’s point of view. Even if Nys were to change his mind about the philosophy of science, the Institut supérieur de philosophie as a whole could not adopt Duhem’s philosophy of physics without having to restructure its programs. Its philosophy courses were underpinned by laboratory work in physics, chemistry, and psychology (see chapter 2.2). It would require a major shift to call this link into question.

Doctoral dissertations at the Institute continued to emphasize the strong link

⁶⁵ Michalski, ‘Mach et Duhem: Étude épistémologique comparée’ (unpublished doctoral dissertation: Louvain, 1910), p. 102, in Archives of the Institut supérieur de philosophie, Louvain-la-Neuve.

between the sciences and philosophy for some time after Nys's death in 1926. For example, in 1932, Dermot Boylan wrote a thesis *L'influence de la physique moderne sur la cosmologie neo-scholastique*. He thought physics had a bearing on hylomorphism which needed to be addressed. The current ideas about the various elements being made up of various groupings of protons and electrons suggested that all change was accidental. Boylan did not believe this himself, but his own arguments for hylomorphism borrowed nothing from physics. Instead they were based on the unity of living beings and on the existence of multiple individuals of the same species. As to Duhem, 'je trouve beaucoup des idées avec lesquelles je suis d'accord, mais je préfère une conception plus *positive* d'une propriété ultime que la notion négative qu'il en donne'. Boylan also noted that Duhem's natural classification was a means of insinuating metaphysics back into physics, which, of course, it was.⁶⁶

It is possible to notice the link between science and philosophy in Boylan's thesis without reading the text, for there is a table of the dimensions of the various subatomic entities which one would expect to see in a physics textbook rather than in a thesis in philosophy. The institutionalization of the connection could not have been helpful in accepting Duhem's understanding of the relation between physics and philosophy. The link would eventually be severed in the 1950s, not on account of Thomist concerns, but because of the new focus towards existentialism and phenomenology in the philosophy department.⁶⁷ But before that, one of Nys's students, the canon Ferdinand Renoirte (1894-1958), became a professor at the institute and recognized the problems with the old program.

⁶⁶ Dermot M. Boylan, 'L'influence de la physique moderne sur la cosmologie neo-scholastique' (Unpublished doctoral dissertation: Louvain, 1932), p. 184, in Archives of the Institut supérieur de philosophie, Louvain-la-Neuve.

⁶⁷ Jean Ladrrière, 'One hundred years of philosophy', in *Tradition and Renewal: The Centennial of Louvain's Institute of Philosophy*, vol. 3, ed. by David A. Boileau and John A. Dick (Louvain: Leuven University Press, 1993), pp. 41-78 (p. 70).

Renoirte was competent to philosophize about the sciences. He studied engineering in Louvain before World War I; and after he came back from the front he earned a doctorate in physical and mathematical science and a second one in philosophy.⁶⁸ Renoirte was too young to figure in any direct debates with Duhem or his contemporaries, yet it is instructive to point out some salient features of his views, for they bear the marks – duly acknowledged – of Duhemian influence. Jean Ladrière, in tracing a century of philosophy at Louvain, writes: ‘In the domain of the philosophy of nature, the decisive contribution has been that of Canon Fernand Renoirte. He openly broke away from the efforts of certain scholars, among them his predecessor Désiré Nys, to show the agreement between so-called traditional cosmology of Aristotelian inspiration, and the given facts of modern science.’⁶⁹

Renoirte’s major work was *Éléments de critique des sciences et de cosmologie* (1945) which was available in English translation by 1950. But Renoirte had revealed his views much earlier. At a conference of the Société Thomiste, held in Louvain in 1935, he delivered a paper ‘Physique et philosophie’. In it, he stated that instruments replaced the commonly accepted meanings of words such as heat, colour, and weight, by operational definitions. It was the task of the physicist to measure and co-ordinate quantities. He would naturally seek to simplify theory by choosing the smallest possible number of well-defined principles which, in the context of a particular theory, would be accepted as explanations for other measurable phenomena. In measuring temperature, for example, the physicist might think that he was measuring the combined effects of molecular speed and weight. But laws and theories, Renoirte insisted, were always provisional. Other explanatory frameworks

⁶⁸ ‘In memoriam: Le chanoine Fernand Renoirte’, *Revue philosophique de Louvain*, 56 (1958), 543-4.

⁶⁹ Jean Ladrière, ‘One hundred years of philosophy’, p. 60.

might be found. There were periods of stability in the progress of physics, but there are also periods of revolution, when terms take on new meanings. The measurement of distance and time, Renoirte noted, were different before and after Einstein's special theory of relativity. Instruments were always theory-laden. Duhem's holism is evident in this description of modern physics.

Duhem would have concurred with Renoirte's conclusion: 'Le physicien se fait [...] du monde une image dans laquelle certains traits expriment vraiment, non la nature, mais la structure du réel; et c'est là une certaine adéquation. Par exemple, l'atome de Bohr signifie le tableau de Mendeljeff; la théorie ondulatoire signifie les interférences.'⁷⁰ Renoirte's use of the word 'signify' rather than 'explain' is no accident. He was aware that the Bohr atom was 'provisional'. Hence, it might not explain at all. But it did give a consistent account of the classified phenomena. Renoirte concluded: 'Le philosophe se leurrerait s'il imaginait qu'il peut accepter les mots du physicien avec une signification plus riche que celle qui est strictement suffisante à l'expression des résultats expérimentaux. Le désir d'éviter les "liaisons dangereuses", comme dit M. Maritain, doit être poussé plus loin qu'il ne le fait lui-même.'⁷¹ Maritain's teaching will be analyzed shortly. The important point here is Renoirte's insistence that philosophy needed to be carefully and profoundly separated from theoretical physics.

Renoirte did not cite Duhem (or anybody else) in his paper, but he mentioned him with full approval in his *Cosmology*. In particular, Renoirte cited Duhem's definition of physical theory. And in his own conclusion to the chapter on theories, he wrote: 'Whatever a theory contains that expresses something other than the

⁷⁰ Fernand Renoirte, 'Physique et philosophie', *Philosophie et sciences: Journées d'études de la Société thomiste: Louvain, 24 et 25 Septembre 1935* (Juvisy (Paris): Cerf, 1935?), pp. 79-91 (p. 91).

⁷¹ Renoirte, 'Physique et philosophie', p. 91.

relations between measurements is foreign to the method of pure physics.⁷² Thus Duhem's teachings won out in Louvain.

6. Further inroads: the Dominicans

The Dominicans were among Duhem's earliest supporters. Lacombe and Gardeil had come to Duhem's defense in print; and both became his longtime correspondents. The letters that passed between Duhem and Gardeil have already provided much material for this thesis. Here, a letter from Gardeil can add that another Dominican, Blondel's antagonist Schwalm, 'partage toutes mes idées sur vos travaux de philosophie scientifique qu'il suit attentivement'.⁷³ But there were other Dominicans who helped to spread Duhemian ideas.

Duhem corresponded with René Hedde from 1904 to 1909. Hedde was a regular contributor to the *Revue thomiste*. In 1904-5, he published an extended article on thermodynamics in which he argued for an instrumentalist understanding of physical theory. To see in the experimental verification of the law of conservation of energy the verification of the law of causality was an error, according to Hedde: 'C'est une erreur qu'évitent cependant les physiciens scrupuleusement soucieux de l'exactitude quand ils reconnaissent que leurs études n'atteignent pas directement la causalité des êtres, mais simplement les successions invariables des phénomènes.'⁷⁴ He went on to argue that the first law of thermodynamics no more threatened the freedom of the will than the second proved the temporal creation of the universe.

In his correspondence with Duhem, Hedde approved of the articles in the

⁷² Fernand Renoirte, *Cosmology: Elements of a Critique of the Sciences and of Cosmology*, trans. by James Coffey (New York: Wagner, 1950), p. 174.

⁷³ Letter from Gardeil to Duhem, 1 December 1896, in ArchAcSci, *fonds Duhem*.

⁷⁴ René Hedde, 'Les deux principes', p. 70.

Revue de philosophie, which would become *La théorie physique*:

La partie me paraît définitivement gagnée auprès de ceux qui réfléchissent; la distinction entre la théorie *explicative* et la théorie *représentative* deviendra bientôt classique, au profit exclusive de cette dernière. Cette distinction est nécessaire en effet pour combattre les tentatives d'explications de ces trois derniers siècles, tout en conservant les théories établies [...]. Vous montrez avec une irréfutable logique, qu'une théorie d'explication physique suppose un système métaphysique et qu'une théorie physique, étrangère à tout système métaphysique, ne saurait être explicative.⁷⁵

Nevertheless, Hedde expressed the fear that unless there were some link between explicative and representative theories, a dangerous dualism would ensue – the world as it was would not be linked to the world as it appeared. Hedde elaborated the point, but in handwriting that got progressively more illegible, so much so that the lacunae become so frequent as to obscure his argument. In any case, it would have been easy for him to miss the importance of natural classification to Duhem's thought – at least the first time around. When the articles were later published as the *Théorie physique*, Hedde wrote a glowing review for the *Revue thomiste*. This time he signalled the importance of natural classification as the link between physics and cosmology. Hedde was just finishing his review when Duhem's 'Physique de croyant' appeared. Hedde signalled the existence of the new article in a footnote and focused on the importance of natural classification.⁷⁶

In his penultimate letter to Duhem, written in 1909 to thank him for a copy of *Sozein ta phainomena*, Hedde reported that Duhem's thought had penetrated among his Dominican confreres: 'J'ai constaté avec plaisir combien mes collègues de Fribourg sont sympathiques à vos idées et suivent de près vos différents travaux.'

⁷⁵ Letter from Hedde to Duhem, 21 July 1904, in ArchAcSci, fonds Duhem.

⁷⁶ René Hedde, 'La vie scientifique: *La théorie physique*', *RevThom*, 14 (1906), 69-91 (p.91).

7. Jacques Maritain

Maritain's first published article, 'La science moderne et la raison', which appeared in the *Revue de philosophie* in 1910, is a scathing denunciation of modern thinking, written by a young man recently converted to Catholicism and even more recently to Thomism: 'les "penseurs" modernes préfèrent *a priori*, et sans aucune hésitations, dix erreurs venant de l'homme à une vérité venant de Dieu.'⁷⁷ The article's importance and continuing relevance, at least in Maritain's mind, can be surmised from its inclusion in a book of essays he published in 1922, *Antimoderne*. 'La science moderne' discusses issues other than the philosophy of science, yet it is this aspect of the article that is of present interest. Maritain's background in biology – he studied under Felix Le Dantec (1869-1917) at the Sorbonne and then in Heidelberg for two years under the neo-vitalist Hans Driesch (1867-1941) – made him better informed than most neo-Thomist philosophers about the actual methods of science. Convinced that life could not be reduced to chemistry, he was confident that the sciences could be clearly distinguished.

The different sciences, Maritain said, varied in their points of contact with revealed dogma. In the case of the physico-mathematical sciences, the possibility of science coming into conflict with dogma was practically non-existent. One reason was that these sciences did not pertain to living beings which were the principal subjects in theological questions. The other reason was based on their methodology and its inherent limitations:

[Physico-mathematical science] 's'occupe de ces natures [non vivantes], non pas en essayant de pénétrer leur réalité essentielle, mais en cherchant à traduire certaines de leurs relations extérieures dans un langage, le langage mathématique, particulièrement commode à l'intelligence et à la pratique de l'homme. Et ainsi non seulement le nombre de ses vérités premières

⁷⁷ Jacques Maritain, 'La science moderne et la raison', *Revue de philosophie*, 16 (1910), 575-603 (p. 584).

inhérentes aux sciences physico-mathématiques est excessivement restreint, mais encore lesdites sciences, en tant qu'on envisage le déroulement de leurs résultats, s'avancent en tournant constamment le dos à ces vérités, et sans risquer de les rencontrer sur leur route, étant occupées uniquement des complications sans cesse croissantes du réseau mathématique qu'elles essaient de tendre sur les phénomènes. C'est ainsi qu'en fait, la science moderne proprement dite, *stricto sensu*, la connaissance physico-mathématique de la nature, qui ne s'occupe ni de l'origine ni de l'histoire de la matière, ni de la nature intime de la matière, ni de la constitution de l'univers, mais seulement des variations accouplées de certaines grandeurs abstraites, reste dans son développement, à cause précisément de ce qu'elle a d'inférieur et d'incomplet, indépendante des vérités révélées.⁷⁸

Unlike Nys and Bulliot, Maritain did not think that modern science was an argument for hylomorphism. He was also aware of the historical vicissitudes of science: progress often turns its back on 'truths'. These were precisely the points which Duhem stressed in his writings:

In the same article, Maritain addressed the status of hypotheses in physics.

The physico-mathematical sciences attempt to establish quantitative relationships between abstract quantities. They try to tailor a mathematical covering to fit restricted aspects of physical reality:

Et lorsqu'elles font quelque hypothèse sur la nature intime ou la constitution ou le mécanisme intérieur des choses ce n'est point pour prendre cette hypothèse au sérieux, comme si elle était un approfondissement de la nature de la réalité, qu'en fait on n'étudie point pour elle-même, c'est pour s'en aider, comme d'un modèle provisoire, d'une représentation schématique, utile aux esprits concrets et imaginatifs, des grandeurs purement abstraites qui font seules l'objet véritable de la science. C'est pourquoi ces hypothèses, comme celle des atomes ou celle de l'éther, sont souvent si misérables au point de vue logique, et c'est pourquoi la science physico-mathématique, après une expérience de deux ou trois siècles, a absolument abandonné à leur égard les ambitions naïves de ses fondateurs. Mais dès qu'elle s'imagine que les grandeurs qu'elle abstrait de la réalité, sont l'essence de la réalité, ou que les hypothèses qu'elle construit la renseignent sur la nature vraie des choses, sur la marche des événements et le fonctionnement de la nature; ou encore que son langage et ses méthodes et ses hypothèses conviennent aux sciences d'une ordre supérieur, et même ont seuls le droit d'y être acceptés, elle n'est plus ni scientifique, ni positive, ni compétente, elle empiète

⁷⁸ Maritain, 'La science moderne', p. 585.

ridiculement sur un domaine qu'elle ne peut pas connaître.⁷⁹

Again, Maritain is aware of the historical fate of hypotheses; and again he is arguing that, albeit useful, they do not reveal the inner workings of nature. Both are Duhemian themes.

Admittedly 'La science moderne' was an early and passionate diatribe against scientism. It did not invoke the Thomist distinction of the sciences which Maritain would adopt and develop in his later works. But Maritain never altered his view that the language, the methods, and the hypotheses of the physico-mathematical sciences do not pertain (*conviennent*) to sciences of a higher order. It is important to keep this in mind when evaluating Niall Martin's argument that there was an inherent incompatibility between Duhem's and Maritain's thought, and, hence, that Duhem's thought could not be reconciled with neo-Thomist philosophy of science.

Martin concedes that both Duhem and Maritain distinguished the sciences (bodies of knowledge), but he claims that their distinctions were different, for Maritain's purpose was to unite them in a scheme that Duhem could never accept.

As Martin put it:

the basis for Maritain's scheme, as of numberless others of like provenance, is the view that some sciences can be subordinated, or subalternated, to others in the Aristotelian scheme of things. A science is conceived of as a deductive system of syllogisms, deduced from one or more definitions of the essences that are the subject matter of that science, and remaining within its genus or natural kind, and it is supposed that the conclusions of one science can serve as the principles for another, as when the science of equilibria and music take their principles, as *subaltern* sciences, from the superior sciences of arithmetic and geometry. Famously, this scheme ran into difficulties with the applied mathematical sciences, such as astronomy in ancient times and terrestrial physics in modern.⁸⁰

Martin's summary of the distinction of the sciences can be read as an accurate

⁷⁹ Maritain, 'La science moderne', p. 588.

⁸⁰ Martin, *Pierre Duhem*, p. 46.

rendition of scholastic teaching. The last sentence, however, betrays a simplistic understanding of the scheme, for the successes of modern physics need not shatter it. The problem occurs if the conclusions, s_1, s_2, \dots, s_n of a superior science are taken to be not just intellectual tools but the principles, a_1, a_2, \dots, a_n of a subaltern science. Such a scheme – if only the world would conform to it! – would preserve the unity of knowledge for there would in fact be no natural means of distinguishing the sciences. Any distinction would be artificial; it would have to be based on the number of logical steps from the ultimate reasons of things to the particular problem at hand: one might be the realm of metaphysician; two or more could be left to the physicist. Martin may be excused for his misunderstanding of Maritain, for many neo-scholastics also made the same mistake about the relationship of the sciences. The misreading is akin to the scholastic definition of philosophy as *scientia per ultimas causas* and physics as *scientia per proximas causas*, invoked at meetings of the Société de Saint Thomas, but with no real grasp of how to distinguish the ultimate from the proximate.

The risk of looking beyond the historical boundaries of this thesis to the publication of Maritain's *Distinguer pour unir* in 1933 is necessary to answer Martin's argument. It is possible to trace many of the ideas in the book to earlier articles by Maritain, but *Distinguer* presents them clearly and completely; moreover, it is a book which Martin himself cites. Maritain begins by distinguishing the sciences of explanation from the sciences of observation. Only the former would fit the Aristotelian and Thomist definition of science as 'knowledge through causes'; they were known to the Greeks as *dioti estin* and to the medievals as *propter quid est* sciences. The sciences of observation merely record some regularity in nature: *hoti estin* or *quia est*. According to Maritain, 'the distinction between these two categories

of sciences is absolutely sharp: they are not reducible to each other.⁸¹ Yet the sciences of observation arouse a sense of wonder which drives man to understand the world, whence springs an irresistible tendency for the sciences of observation to turn to the sciences of explanation for support. Maritain believed that the sciences that provide the explanatory framework will then imprint their character on the observational sciences.

The explanatory sciences are distinguished according to degree of abstraction from matter.⁸² There is no true science of the individual, hence some level of abstraction is necessary for each of the sciences. At the lowest level of abstraction is *physica*. (The Latin form indicates that the science is neither restricted to mathematical physics nor to the study of inorganic objects, but includes the study of all corporeal natures.) *Physica* abstracts from the particular matter of an individual instance of a nature, but considers both the material and formal aspects of nature. Its subject matter of is *ens sensibile*, being as it can be sensed. *Physica*, for example, studies man, whose nature includes a body, although the body as *physica* conceives it is not the body of any given man. At the next level of abstraction is mathematics. It studies quantity – number or extension – which cannot exist outside of the mind other than in matter, but which can be conceived without matter. (Maritain, in a long footnote, showed that he was aware of the difficulties of the philosophy of mathematics;⁸³ nevertheless, the cited definition of mathematics is Thomist and will suffice for the present discussion.) Metaphysics abstracts from all matter; it studies entities which can be conceived without matter and which sometimes can exist

⁸¹ Maritain, *Distinguish*, p. 34.

⁸² Maritain is following in the Thomistic tradition. See Thomas Aquinas, *The division and methods of the sciences*, trans. by Armand Maurer, *Mediaeval Sources in Translation*, no. 3, 4th edition (Toronto: Pontifical Institute of Medieval Studies, 1986).

⁸³ Maritain, *Distinguish*, pp. 35-6.

without matter. Substance and accident, potency and act, truth, goodness, beauty, the angels, and God are all suitable subjects for metaphysics. It is the study of being itself, *ens ut sic*. Metaphysics is considered to be the highest science and *physica* the lowest because intelligibility increases with actuality. Because matter is the principle of potency, abstraction from it provides higher levels of actuality and hence sciences of higher levels of intelligibility.

The scheme is complicated somewhat by the fact that the degrees of abstraction are not just successive strippings of matter. The abstractions are different in kind. Although *physica* and metaphysics are separated by mathematics, they are closer to one another in their concern with things as they really are outside of the human mind. Mathematics does not share this concern; hence, it is a different kind of abstraction. But like metaphysics, it provides consistent reasons within its level of abstraction. And because there are aspects of corporeal being that can be quantified, mathematics also shares some concerns with *physica*.

Distinctions within *physica* will show its relation to modern physics. The object of this lowest level of abstraction is *ens sensible*. If the emphasis is put on *ens*, *physica* will have to seek its explanatory framework from metaphysics and thus become what Maritain calls natural philosophy. It is philosophy rather than science (in the modern sense of the word) because it tries to penetrate to the reasons for the existence of corporeal objects. It deals with matter and form; it tries to understand local motion and change in non-quantitative terms; it tries to distinguish between animal and vegetative souls; it concerns itself with final causality. In short, it is what can be found in Aristotle's *Physics*.

If, on the other hand, the emphasis in *physica* is on *sensible*, *physica* will seek its explanatory system from mathematics and be transformed into mathematical

physics. Maritain puts it this way:

The great discovery of modern times, foreshadowed by the doctors of the fourteenth century and by Leonardo da Vinci, and achieved by Descartes and Galileo, is the discovery of the possibility of a universal science of sensible nature informed not by philosophy but by mathematics: *physico-mathematical* science. This tremendous discovery [...] has given rise [...] to the terrible misunderstanding which, for three centuries, has embroiled modern science and the *philosophia perennis*. It has given rise to great metaphysical errors to the extent that it has been thought to provide a true philosophy of nature.⁸⁴

Maritain went on to explain that this new science is a *scientia media*, an intermediate 'science for which physical reality provides the matter (through the measurement it permits us to gather from it) but whose formal object and method of conceptualization remain mathematical: a science *materially physical* and *formally mathematical*'.⁸⁵

It should be clear by now that, in Maritain's scheme of subalternation, the higher sciences provide the principles of the subalternate sciences not as starting points or axioms but as tools of analysis. As tools they are useful, but the knowledge thus gained is too different on account of the different levels of abstraction to be transported from one science to another. When the *sensibile* is stressed, every definition within *physica* 'is then taken with reference to sensible observations and indicates something which presents certain well-determined observable quantities. Empirical science will, to the same extent, tend to set up a conceptual lexicon entirely independent of the conceptual lexicon of sciences which, like the philosophy of nature and metaphysics, determine their definitions by referring to intelligible being.'⁸⁶

⁸⁴ Maritain, *Distinguish*, p. 41.

⁸⁵ Maritain, *Distinguish*, pp. 41-2.

⁸⁶ Maritain, *Distinguish*, p. 38.

Maritain went on to discuss the reasons why scientists almost invariably begin to consider their theories as revealing the intimate structure of the universe. Every human being, he believed, has an implicit metaphysics. It is natural to posit a substance x as the origin of phenomena. And the notion of causality also leads to the reification of mathematical terms which are then incorporated into systems of causal explanations. Maritain praised Émile Meyerson for stressing that a truly positivistic science is not possible.⁶⁷ But that was not to say that physical theories are true explanations:

In respect to the explanation of reality, there can be no hope, in our opinion, of ever finding a continuity or dovetailing of the conceptual elaborations of physico-mathematics and the proper texture of philosophical and metaphysical knowledge. That would violate the very nature of things. [...] Physico-mathematical science is not formally a physical science. Although it is physical as regards the matter in which it verifies its judgments, and although it is oriented towards physical reality and physical causes as the terminus of its investigation, physico-mathematical science does not, however, aim to grasp their inner ontological nature itself.

Maritain explained further what modern physics hoped to do:

Physics rests upon ontological reality [...] But it looks upon this ontological reality, these physical causes, from an exclusively mathematical point of view. It considers them only in respect to certain analytical translations, certain cross-sections effected by mathematics. It retains only the measurable behaviour of the real, namely, measurements made by our instruments. [...] Once in possession of its measures, its essential aim is to weave a network of mathematical relations among them. These relations are deductive in form and constitute the formal object of physics. They undoubtedly need to be complemented by a certain hypothetical reconstruction of the physically real, but physics only demands that their final numerical results coincide with the measurements made by our instruments.

Like Duhem, Maritain was giving full liberty to the physicist to choose his terms and construct his theory. The only criterion for the 'truth' of the theory was its correspondence to laboratory measurements. Maritain went on to defend this notion

⁶⁷ See, for example, *Distinguish*, p. 48, or *Philosophy of Nature* (New York: Philosophical Library, 1951), pp. 62-9.

of 'truth':

There is no pragmatism here. [...] As every other science, physics exists to be true; and the definition of truth – the conformity of our judgments to things – holds good for it just as much as for other sciences. In this case, however, that definition has the following meaning: a physico-mathematical theory will be called 'true' when a coherent and fullest possible system of mathematical symbols and the explanatory entities it organizes coincides, throughout all its numerical conclusions, with measurements we have made upon the real; but it is in no wise necessary that any physical reality, any particular nature, or any ontological law in the world of bodies, correspond *determinately* to each of the symbols and mathematical entities in question. The need for causal physical explanation, still immanent to the mind of the physicist, finally issues (in the highest of his syntheses) in the construction of a certain number of beings of reason based on the real and providing an image of the world (or the shadow of an image) apt to support his mathematical deduction. It would betray a quite uncritical optimism, a truly naive optimism, to hope to establish any continuity between the way in which physico-mathematical theories get hold of things and the way philosophical theories do. (For philosophy sets out to grasp ontological principles according to their very reality).

This extended citation shows remarkable similarities to Duhem. Duhem, for example, refused to speak of 'truth' when it came to physical theory, but his criterion of usefulness was the same as Maritain's definition of truth in this context. Duhem also resisted the temptation to create an ontological world for his mathematical entities, but he conceded its usefulness to others. Moreover, his objections to such models were based on their insufficiencies to handle all the known phenomena, to say nothing of what the future might reveal. The various mechanical models of Duhem's era were very far from approaching a natural classification. The hypothetical scenario which Maritain described in the citation, on the other hand, was a physical theory well on its way to becoming a natural classification. Insofar as the explanations which Maritain had in mind provide 'a shadow of an image' they do no more than Duhem's idea of a natural classification which casts shadows of reality on to a wall of Plato's cave for the physicist's enlightenment.

The key to natural classification was analogy. Maritain preferred to speak of

'emphasis' on either of the two aspects of *ens sensibile*. But emphasis is as vague as analogy. On another occasion he spoke of philosophy and science giving different 'oblique' views of the world.⁸⁸ Maritain specifically approved of Duhem's insistence that common-sense observation is more certain although less accurate and detailed than the results of physical experiment.⁸⁹ He went on to distinguish between *dianoetic* knowledge (knowledge of essences), which, he said, was possible for philosophy (and strictly speaking only for human nature for man does not know any other essence from the inside), and *perinoetic* knowledge, which allowed the physical sciences to circumscribe a substance without penetrating its essence. Silver, for example, could be identified by its melting point, its electrical and thermal conductivity, and its chemical properties, but its essence could not be penetrated. Duhem did not bother to make such refinements, but they correspond to his assertion that human beings could know things about the world at a greater level of certainty through common-sense knowledge than through physical theory.

There are other similarities between Maritain's and Duhem's conceptions of physical theory. Both thought that sound philosophy was impregnable to progress in science, although both thought that philosophy should be more closely linked with science. The apparent contradiction is resolved in Maritain's distinction between formal and material dependence. Philosophy is *formally independent of physica*, because its constitutive principles come from a higher level of abstraction. On the other hand, it is *materially dependent on physica* for several reasons. Maritain believed that philosophy should be pedagogically the last science. A philosopher needs to know something of the lower sciences in order to help him to distinguish

⁸⁸ Maritain, 'Dieu et Science', p. 1183.

⁸⁹ Maritain, *Distinguish*, p. 57.

their limits and evaluate their claims to truth. A philosopher also uses the lower sciences to illustrate his ideas. 'Finally, and above all, the progress of science (at least as regards the established facts, if not the theories) should normally renew and enrich the material it provides for the philosopher's elucidations, especially in all that has to do with the philosophy of nature.'⁹⁰ Nevertheless, Maritain insisted that the dependence of philosophy on the lower sciences remains material:

The changes involved affect, above all, the imaginable representation, so important in respect to terminology and the aura of associations that surround didactic terms. To imagine that philosophical doctrines have to be changed with every scientific revolution would be as absurd as to think that the soul is transformed with every change of diet.⁹¹

Again, Duhem did not explicitly make these distinctions, but he taught that (1) physical theory cannot contradict a metaphysical truth and (2) philosophy should pay more attention to the sciences. For him, these truths were a matter of common sense. Perhaps the agreement between Duhem and Maritain can be best brought to light by the following quotation from *Distinguer pour unir*:

It is also an illusion to believe that by appealing to scientific facts without first illuminating them by a higher light, any philosophical debate – the debate about hylomorphism, for instance – may be settled. Of themselves, they have nothing to say on that score. Let them not be tortured in order to wring a pseudo-confession from them!⁹²

It should by now be clear that Martin failed to understand Maritain if he thought that Duhem's notion of physical theory was 'subversive' to the neo-Thomist project. But Martin is correct when he points out that Maritain felt an unease for Duhem's thought. He cites, for example, a passage in *Distinguer*, and then goes on to say 'that at this point it is not particularly clear why Maritain thinks he is disagreeing

⁹⁰ Maritain, *Distinguish*, p. 50.

⁹¹ Maritain, *Distinguish*, p. 50.

⁹² Maritain, *Distinguish*, p. 58.

with Duhem [...] but disagreeing he is'.⁹³ This unease needs to be explained.

Maritain thought that Duhem was trying to turn physics into a purely formal mathematical science, with no room for causal explanation, in order to make room for another science – natural philosophy. In this way, there could be a qualitative science alongside a purely mathematical effort to save the phenomena. According to Maritain:

Duhem fell into a conception of science, of the science of the physicist that was too idealist, almost nominalist in character and at the same time, – from the point of view of the sciences themselves this is the most serious aspect in such a conception, – he suppressed the proper stimulation to physical research. Science became so pure in its mathematical symbolism that the principal and motivating appeal of physical *research*, namely the discovery of causes, the sense, the taste of the particular mystery to be discerned in physical existence, would have been completely lacking for the physicist had Duhem's conception of physical theory been correct.⁹⁴

Maritain went on to label Duhem's view as 'formal mathematicism'. This would be an accurate reading of Duhem were one to neglect his notion of natural classification. But it hardly squares with Duhem's insistence that '*it would be unreasonable to work for the progress of physical theory if this theory were not the increasingly better defined and more precise reflection of a metaphysics; the belief in an order transcending physics is the sole justification of physical theory*'.⁹⁵

It is not surprising that Maritain missed this key to Duhem's thought, for both Jaki and Martin point out that he read very little of Duhem. This is striking in itself for it implies that he must have picked up a lot of Duhem's ideas from numerous book reviews in various neo-scholastic journals and by osmosis from casual conversations in academic common-rooms. It is unlikely that Maritain could have

⁹³ Martin, *Pierre Duhem*, p. 204.

⁹⁴ Maritain, *Philosophy of Nature*, p. 62.

⁹⁵ Duhem, 'The Value of Physical Theory', p. 335.

developed on his own a conception of physical science in his first article that he would not have to repudiate later. It might at first seem possible to attribute the source of Maritain's ideas to Boutroux and Poincaré, but the evidence points to Duhem. Maritain cited Duhem favourably in several places in *Distinguer*; he cited Poincaré favourably only once – denying that modern physics reveals the true nature of things – but also used him as an example to illustrate that great scientists are often bad philosophers. And he completely ignored Boutroux. It is Duhem whom he respects, and on occasion argues with. This is not surprising given that Maritain was associated with the same institutions where Duhem's thought was known and debated – Louvain, the Institut catholique, and the *Revue de philosophie*. Maritain's citation of the importance of fourteenth century Parisian masters as the forerunners of modern physics could only have come from someone who was aware of Duhem's achievement.

Maritain's treatment of Duhem reveals Duhem's influence on contemporary Catholic thinkers. It seems to me that his ideas were so current that a person might feel no need to read them in the original. Although much of what Duhem said was correctly understood, the neglect of his notion of natural classification was persistent and cast a shadow over his achievement in the minds of neo-Thomists. Thus Maritain could see himself disagreeing with him, while at the same time presenting his ideas in the language of scholastic thought. If Maritain continues to be cited as the main authority in neo-Thomist philosophy of science, then Duhem must be counted among the most significant contributors to the movement.

CHAPTER 6

Sed Contra: Some Necessary Distinctions

Un thomiste qui aimait à lire Saint Augustin, qui citait volontiers Pascal, et qui s'assimilait profondément la pensée de Saint Thomas. – *Garrigou-Lagrange on Ambroise Gardeil*¹

The title for this chapter is derived from Thomas's standard method of setting out an argument in the *Summa Theologiae*. In asking a question, such as whether God exists, Thomas first listed objections against the position he would adopt, for example, (1) the alleged completeness of natural explanations of the universe and (2) the existence of evil. Then he would give a contrary opinion – *sed contra* – and proceed to argue for it in his response. After presenting the general argument for his position, he would address each of the objections individually, at times ending with a variation on the phrase *Et sic patet solutio ad objectiones* – and thus appears the solution to the objections.

The earlier chapters of this thesis can be thought of as an extended argument for Duhem's compatibility with and contribution to the neo-Thomist movement. Objections to this thesis, mainly from Martin, have been cited and dealt with as the occasion arose under headings designed to organize the presentation of the relevant materials. Inevitably, however, there are further objections that need to be addressed that resisted the mold. These are taken up in this chapter which ends with a summary of the major argument of the thesis.

¹ Garrigou-Lagrange, 'In memoriam: Le Père A. Gardeil', p. 800.

1. *Pascalian Inspirations*

An alleged difficulty with Duhem's compatibility with neo-Thomism is his Pascalian inspiration. Duhem's reliance on Pascal for key points in his own doctrine is beyond doubt as Jean-François Stoffel has shown, but it is not a sign of an anti-scholastic animus.² In previous chapters, several neo-Thomists with an admitted admiration for Pascal have been cited, including Duhem's correspondents Gardeil and Lacombe. The list could easily be extended for, as Baudrillart records, 'l'un des traits les plus caractéristiques de l'inquiétude religieuse de la fin du XIX^e, c'est assurément l'extrême faveur, on pourrait dire le culte, dont jouit Pascal auprès des esprits les plus différents'.³

Pascal was commonly perceived to have been skeptical about the powers of the intellect and to have recovered his religious faith by appeal to moral probabilities – hence, the Pascalian wager. Were this true, he would be a proponent of fideism, which is incompatible with Thomism, but the case is far from proven. It rests on Pascal's insistence on the 'reasons of the heart': 'le coeur a ses raisons, que la raison ne connaît point.' But these 'reasons of the heart' are not to be construed as mere sentiment or capricious intuition, as the following citation from the same article in the *Pensées* shows:

Nous connaissons la vérité, non seulement par la raison, mais encore par le coeur; c'est de cette dernière sorte que nous connaissons les premiers principes, et c'est en vain que le raisonnement, qui n'y a point de part, essaye de les combattre. [...] Car la connaissance des premiers principes, comme qu'il y a espace, temps, mouvement, nombres, [est] aussi ferme qu'aucune de celles que nos raisonnements nous donnent.⁴

² Jean-François Stoffel, 'Blaise Pascal dans l'oeuvre de Pierre Duhem', in *Nouvelles tendances en histoire et philosophie des sciences*, ed. by Robert Halleux and Anne-Catherine Bernès (Brussels: Palais des Académies, 1993), pp. 53-81.

³ Baudrillart, *Vie de Mgr d'Hulst*, II, p.185.

⁴ Blaise Pascal, 'Article sixième: des divers moyens de croire -- la raison et le coeur', *Pensées et Opuscules*, (Paris: Larousse, [n.d.]), pp. 63-7 (pp. 65-6).

Pascal is clear, but the ‘reasons of the heart’ continue to cause problems. Martin, for example, seems at times to understand that Duhem used the Pascalian distinction to argue that there are different orders of knowledge. But then he writes that ‘the heart, as Pascal said in a fragment already used above, has its order, which is not that of the mind or the intellect’ (le coeur a son ordre; l’esprit a le sien).⁵ Pascal might be forgiven for using ‘esprit’ in the passage, but a modern commentator has no business translating the text as ‘mind or intellect’ because the Pascalian heart *knows* (*connaît*), and, hence, it is a facet of the intellect. It is contrasted with knowledge gained by deductive reasoning, but not knowledge *per se*.⁶

Baudrillart noted that the popular perception of Pascal as a fideist provided the motive for the religiously anxious to turn to him, but that the perception was nevertheless wrong.⁷ Indeed several neo-Thomists took the time to refute the charge of Pascal’s fideism. As early as 1893, in a survey of neo-Thomism, Picavet noted that Matthias Sierp, writing in the *Philosophisches Jahrbuch*, had cleared Pascal of the charge.⁸ Whether in some ultimate sense Pascal’s thought is incompatible with Thomas’s is not the point at issue here. The important point is that Duhem’s contemporaries who were self-acknowledged Thomists did not see any contradictions in reading Pascal and many looked to him for philosophical insights.

⁵ Martin, *Pierre Duhem*, p. 109; Pascal, ‘Article sixième’, p. 66.

⁶ The seventeenth-century fluidity of terms for inner human experience can be seen in Descartes’s description of a thinking entity to be ‘a thing that doubts, understands, affirms, denies, wills, refuses, and which also imagines and senses’. ‘Second Meditation’, *Meditations on First Philosophy*, in *Classics of Western Philosophy*, ed. by Steven M. Cahn, 3rd edition (Indianapolis: Hackett, 1977), pp. 415-9 (p. 417).

⁷ Baudrillart, *Vie de Mgr d’Hulst*, II, p. 185.

⁸ François Picavet, ‘Le mouvement néo-thomiste’, p. 292; Matthias Sierp, ‘Pascals Stellung zum Skepticismus: Ein Beitrag zur Geschichte der neueren Philosophie’, *Philosophisches Jahrbuch*, 2 (1889), 60-73, 310-28, and 3 (1890), 173-87, 307-18, 403-10.

2. *Blondel and Modernism: some Duhemian observations*

Martin makes much of Duhem's friendship with Blondel and his outrage at the anti-modernist measures which shut down Blondel's *Annales de philosophie chrétienne* in 1913.⁹ But this proves neither that Duhem's thought was irreconcilable with some forms of neo-Thomism nor that he had a loathing for all neo-Thomists. Two passages from Duhem's letters to Gardeil will quickly redress the balance. The first was written on 4 December 1896, during the controversy on the nature of faith between the Dominican Schwalm and Blondel. In a *post-scriptum* Duhem wrote:

J'ai envoyé mon petit travail au P. Schwalm; ignorant son adresse, je l'ai envoyé à la Revue Thomiste. Il a été dur pour mon pauvre ami Blondel – une belle âme, mais un des esprits les plus obscurs et les plus faux que je connaisse.¹⁰

In January 1897, Duhem had informed Blondel that his arguments were consistent, provided that one accepted the premises. Duhem clearly did not accept the premises, as Martin himself acknowledges.¹¹

The second letter was written in response to a question by Gardeil, exiled in Belgium, about the modernist crisis in Paris. Unfortunately, Duhem's letter is undated, but it must have been written after the anti-modernist encyclical of 1907:

Toutefois, à Pâques, j'ai fait un petit voyage à Paris [...] J'ai rendu visite à quelques personnes de chacun des camps, moderniste et anti-moderniste. A de rares exceptions près, les uns et les autres m'ont épouvané et attristé. De part et d'autre, j'ai constaté la même obstination, la même hostilité. Les modernistes, convaincus que la scolastique est morte sans retour, que rien n'en saurait être repris et adapté aux exigences actuelles, traitant de veilles badernes tous ceux qui croient que la pensée humaine ne procède pas de manière essentiellement différente au XIII^e siècle et au XX^e siècle. Les anti-modernistes, au contraire, refusant d'admettre que six siècles de labeur intellectuel aient pu ouvrir des perspectives nouvelles,

⁹ Martin, *Pierre Duhem*, pp. 49-59.

¹⁰ Letter from Duhem to Gardeil, 4 December 1896, in ArchSaulchoir.

¹¹ Martin, *Pierre Duhem*, p. 37; letter from Duhem to Blondel, 17 January 1897, in Blondel Archives in Louvain-la-Neuve.

poser des questions différentes dans le fond, et non pas seulement dans la forme, de celles que les scolastiques ont résolues; niant que le modernisme ait sa raison d'être dans l'existence même de ces difficultés nouvelles et dans l'absence des réponses qu'elles sollicitent.¹²

In the rest of the letter, Duhem called for and applauded efforts such as Gardeil's to work towards a synthesis of scholasticism and modern insights and concerns. He cited Lacombe as being especially well-suited to work toward such a synthesis.

It is easy to find many quotations from Duhem's letter in which he had strong criticisms for various members of the hierarchy, including the Pope, especially with regard to the Roman condemnation of the *Annales de philosophie chrétienne*. But such outbursts do not prove that Duhem rejected neo-Thomism as a whole, nor that his Catholic faith became irreconcilable with his intellectual stance. His piety and anti-modernist tendencies – his dislike for revisionist histories of Saints, for example – can be surmised from his letters to his daughter. To use Duhem's association with Blondel as an argument for an anti-Thomist animus is much too simplistic.

3. Duhem on Saint Thomas Aquinas

It may seem strange to put this section at the end of the last chapter of a thesis on Duhem and neo-Thomism. Yet Duhem himself focused his attention on Thomas explicitly only towards the end of his own life in the fifth volume of his *Système du monde*; and the chapter which he devoted to the Saint has little to do with physical science.¹³ The *raison d'être* of the present thesis is not about Duhem's engagement with Thomas's actual thought, but about his relation to the various conceptions of physical theory in neo-Thomist circles. Nevertheless, a few observations about Duhem's direct engagement with Thomas will clarify his ultimate dismissal of the

¹² Letter from Duhem to Gardeil, undated, in ArchSaulchoir.

¹³ Pierre Duhem, *Système du Monde*, 10 vols (Paris: Hermann et Fils, 1913-1959, v (1917)), v, pp. 468-570.

Saint as a muddle-headed philosopher.

Duhem first cited Thomas in 'Physique et métaphysique'. He approved of the passage in the Saint's commentary on Aristotle's *De Caelo* in which Thomas spoke of hypotheses in astronomy as saving the phenomena.¹⁴ Mansion, the editor of the *Revue des questions scientifiques*, received the manuscript on 6 August 1893. On 28 August 1893, he sent Duhem a postcard to let him know about a passage in the *Summa Theologiae* in which Thomas had expressed the same opinion. Duhem cited this passage in *Théorie Physique*.¹⁵ Later, he cited both passages in *Sozein ta phainomena*. Beyond these passages, Duhem did not cite Thomas again until the *Système du monde*, although he did refer to Thomas in passing on other issues. Thus, in *Théorie physique*, one can find: 'From the thirteenth century on, the best of the Scholastics, including Saint Thomas, admitted the possibility of astral influences other than light.'¹⁶ But such passages are rare.

The question naturally arises as to whether, prior to beginning the *Système du monde*, Duhem had read any of Thomas's writings for himself or whether he was dependent on friends such as Mansion for his information. Fortunately for the historian, in a letter to Gardeil, dated 4 December 1896, Duhem wrote: 'j'ai pu lire les Commentaires de St. Thomas, mais je n'ai pu me documenter comme je l'aurais voulu au sujet des scolastiques de la Renaissance [on account of the dearth of books on the subject in the Bordeaux libraries]'. Much later, Duhem overcame this difficulty by having books and manuscripts sent to him from Paris. His notebooks are filled with transcriptions from materials which he was obliged to return. But they

¹⁴ Duhem, 'Physics and Metaphysics', p. 41.

¹⁵ Duhem, *AimSPT*, p. 41; *To Save the Appearances*, pp. 41-2.

¹⁶ Duhem, *AimSPT*, p. 233.

contain none of Thomas's writings, probably on account of the availability of published texts. For certainly by the time that Duhem wrote the *Système*, he must have read the *de Ente et Essentia*, and parts of the commentaries on Aristotle, on the *Sentences* of Peter Lombard, and on the *Liber de causis*; the *Summa contra gentiles* and the *Summa theologiae*; the *Quodlibetal Questions* and the *Disputed questions*; and the *De natura materiae*, all of which are cited in the footnotes; along with some other lesser known works.

The *Système* developed from a series of public lectures on the history of science which Duhem began to deliver in Bordeaux in November 1909.¹⁷ In the academic year 1911-12, the subtitle for the lectures was 'La scolastique latine jusqu'à 1277'; the following year, he lectured on 'Les écoles dominicaines et franciscaines au XIII siècle'. By then, he had presumably read much of Thomas. On 20 July 1913, he wrote a letter to Blondel which confirms the conjecture. Bewailing the suppression of the *Annales*, he had some fairly nasty things to say about 'tous nos néo-thomistes'. They took refuge in verbiage to pretend to answer all sorts of questions which they did not begin to understand. Moreover, Duhem had become convinced that the neo-scholastics were ignorant of their medieval heritage:

Une autre impression très nette, qui va croissant au fur et à mesure que je creuse l'histoire de la Scolastique, c'est que, par ignorance ou par préjugé, nos néo-thomistes nous présentent un faux Aristote, un faux Saint Thomas, une fausse Scolastique, et qu'ils ne comprennent absolument rien à ce grand mouvement intellectuel du Moyen Age, qu'ils nous vantent, qui est admirable en effet, mais qui ne ressemble en rien à ce qu'ils en racontent.¹⁸

It should come as no surprise that Martin has cited this passage as evidence that Duhem was at odds with neo-Thomism. But outbursts of anger rarely come with

¹⁷ Jaki, *Uneasy Genius*, p. 195.

¹⁸ Letter from Duhem to Blondel, 20 July 1913, in Blondel Archives in Louvain-la-Neuve.

nuances. The worst that the passage can do is to serve as evidence that Duhem was a hypocrite, for he continued to correspond with and use the services of Bulliot and Peillaube to complete the *Système*. No neo-Thomist seems to have been aware of what the posthumous publication of the fifth volume in 1917 would bring to light. Garrigou-Lagrange wrote in all innocence on 2 December 1913 to congratulate Duhem on his election to the Académie des Sciences: 'Especially all thomists now have reason to rejoice.'¹⁹

Duhem devoted approximately one hundred pages of the *Système* to a study of Saint Thomas. The purpose of the article seems to have been to show that Christianity is incompatible with Aristotelian metaphysics. The chapter which immediately preceded the one on Thomas was devoted to Albert the Great. Thomas's teacher, Duhem claimed, had expounded Aristotle faithfully without committing himself to an opinion about the intrinsic truth of positions which were contrary to Christian dogma. Thomas was not content with this approach because he knew that the human intellect could not tolerate a contradiction between philosophical 'truth' and theological 'truth'. Thus he tried to achieve a synthesis of truths derived from the various sources. Unfortunately, the result was, in Duhem's estimation, a disastrous failure. The tone of Duhem's condemnation was so harsh as to surprise even his good friend Albert Dufourcq, who otherwise sympathized with the anti-Thomist thrust of Archbishop Tempier's decree of 1277.²⁰ 'Il n'y a pas de philosophie thomiste', Duhem wrote, if by philosophy is meant a co-ordinated system of propositions whose principles or whose co-ordination is due to Thomas.²¹ There

¹⁹ Garrigou-Lagrange, quoted in Jaki, 'The Physicist and the Metaphysician', p. 194.

²⁰ Jaki, *Uneasy Genius*, p. 357.

²¹ Duhem, *Système*, v, p. 569.

was not a single noteworthy original thought in the whole Thomist corpus. Nor did Thomas achieve a new synthesis:

Son désir de synthèse est si grand qu'il aveugle en lui le discernement du sens critique. Il ne lui vient pas à l'esprit que, de quelque manière qu'on les découpe et disloque, les doctrines d'Aristote, du *Livre des Causes*, d'Avicenne n'arriveront jamais à se raccorder les unes aux autres, qu'elles sont radicalement hétérogènes et incompatibles, et surtout qu'elles sont inconciliables avec la foi chrétienne. Lorsqu'entre les fragments juxtaposés, le désaccord éclate trop criant, il ne désespère cependant pas du succès; il pense seulement qu'il avait établi un rapprochement maladroit et, dans un autre ouvrage, il réunit les mêmes morceaux suivant un ordre nouveau. Parfois, sa conviction que les diverses philosophies sont concordantes le porte à imiter l'enfant dont la main presse un peu trop fort sur les pièces du jeu rebelles à l'engrenage qu'on veut leur imposer; il force et déforme le sens où même la lettre de certains passages; peut-il songer que les principes de Boèce ou ceux du *Livre des Causes* sont à jamais inconciliables avec la doctrine d'Avicenne?²²

It would be as bold to examine this judgment in a few pages as it had been for Duhem to write his chapter with hardly any reference to contemporary Thomist literature, but there is hardly any need to do examine this piece of Duhem's writing in detail for it deals almost exclusively with metaphysical topics which bear little relation to contemporary debates about physical theory. Duhem, for example, argued that Aristotle's distinction between potency and act could not be reconciled with Avicenna's distinction between essence and existence, and neither of these could be understood within a doctrine of creation in time. If Thomas made them fit, it was by distorting them fundamentally. Whether the claim is valid or not bears no relation to Duhem's notion of physical theory.

There is a certain irony in the *Système* which should be noted, if for no other reason than to show how difficult it is to achieve a synthesis of all knowledge. In order to make his case against Thomas, Duhem failed to take into account analogical use of terms. If potency and act correspond to matter and form, he argued, then it

²² Duhem, *Système*, v, p. 570.

was inconsistent to speak of potency and act with respect to angels and yet deny, as Thomas had done, that they were composed of at least spiritual matter. Any appreciation of the Thomist position requires that terms be used analogically. There is, according to Thomas, a divide between various grades of being which makes univocal use of terms impossible. The term 'good' as applied to God means something different from 'good' as applied to man. Duhem stressed the importance of analogy when speaking of the relation of physics to metaphysics. It is surprising, then, that he thought that all metaphysics could be forced into one plane of understanding.

There are two possible reasons for Duhem's brusque dismissal of Thomas. The first is an exasperation with neo-Thomists who thought that they had an answer for everything. He may have been irritated with the scholastics who continued to view his notion of physical theory as skeptical; and he was certainly angry that Blondel was condemned, probably at the instigation of neo-Thomists.

The second reason was Duhem's discovery of the medieval sources of modern science. He wanted to emphasize the importance of the condemnation of 1277 to the development of science on account of its break with several key Aristotelian doctrines. Thomas had been implicated in the condemnation; and Thomas was believed to have 'baptized' Aristotle. Thus Duhem was bound to denigrate Thomas if he wanted to strengthen his argument that science developed in the aftermath of the condemnation through the work of people like Jean Buridan and Nicolas Oresme, who sought to observe and investigate the universe which God had chosen to create, rather than to enunciate truths about the only possible universe God was constrained to create by Aristotle's logic.

4. Conclusion

Jaki notes that Duhem was correcting the page proofs of the fifth volume of the *Système* when he died in September 1916. It was the last volume that would be printed until his daughter Hélène finally managed to get the last five volumes published in the 1950s. There is no question that Duhem went into the grave convinced that Thomas was a muddle-headed thinker and that many neo-Thomists were doing the Church harm in resurrecting his philosophy.

Yet there is also no doubt that Duhem profoundly influenced some of the best thinkers of the movement who tried to understand modern physical science. As Mansion noted, Duhem's early articles in the *Revue des questions scientifiques* gave a new direction to the Brussels Society. Duhem's interventions at the Scientific Congress in 1894 were known to all and appreciated by many. Although he did not attend any further congresses, it is clear, from André de la Barre's paper, that his views gained ascendancy at the Fribourg Congress in 1897. The *Théorie physique* was reviewed favourably even by Bulliot who nevertheless could not separate himself entirely from his old modes of thinking. It was only institutionalized intellectual inertia which prevented Duhem's total acceptance by thinkers in Louvain. Nys and his students found much to praise in him, but remained wary on account of his refusal to link physics and philosophy directly. It would take several more decades for the laboratory program to be dropped as a requirement for a degree in philosophy and for Renoirte's philosophy of science to replace Nys's *Cosmology*. In Paris, at the Institut catholique, Duhem was an influence through his friendship with Peillaube and Bulliot and through his contribution to the founding of the *Revue de philosophie*. It should be remembered that there was serious talk of making him the dean of philosophy in 1912. And the fact that Maritain picked up Duhem's thought

by osmosis and thought himself competent to argue with him in print without much first-hand experience of his writings testifies to Duhem's continuing influence at the Institute.

It must be admitted, however, that there was a distrust of Duhem's thought even among those who admired large sections of it. Mansion, Gardeil, and Lacombe were the exceptions in giving him consistent unqualified support. Jaki's phrase 'uneasy genius' is an apt description of the man whose ideas eventually helped neo-Thomists to make the necessary distinctions between philosophy and physics as it developed since the seventeenth, if not the thirteenth, century. Although both Aristotle and Thomas admitted the possibility of a mixed physico-mathematical science, neither worked out the philosophical details of the hybrid, because, apart from astronomy, no such science existed in their day. The recognition of the novel character of the science as it entered a phase of accelerated development in the seventeenth century, Maritain lamented, could have eliminated 300 years of philosophical misunderstanding. If Maritain's *Distinguer pour unir* has become the work most cited by neo-Thomists as developing the notion of a physico-mathematical science, then Duhem deserves a large share of the credit for helping Thomist philosophers come to grips with modern physics. *Et sic patet solutio ad objectiones.*

Appendix

Pierre Duhem: A Biographical Sketch

Stanley Jaki's *Uneasy Genius* is the fullest biography of Duhem, but other books, listed in the bibliography, can also provide a useful introduction to Duhem's life. The present biographical sketch is meant only to acquaint readers who are not already familiar with the life of Pierre Duhem with sufficient details to permit them to follow the arguments in the thesis.

Pierre Maurice Marie Duhem was born in Paris on 9 June 1861, the eldest of four children of Pierre-Joseph Duhem, a textile merchant, and his wife Marie-Alexandrine née Fabre. The family was devoutly Catholic. (Pierre's only sibling to survive to adulthood, his sister Marie, became a nun.) Having witnessed fighting in close quarters in both the Franco-Prussian war in 1870 and the uprising of the Paris commune in 1871, Pierre entered the Collège Stanislas in the fall of 1872. He enjoyed his years at this prestigious Catholic school and distinguished himself in many disciplines, but eventually chose to study physics. He entered the École Normale in 1882, after finishing the entrance exam 'first in the list with a marked superiority over his competitors'.

Encouraged by Jules Tannery, Duhem submitted a doctoral thesis on thermodynamic potentials in December 1884. The thesis was rejected in June 1885, on account of Duhem's slighting of Berthelot's principle of maximum work. The thesis cannot have been much different from Duhem's *Le potentiel thermodynamique* (1886), which has been included in the 'Landmarks of Science' series. Still at the École, Duhem worked in the laboratory of Pasteur, who seriously tried to woo him to bacteriological chemistry but could not overcome the young man's devotion to thermodynamics. Barred from attempting another doctoral thesis in physics, Duhem earned his doctorate in mathematics in 1888 by rewriting his earlier thesis to emphasize its mathematical achievements. Jules Tannery reviewed the thesis in

glowing terms under the title 'Théorie nouvelle de l'aimantation par influence fondée sur la thermodynamique', which was calculated to infuriate the physicists who had rejected the earlier work. Unfortunately for Duhem, Berthelot wielded so much power in the scientific establishment that his dictum – 'This young man shall never teach in Paris' – proved true.

Duhem began his teaching career in Lille in the fall of 1887. In October 1890, he married Marie-Adèle Chayet, a cousin of the philosopher Léon Ollé-Laprune. A daughter Hélène was born in September 1891. Less than a year later, Marie-Adèle died in childbirth along with the infant son. Duhem did not remarry. His mother had become a widow by the time that Hélène was born and so could stay with him to look after the child. The three Duhems lived together until 1906, when Mme Duhem's death and Hélène's departure for the duration of the school terms left Pierre on his own for the greater part of the year. Hélène remained single and dedicated some twenty-five years of her life getting the last five volumes of the *Système du monde* published.

Duhem did not let personal tragedy destroy him. In Lille, he developed his holism, when he found that neither mechanism nor the *hypothetico-deductive method* could withstand the logical criticisms of his students. In 1891, he joined the Société scientifique de Bruxelles; and, in 1892, he began to write articles on physical theory for the *Revue des questions scientifiques*. This could not have helped his cause with the administration of the state university, who, even before the first article appeared, found his frequent rapports with members of the Institut catholique de Lille an embarrassment. When Duhem lost his temper over the rescheduling of exams in July 1893, his enemies took the opportunity to secure his transfer to the backwater of Rennes.

Duhem did not stay for long in Rennes. The university acknowledged that his talents were being wasted there, and he tried hard to get a position in Paris. Yet, during his stay in Rennes, he wrote his article on the impossibility of a crucial experiment in physics; and, while still a professor there, he went to the Brussels Congress in September 1894. By October of the same year, he was transferred to Bordeaux. Disappointed that he had not been called to Paris, he nevertheless accepted the transfer after receiving assurances from the Ministry of Public Instruction that Bordeaux was a necessary stepping stone to the capital. He instructed the movers to keep everything except the basic essentials packed in boxes. And thus he lived for several months before it became clear that his stay in Bordeaux would be protracted. He remained professor of theoretical physics in Bordeaux until his death at the age of fifty-five in 1916.

Although exiled in Aquitaine, Duhem was not completely forgotten by the scientific community in France. In 1900, he became a corresponding member of the Académie des Sciences; and in 1913, he was elected as one of the first non-resident members of that learned body. But the French were slow to acknowledge his talents. In preparing a *curriculum vitae* for the 1913 balloting, Duhem could list his membership in the Scientific Academies and Societies of Holland, Belgium, and Cracow, along with honorary doctorates from Louvain and Cracow.

When Duhem began teaching, generalized thermodynamics was on the cutting edge in physics. Yet there were rapid changes in the discipline on the horizon. Hertz's experiments in 1888 inspired a great interest in Maxwell's theory on the Continent. This was soon followed by the discovery of x-rays and radioactivity. Duhem was aware of the rush to take part in the new research programs but he resisted the crowd, convinced that physics could not be logically unified by such an

approach. While at the beginning of Duhem's career in Bordeaux, students would be willing to forsake the allures of the capital to study under a rising star, by the early years of the new century, they were hesitant to go to Bordeaux to be formed by a man who was becoming famous for his rejection of Maxwell and atomism. Nevertheless, this dearth of students did not discourage him from publishing *Énergétique* in 1911.

Duhem's lighter workload as a professor of physics gave him more time to deliver lectures, first on the philosophy of physics in 1903-4, which culminated in the *Théorie physique*, and later, beginning in 1909, on the history of physics. Duhem, however, had been aware of the importance of history to the philosophy of science for quite some time. In 1896, he published 'L'évolution des théories physiques du XVII^e jusqu'à nos jours'. He helped to found the *Revue de philosophie* in 1900 by contributing a long article on the history of chemistry. And in 1903, he published *L'évolution de la mécanique*. But it was only later in the same year (as Niall Martin has shown), while working on *Origines de la statique*, that Duhem discovered the importance of the Middle Ages to the subsequent development of science. He published *Sozein ta phainomena* in 1908, and devoted the last years of his life to producing the ten volumes of *Système du monde*, five of which were published by 1917, and five of which saw the light of day only in the 1950s. Although Duhem is now primarily known for his work in philosophy and history, he always considered himself first and foremost a physicist, and continued to publish scientific articles and to send technical papers to the Académie des Sciences – seven in the year of his death alone.

Duhem was undoubtedly an extremely talented individual. The importance of his 'failed' doctorate to science is ample evidence of his acumen as a physicist.

Pasteur's interest in him speaks of his versatility, as do his many drawings which have recently been published by Jaki. André Chevrillon, his colleague and friend in Lille, provides further details, in a letter he wrote to H  l  ne Duhem:

Il avait un   quipement intellectuel admirable. Sur les classiques fran  ais et anciens il en savait plus que la plupart de nous, professeur litt  raires. Il lisait le grec plus facilement que nous. Il connaissait    fond la physique, la m  taphysique et la logique d'Aristote; il nous citait par coeur Lucr  ce; il semblait avoir fait une   tude sp  ciale de Descartes et de Pascal. Quand on pense qu'avec cela toutes les sciences proprement dites: math  matiques, physique, chimie, g  ologie, cristallographie, biologie lui   taient famili  res, on mesure l'  tendue extraordinaire de sa culture.¹

Even if fondness and the distant past may have combined to exaggerate Duhem in his friend's mind, one must not forget that Duhem had to have read a great number of medieval manuscripts in Latin in preparing the *Syst  me du monde*. And one must also not underestimate Duhem's capacity to develop his talents by sheer hard work.

It would be wrong, however, to think of Duhem as a scholar pursuing his researches in an ivory tower. He could be found on Sundays first at Mass and then on long walks with Catholic students at the university. He could be passionate in his personal letters, both about friends whom he considered stupid at times – such as the neo-scholastic Bulliot – and about enemies of France as he saw them. In 1899, he shared his vision of France at the annual alumni dinner of the School and Institute Sainte-Marie in Bordeaux. His speech extolled both the Army and Christian Culture at a time when the country was deeply divided over Dreyfus and the State was growing ever more hostile to the Church. His standing at the University was not enhanced by the publication of the speech in a conservative daily newspaper. Although Duhem weathered the difficulties at the time, the charge of anti-semitism continues to be levelled against him.

¹ H  l  ne Duhem, *Un savant fran  ais*, pp. 76-7.

Duhem would not pass a test of political correctness, but he has, I believe, passed the more important test of charity. Jaki cites several instances of charitable works he performed for people in and around Cabrespine, the little town near Carcassonne where he spent his vacations, where the *Revue de philosophie* became a reality, and where he is now buried. In April 1998, I visited the town to pay my respects at his grave and to take a walk in the mountains where he loved to hike. Although the main road through the town is called 'Rue Pierre Duhem', none of the younger people in Cabrespine seemed to know of him. But M. Charles Braille knew him. His 86-year-old wife met me as I was looking in vain for a grocery store, and insisted that I must come to her home so that she could make me an omelette. So I found myself sitting at a table with her 88-year-old husband explaining what I was doing in this small hamlet. Charles Braille was six years old when Pierre Duhem died. Yes, he remembered the famous physicist who was never rich because he was always helping the poor: 'Oui, je me souviens du jour où M. Duhem est mort. Il était un bon homme. Tout le monde l'aimait.'

List of Archival Sources

Only the archives containing often-cited documents have been given an abbreviation.

1. Archives of the Académie des Sciences, Paris (ArchAcSci).
 These are the major archives for Duhem. The first two boxes contain letters written to him, in alphabetical order by correspondent. The best catalogue is an appendix to Jean-François Stoffel's doctoral thesis (see bibliography).
2. Archives of the Archdiocese of Paris.
 Useful information on priests. Letters from Duhem to Pautonnier (which I have photocopied and deposited in ArchAcSci).
3. Archives of the Institut catholique de Paris (ArchICP).
 Dossiers on Bulliot, de Lapparent, Farges, Peillaube.
4. Library of the Dominicans, Le Saulchoir, Paris (ArchSaulchoir).
 Letters from Duhem to Gardeil.
5. Archives of the Society of Mary, Paris.
 Dossiers on Bulliot and Peillaube.
6. Archives of the Société scientifique de Bruxelles, Namur, Belgium.
 Assorted papers, early minute books.
7. Archives of the Institut supérieur de philosophie, Leuven, Belgium.
 Course catalogs, student records.
8. Archives of the Institut supérieur de philosophie, Louvain-la-Neuve, Belgium.
 Unpublished theses by Nys's students.
9. Blondel Archives, Louvain-la-Neuve.
 Letters from Duhem to Blondel.

Bibliography

This bibliography is meant to provide two purposes: (1) to provide bibliographic information for footnotes which are cited by author and abridged title and (2) to suggest relevant material to consult on the various subjects encountered in the thesis. The bibliography is organized by author and title in order to facilitate finding the full information for an abridged footnote; and it is short enough that it should not discourage the reader who would have preferred a thematic approach. But a few words of introduction might be helpful.

Stoffel's bibliography of Duhemian primary and secondary literature is a must for any serious Duhem scholars. The neo-scholastic manuals by Mercier and Farges, both of which went through many editions and printings, give a good indication why some scholars rightly separate Duhem from neo-scholasticism. But this view must be offset by the works of Maritain and Renoirte. The entries for Weisheipl and Dewan give a good indication of the debate among neo-Thomists about the place of natural philosophy and metaphysics, but from a different perspective to the one of this thesis.

In addition to the reference works familiar to readers with a background in the history of science, the following may provide useful information on various points of Catholic doctrine and on various well-known Catholic thinkers: *Catechism of the Catholic Church* (San Francisco: Ignatius, 1999), *Catholic Encyclopedia* (New York: Appleton, 1907-12), and the *New Catholic Encyclopedia* (New York: McGraw-Hill, 1967). Two reference works that focus primarily on France are: (1) *Catholicisme: hier, aujourd'hui, et demain. Encyclopédie en sept volumes* (Paris: Letouzey et Ane, 1948-) and (2) *Les sciences religieuses*, Dictionnaire du monde religieux dans la France contemporaine, no. 9 (Paris: Beauchesne, 1996). The *Revue des questions scientifiques* has many biographical articles. The *Annales de philosophie chrétienne*, the *Revue thomiste*, and the *Revue de philosophie* will also be indispensable. For the rest, the bibliography will have to speak for itself.

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