THE HYLOMORPHIC DOCTRINE OF PRESENCE BY POWERS AND ITS RELATIONSHIP WITH CONTEMPORARY SCIENCE

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Dedication

À la mémoire de mon père, Pierre Savard, MSRC (1936-1998).

ABSTRACT

Aristotle's hylomorphic doctrine of presence by powers, adopted by Thomas Aquinas, states that the substantial forms of the parts of natural wholes are not present in act, but rather *by their powers*. Over the past century and a half, scholars have attempted to relate this doctrine to experimental scientific knowledge. Major issues include the relation between philosophy and science, the unity or plurality of substantial form, outdated elemental powers, and questions of translation. Building on the work of Jacques Maritain, William Wallace, Terence Nichols and other Thomists, I propose that the mediated inherence of the powers of the soul, as presented by Thomas Aquinas, provides a satisfactory means of applying the doctrine of presence by powers to the contemporary biological, chemical and physical understanding of the human being. In so doing, I affirm the continuing relevance of a philosophy of nature cast in the Aristotelian and Thomistic traditions.

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Introduction

A. The Issue of Presence by Powers

Over the past century and a half, within the larger scope of Aristotelian and Thomistic scholarship, the general project of relating philosophical principles to the findings of experimental science has been pursued by a number of schools and individual scholars. This has occurred under the watchful eye of such critics as Jacques Maritain, who emphasized the distinction between the philosophical and the experimental realms, and who warned against the dangers of superficial "concordismes." [1]

A particular aspect of the project has focused on Aristotle's doctrine of presence by powers, regarding the existence of parts in substantial wholes. According to the Stagirite, the substantial forms of the parts are not present in act, but rather by their powers, in such substantial or natural wholes. [2] As we will see further below, the doctrine is adopted *in toto* by Thomas Aquinas. How are we to relate this doctrine to our contemporary scientific understanding of material wholes?

This project was notably pursued in the framework of the neo-Thomistic movement at the turn of the XXth century. The River Forest School also pursued it in the second half of that century, along with francophone scholars such as Daujat, Salet and Chalmel. Most recently, Anglophones such as Bobik, Nichols, Baldner, Goyette, Decaen and Storck have contributed to the effort. [3]

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[1] Maritain's position is developed in two of his works in particular, *La philosophie de la nature: Essai critique sur ses frontières et son objet,* 2e édition (Paris: Téqui, 1935) and *Distinguish to Unite or The Degrees of Knowledge,* translated by Gerald B. Phelan (New York: Charles Scribner's Sons, 1959).

[2] Aristotle, *De Generatione et Corruptione*, transl. H.H. Joachim, ed. W.D. Ross (Oxford: Clarendon Press, 1951), I, 10, 327b23-31.

[3] References to individual works will be found below, and in the main body of the thesis.

In the eyes of some current and recent observers, the issue of presence by powers is not merely secondary. As reported by Steven Baldner, Annneliese Maier states: "the collapse of scholastic philosophy was brought about, in part, by the inability of hylomorphic doctrine to account for the real presence of elements in compounds." [4] In like manner, John Goyette, Terence Nichols, Christopher Decaen and Michael Storck identify the issue of presence by powers as an unresolved point of difficulty for the Aristotelian and Thomistic traditions. [5]

B. Ancient Versus Modern Views

In the present context, with experimental science yielding up an ever-deeper understanding of matter, the ancient hylomorphic doctrine of presence by powers appears especially difficult to hold. Reductionism offers us a much more alluring approach. Lawrence Dewan puts it as follows:

[4] Steven Baldner, "St. Albert the Great and St. Thomas Aquinas on the Presence of Elements in Compounds," *Sapientia* 54 (1999), p. 41. Baldner is referring to Anneliese Maier's « Die Struktur der materiellen Substanz », in *An der Grenz von Scholastik und Naturphilosophie,* 2nd ed. (Rome: Edizioni di Storia et Letteratura, 1952), pp. 3-140.

[5] See John Goyette, "Substantial Form and the Recovery of an Aristotelian Natural Science," *The Thomist* 66 (2002), p. 519, and Terence L. Nichols, "Aquinas's Concept of Substantial Form and Modern Science," *International Philosophical Quarterly* 143 (1996), pp. 303-304. For rich bibliographies on the questions of presence by powers and hylomorphism in the face of modern science, two works stand out in particular. Christopher Decaen focuses on both Thomistic and Aristotelian scholarship in his "Elemental Virtual Presence in St. Thomas," *The Thomist* Vol. 64 (Washington: The Thomist Press, 2000), pp. 271-300. An exhaustive list is also found in Michael Storck, "St. Thomas Aquinas on the Presence of the Elements in Living Substances" (draft Ph.D. diss., Catholic University of America, 2004).

> We have a strong tendency to reduce things to a *mechanical* character. We have a tendency towards a *particle* theory, i.e. to think of each distinctive being as made up of 'a lot of little beings (substances!)'. The bear, one might say, is an assemblage of "molecules" or some other sort of small item. "Mr. Smith is a bundle of events." This kind of picture is a formula for permanently setting aside the being of things, a technique for evading "substance"…If we are to have a grasp of substance, we must allow the *unity* of substance to dominate the *multiplicity* of parts." [6]

As pointed out by Dewan, such a reductionist tendency was already apparent among the pre-Socratics. In his introductory developments to the *Metaphysics* and the *Physics,* Aristotle provided a response to this view. However, the Stagirite has been seriously challenged by the success of the mechanistic approach in modern experimental science. Isaac Newton saw no need for Aristotelian formal or final causes to account for the motion of bodies under the force of universal gravitation. As for quantum mechanics, it certainly appears to bring into question the exact causal understanding of natural wholes.

In such a setting, could the modern era be expected to retain Aristotle's doctrine of presence by powers, based as it is on his hylomorphic theory of material substance? In fact, his entire philosophy of nature has come into question, along with that of Aquinas.

Scholasticism fell from grace in the Renaissance. Since then, the philosophy of science has progressed through such transformations as Bacon's redefinition of form, Descartes' mechanicism, Hume's questioning of causality, Kant's unknowable noumenon, Comte's positivism, all the way to Thomas Kuhn's paradigm shifts. This historical process appears to have established a basic incommensurability between an Aristotelian conception of the world and the findings of experimental science. Quantification has transformed this science, yielding up knowledge that appears to be of a different order than the Ancients' qualitative understanding of the world. In conjunction with these changes, the humanities and the physical sciences have

[6] Lawrence Dewan, "The Importance of Substance," in *Form and Being: Studies in Thomistic Metaphysics* (Washington, Catholic University of America Press, 2006), p. 115.

drifted far apart. Today, scholarship appears sundered into a multitude of disciplines, each with its own independent view on reality.

Still, in the present day, some Thomists argue that the Scholastic approach offers a valid, synthetic view of the world. As put by William Wallace,

> Thomism is sufficiently analytical to be acceptable to the scientific mind. Apart from providing an analysis, however, it is also a *synthesis*, and one that is capable of tying together the most diverse strands of knowledge in a meaningful way. Its basic insights into the structure of matter, into the living organism, into man and society, etc., provide a broad foundation on which rapidly multiplying scientific disciplines may find a unified intelligibility. [7]

Terence Nichols adds:

> As William Wallace has argued, the recovery of an Aristotelian and Thomistic notion of nature, especially hylomorphism, could serve as a means of integrating the physical and human sciences, including morality, and so begin a retrieval of a desperately needed integration centered on the human person. Yet, an integrated notion of nature depends entirely on the recovery of a scientifically credible concept of substantial form. [8]

Nichols further states that "Such a retrieval could ground a recovery of intrinsic natures and purposes, returning us to a world of organisms instead of to a world of machines." [9]

In this thesis, we will argue that a "scientifically credible" concept of substantial form can indeed be recovered. However, we will hold that such a recovery rests on a properly philosophical interpretation of scientific facts, in line with Jacques Maritain. Building on Wallace's "powers model," making use of Terence Nichols' developments on subsidiarity, and adopting Aquinas' notion of the mediated inherence of powers, we will argue that the ancient understanding of the presence of parts in natural wholes is applicable to the fruits of contemporary science.

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[7] William Wallace, "Thomism and Modern Science: Relationships Past, Present and Future," *The Thomist* 32 (1968), pp. 80-81.
[8] Terence L. Nichols, *Op. Cit.,* p. 318.
[9] *Ibid*., p. 306.

C. Limitations of our Study

In the first place, our project only constitutes a first thrust, and it would likely require a lengthy effort to be brought to completion.

Furthermore, our objective is to concentrate on the contemporary challenges faced by the doctrine of presence by powers. Therefore, although we will make reference to some earlier forms of the controversy, we will focus on the period ranging from the last quarter of the XIXth century to the present time.

In this period, we have seen experimental science turn the page on a Newtonian view of the world. Post-Newtonian physics has come to the fore with electromagnetism, relativity, fundamental particles and quantum mechanics. These advances have been rapidly put to use in chemistry, where Dalton had already thrown light on the existence of modern atoms. As for the life sciences, galvanized by Darwin's theory of evolution, they have been transformed by the experimental success of organic chemistry, biochemistry, physiology and genomics.

The late XIXth century was also the setting for a neo-Thomistic renaissance. This has led to a sizeable body of scholarship addressing the philosophy of nature, including the issues of hylomorphism and presence by powers. We will draw from this rich source of documentation, in both English and French. [10]

[10] There also exists a sizeable Spanish body of literature on this question; unfortunately, it is not directly accessible to us.

D. Plan of the Thesis

In our opening chapter, we will first examine Aristotle's doctrine of presence by powers, as adopted by Thomas Aquinas. We will note some key problems of interpretation. We will then review attempts to apply the doctrine to experimental scientific knowledge since the last quarter of the XIXth century. Given the persistence of a key objection to the doctrine, we will examine a selection of alternative readings that attempt to harmonize presence by powers with experimental science. This will include Terence Nichols' work on subsidiary forms. We will note that such readings – Nichols' in particular – challenge the doctrine's philosophical underpinnings, raising the central question of the relation between a philosophy of nature and experimental science.

In our second chapter, we will explore the relation between these two modes of knowledge. We will note that metaphysics underpins experimental science by providing it with fundamental definitions. We will then provide a detailed review of Jacques Maritain's concerns regarding epistemological distinction, along with the alternative view of Benedict Ashley and the River Forest School. We will finally focus on the powers of natural wholes as the privileged point of application of the philosophy of nature to the findings of experimental science.

In our third chapter, we will come back to presence by powers per se. We will address the key problem presented by Nichols' subsidiary forms: the questioning of substance-accident language. In response, we will note that subsidiarity is consistent with the mediated inherence of the powers of natural wholes, as per Aquinas' developments on the matter. We will also adopt contemporary analogues to Aristotle's elemental and mixed powers, in spite of certain key epistemological issues. We will then apply mediated inherence to the powers of the natural whole known as the human being, as these powers are understood by contemporary experimental

science. Finally, we will offer particular answers to the further issues raised in the first and second chapters.

Having provided a detailed application of the doctrine of presence by powers to knowledge gained through experimental science, we will close with an affirmation of the continued relevance of an Aristotelian and Thomistic philosophy of nature.

Chapter I. Presence by Powers: An Initial Examination

Introduction

In this chapter, we will review the philosophical doctrine of presence by powers, along with attempts to apply the doctrine to experimental scientific knowledge since the late XIXth century.

In Section A, we will describe the doctrine as per its foundation in Aristotelian hylomorphism and its application to both inanimate and living beings. We will review the notions of substance and accident, prime matter and substantial form, act and potency, substantial unity, elemental powers, elements, mixed powers, mixed bodies and souls, as they all play a role in the doctrine of presence by powers. We will base our development on key texts in Aristotle and Thomas' corpus.

In Section B, we will explore the applications of the doctrine to experimental science. We will first discuss two key problems: the interpretation of *dunamis* and *virtute* as "virtual presence," and the outdated nature of Aristotle's elemental and mixed powers. We will then focus on a particular critique of the doctrine, which, although formulated in the late XIXth century, is still coherent with the common understanding of matter. We will close with an overview of attempts to apply the doctrine since the late XIXth century. Although the latest applications appear promising, we will note that they are still open to criticism.

In Section C, we will explore some recent alternative readings of presence by powers. In their concern for compatibility between the philosophy of nature and chemistry, physics and biology, these scholars affirm the multiplicity of formal principles within natural wholes, and

question the validity of substance-accident language. They therefore challenge the philosophical foundations of the doctrine of presence by powers. This raises the underlying question of the relationship between an Aristotelian natural philosophy and experimental science. This will lead us on to Chapter II, where the relationship in question will be explored in some detail.

A. The Doctrine of Presence by Powers

1. Aristotelian and Thomistic Roots

In its simplest form, the doctrine of presence by powers deals with the forms of elements in mixed bodies: "The forms of the elements, therefore, are in the mixed bodies not in act but by power." [1] All of the terms used in this statement are properly Aristotelian. Thomas Aquinas adopts them *in toto* in his own treatment of the subject. Therefore, in order to examine the doctrine, we will need to lay out in some detail Aristotle's original teachings regarding these matters, along with St. Thomas' contributions.

The doctrine of presence by powers is framed in terms of Aristotle's hylomorphic doctrine of substance. The latter is a central theme of his metaphysics, and serves as the foundation for his philosophy of nature. Aristotle devotes a considerable portion of the *Metaphysics* to his notion of substance, developing the associated themes of unity and multiplicity, act and potency, and matter and form. The early books of the *Physics* are also

[1] Thomas Aquinas, *De Mixtione Elementorum,* II, 145-53, cited in English by Christopher Decaen in "Elemental Virtual Presence in St. Thomas," *The Thomist* 64 (2000), p. 282. Aquinas is commenting on Aristotle's basic text on presence by powers, *De Generatione et Corruptione*, I, 10, 327b29-31. Decaen's article treats the question of presence by powers, or virtual presence, in considerable detail. We are indebted to his painstaking exploration of possible interpretations of the doctrine, and to his detailed discussion of previous articles on the question.

devoted to substantial form and prime matter, as solutions to the problem of substantial change. However, the doctrine of presence by powers is not specifically developed in these treatises.

It is in his more specialized works that Aristotle brings the doctrine to the fore. In *De Generatione et Corruptione,* the doctrine is explained in the general case of the elements in mixed bodies. In the *Meteorologica,* the doctrine is applied to elements, mixed bodies, and the parts of living bodies. Finally, in the *De Anima*, the doctrine is applied to living beings as a whole. [2]

Aquinas adopts the doctrine of presence by powers in his own philosophy of nature. It is present in his commentaries on the above works of Aristotle; in his shorter specialized works on the philosophy of material substance, *De Principiis Naturae* and *De Mixtione Elementorum*; [3] in his own work on the soul, *Quaestiones de Anima*; and in his philosophical and theological syntheses, the *Summa Theologiae* and the *Summa Contra Gentiles.* [4]

We will now review the notions of substance, accident, matter and form, in order to properly frame the doctrine of presence by powers.

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[2] Unless otherwise indicated, all citations and references to Aristotle are taken from the W. D. Ross edition of *The Works of Aristotle.* This includes the following volumes and works: *Categoriae,* transl. by E.M. Edgehill, Volume I (Oxford: Oxford University Press, 1955); Physica*,* transl. R.P. Hardie and R.K. Gaye, and *De Generatione et Corruptione,* transl. H.H. Joachim, Volume II (Oxford: Clarendon Press, 1951); Meteorologica*,* transl. E.W. Webster, and *De Anima,* transl. J.A. Smith, Volume III (Oxford: Clarendon Press, 1951); Metaphysica*,* transl. W. D. Ross, Volume VIII (Oxford: Clarendon Press, 1954).

[3] A recent English version is provided by Joseph Bobik in his *Aquinas on Matter and Form and the Elements: A Translation and Interpretation of the De Principiis Naturae and the De Mixtione Elementorum of St. Thomas Aquinas* (Notre Dame, IN: University of Notre Dame Press, 1998). We will also be making reference to Steven Baldner's translation of selected passages from the *De Mixtione Elementorum*, as provided in "St. Albert the Great and St. Thomas Aquinas on the Presence of Elements in Compounds," *Sapientia* 54 (1999), pp. 41-57.

[4] Unless otherwise indicated, all citations and references to these works of Aquinas will be taken from *Questions on the Soul (Quaestiones de Anima),* transl. James H. Robb (Milwaukee: Marquette University Press, 1984); *Summa Theologiae,* transl. Fathers of the English Dominican Province (Notre Dame, IN: Ave Maria Press, 1981); and *Summa Contra Gentiles,* transl. Vernon J. Bourke (Notre Dame, IN: University of Notre Dame Press, 1975).

2. Aristotle's Notion of Substance

Aristotle defines substance in terms of a key distinction: predication. "We call 'substance' the simple bodies, i.e. earth and water, fire and everything of the sort, and in general bodies and the things composed of them.(…). All these are called substance because they are not predicated of a subject but everything else is predicated of them." [5] We have here the fundamental distinction between substance and accident: an accident is predicated of another, while a substance is not. An accident eventually refers back to a substance.

Aristotle closely relates the notions of substance and nature. In the *Physica,* he defines nature as an inherent principle of motion and rest. [6] According to him, all material substances have their own such principle – their own nature. Conversely, a material entity which does not have its own nature is not a substance, but rather an aggregate of substances – for example, a corpse.

In Aristotle's view, the material world consists of a vast number of different substances, ranging from the simple to the complex. Substances can be of great simplicity, as in the elements of Empedocles – fire, earth, air and water. Substances can also be of great complexity, as in plants and animals. For Aristotle, the human being is the most complex substance of all. Such a complex being is still a substance, since it is not predicated of another, and it has its own nature: it moves and comes to rest in itself.

[5] Aristotle, *Metaphysica*, V, 8, 1017b14. See also the *Categoriae,* I, 5, 2a11-12.
[6] Aristotle, *Physica,* II, 1, 192b14-15.

3. The Hylomorphic Doctrine of Material Substance

According to Aristotle, our changing, observable world is composed of different kinds of substances, and each of these is present in many individual cases. Most of these substances are composed of many parts. In addition, they all appear to undergo substantial change, one nature following upon another, for instance in generation and corruption. How can we best account for the "species-individual" structure of the world, for the "one and the many" nature of substances and their parts, and for what appears to be substantial change?

Aristotle answers these questions in the *Metaphysics* and the *Physics,* and his findings form the basis of his philosophy of nature. According to him, material substances consist of two fundamental principles. One is the principle of unity and of change, while the other is the principle of multiplicity and of continuity. He names these principles substantial form and prime matter. Substantial form is ultimately responsible for the nature of a new, single, substantial being – e.g. the humanity of a new human being. Prime matter is ultimately responsible for the multiplicity of beings of the same species, and for their continuity with the beings that went before and those that will come after. These two principles can be seen to give us an economical explanation for both substantial change, and the species - individual nature of the world. [7] The doctrine is termed hylomorphism from the Greek *hyle* or matter, and *morphe* or form.

A third ontological principle – privation – is required to fully explain substantial change. Privation is the contrary of form. In substantial change, matter proceeds from one contrary to

[7] Andrew G. Van Melsen, *Philosophy of Nature,* 3rd ed. (Pittsburgh: Duquesne University Press, 1961), pp. 118-120. Van Melsen prefers the species-individuality argument as the basis for matter and form. He holds that the traditional argument from substantial change is less convincing in the current scientific context, given the evident subsistence of atoms and molecules throughout such change. Pedro Descoqs explores a similar position in his *Essai critique sur l'hylémorphisme* (Paris: Gabriel Beauchesne, 1924).

another: from the presence of form "a" and the privation of form "b," to the presence of form "b" and the privation of form "a." [8]

Matter and form are not to be confused with material or spatial parts. "We might call the form and matter of a material object its *metaphysical parts* (italics added) in order to distinguish them from the same object's *integral parts* (italics added), that is, the discrete quantitative portion of the material object." [9]

The linchpin of the hylomorphic doctrine is the existential relationship between prime matter and substantial form. Aristotle relates them in terms of his ultimate principles of existence – act and potency. Form and matter are related as actuality to potentiality. "The form exists actually.(…).the matter exists potentially." [10] Potential existence is indeterminate and open to all possibilities, while actual existence is determined and one. Therefore, we can speak of the substantial form as responsible for the one existential act of the substance with respect to the universal existential potency of prime matter. [11]

According to Aristotle, prime matter and substantial form cannot exist independently. It is the substance that exists by the substantial form and from the potency of prime matter. In his commentary on Aristotle's *Physics,* Aquinas concurs: "Primary matter…is one principle of nature. It is not one as a "this something", that is, as some determinate individual, as though it had form and unity in act, but is rather called being and one *insofar as it is in potency to form* (italics added). The other principle…is the nature (ratio) or form." [12]

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[8] Aristotle, *Physica,* I, 7, 191a1-23.
[9] Christopher M. Brown, "Artifacts, Substances, and Transubstantiation: Solving A Puzzle for Aquinas's Views," *The Thomist* 71 (2007), p. 92.
[10] Aristotle, *Metaphysica,* Λ, 5, 1071a7-10.
[11] Thonnard, F.-J., *Précis de philosophie en harmonie avec les sciences modernes* (Paris: Desclée, 1950), pp. 417-421.
[12] Thomas Aquinas, *Commentary on Aristotle's Physics*, transl. Blackwell, Spath, Thirlkel (Notre Dame; IN: Dumb Ox Books, 1999), I, Lectio 13, Par. 118, p. 56. For Aquinas, there is one exception to this rule: the human substantial form can exist apart from prime matter, on account of its immaterial intellectual powers (*Summa Theologiae*, I, q.75, a.6.)

Finally, substantial form and prime matter are vastly different in terms of their epistemological status. According to Aristotle, substantial form as radical principle of determination is also the principle of intelligibility in a substance. In contrast, prime matter, as radical principle of determinability, is essentially unintelligible and unknowable in itself. Prime matter is only intelligible in terms of the notions of substantial form and substance.

The difficulties presented by these concepts are recognized by scholars in the Aristotelian and Thomistic tradition. According to Lawrence Dewan, "We find such items as *substantial* form difficult to grasp. Still worse is *matter.* Some of the things said about these items are strange. But part of the problem is that we have not seen, at the outset, how strange is sensible substance itself. It is a target of the *mind*, the mind 'reading the interior' of sensible phenomena." [13]

The operation of "reading the interior" of sensible phenomena involves particular problems of its own. Do philosophers and experimental scientists both read the interior of sensible phenomena? Both might answer in the affirmative. But do they read this interior in the same way? If not, how can they carry on a conversation about the world and its great variety of substances? We will explore this central issue in Chapter II, and we will apply our findings to the question of presence by powers in Chapter III.

[13] Lawrence Dewan, "The Importance of Substance," in *Form and Being: Studies in Thomistic Metaphysics* (Washington: Catholic University of America Press, 2006), p. 118.

4. The Unity of Substantial Form

Aristotle and Aquinas both affirm that there can only be one substantial form in any one substance. In a given substance, the potency of prime matter is only actualized through one substantial form. This is the doctrine of hylomorphic substantial unity.

Any other form must be accidental. Expressed in terms of substance-accident language, accidents can inhere in a substance, but one substance cannot inhere in another substance. As Aristotle puts it, the parts of a substance cannot be substances. [14]

As put by Aquinas, substantial being and unity are from the substantial form. "Of one thing there is but one substantial being. But the substantial form gives substantial being. Therefore of one thing there is but one substantial form." [15] In this text, "thing" is understood as "substance."

Not all of Aristotle and Aquinas' commentators have agreed with this doctrine. The question of the unity or multiplicity of substantial form has been the subject of debate since the time of Aristotle. Particularly intense exchange occurred in Europe in the upper Middle Ages, when Aristotle's whole works were translated into Latin. During this era, such scholars as Avicenna, Averroes, Bonaventure, Roger Bacon and Duns Scot defended the plurality of substantial forms, while others, such as Albert the Great, Thomas Aquinas and Giles of Rome, defended the unity of substantial form. The presence of parts in wholes, the corporeal independence of intellect, the immortality of the soul and the mystery of the Incarnation posed significant problems for the unity of substantial form in the human being. [16]

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[14] Aristotle, *Metaphysica,* Z, 16, 1041a5.

[15] Thomas Aquinas, *Summa Theologiae,* I, q.76, a.4, sed contra.

[16] For a comprehensive treatment of the question, and of its continued relevance to philosophy, see D.A. Callus, "The Origins of the Problem of the Unity of Form" in *The Dignity of Science,* ed. J.A. Weisheipl (Washington: The Thomist Press, 1961) and his article "Forms, Unicity and Plurality of," in the *New Catholic Encyclopedia* (Washington: Catholic University of America, 1967), Vol. 6, pp. 1024-1027.

5. Presence by Powers: the Basic Doctrine

Having identified some key concepts and issues, we are now ready to examine the doctrine of presence by powers per se. How does Aristotle account for the evident retention of the qualities and powers of parts in natural wholes?

a) The Basic Texts

As noted earlier, Aristotle's fundamental account of presence by powers is found in his treatise *De Generatione et Corruptione*, where he specifies the way in which the elements are present in a complex substance. The elements are "the primary component immanent in a thing, and indivisible in kind into other kinds." [17] He speaks of the presence of elemental "constituents" in a "compound" or "mixed body," which is clearly understood to be a substance with one substantial form. [18] The account goes as follows:

[17] Aristotle, *Metaphysica,* V, 3, 1014a27.

[18] See Decaen, *Op. Cit.,* for his overview of the various translations in use that include "mixture," "compound" and "mixt." Clearly, Aristotle has in mind a true substance. The term "mixture" would be inappropriate today, since modern chemistry identifies this term with an aggregate of chemical substances which retain their separate identities, while a compound is that in which chemical elements have united to form a new chemical substance. The expression "compound" might also be confusing, as it conveys the notion of a substance, but not necessarily the substance of Aristotle. Finally, the term "mixt" is interesting, as it does not correspond to any contemporary scientific use. It could be useful as a philosophical term, to indicate the combination of former substances into a new substance, at all levels of combination. Pierre Duhem uses this term in his *Le mixte et la combinaison chimique: Essai sur l'évolution d'une idée.* (Paris: Gauthier-Villars, 1902). Notwithstanding these observations, we will use the term "compound" to signify a complex material substance, in line with Decaen's translation.

> Since, however, some things *are-potentially* while others *are-actually*, the constituents combined in a compound can 'be' in a sense and yet 'not-be'. The compound may *be-actually* other than the constituents from which it has resulted; nevertheless each of them may still *be-potentially* what it was before they were combined, and both of them may survive undestroyed.(…).(it is evident that the combining constituents not only coalesce, having formerly existed in separation, but also can again be separated out from the compound.) The constituents, therefore, 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' is preserved. [19]

In the compound, the constituents do not maintain their substantial form; rather, their "power of action" is preserved. As we will see below, this account is central, as it applies by analogy to all substantial integrations of material parts, from the "lowest" level of the elements all the way to the "highest" substances such as living human beings.

In his *De Mixtu Elementorum*, Aquinas exposes the same doctrine of presence by powers regarding the combination of the elements into mixed substances:

> We must find another way to state how the elements are, on the one hand, genuinely united and, on the other, are not entirely deprived of their nature but remain in the mixture after a special manner. It is the *active forces* (italics added) emanating from the substantial forms of the elementary bodies which are conserved in the mixed bodies. Consequently, the substantial forms of the elements exist in the mixture not with respect to their proper act (*non quidem actu)* but with respect to their active power (*sed virtute*). [20]

b) <u>The Meaning of "Dunamis" and "Virtute"</u>

What is this "power of action" (dunamis) [21] in Aristotle, which Aquinas refers to as "active forces" or "active power (sed virtute)?" This is a central problem for interpreting the doctrine. As reviewed by Decaen, a number of different interpretations have been proposed for

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[19] Aristotle, *De Generatione et Corruptione,* I, 10, 327b23-31.
[20] Thomas Aquinas, *De Mixtu Elementorum in Opuscula Philosophica* (Marietti, 1954), pp. 155-56. As translated by V. Larkin in "On the Combining of the Elements," *Isis* 51 (1960), pp. 67-72. As quoted by Nichols in "Aquinas' Concept of Substantial Form and Modern Science," *International Philosophical Quarterly* 36 (1996), p. 315.
[21] From the Greek text of *De Generatione*, as cited by Decaen, *Op. Cit.,* p. 284.

the terms *dunamis* and *virtute*, among both Aristotelian and Thomistic commentators. The meanings range from a state of nearly pure potency, as in the potency of prime matter, all the way to a direct reference to Aristotle's elemental powers. [22] These would be the powers explained at length in Aristotle's *De Generatione et Corruptione,* and in his *Meteorologica.*

We will return to this central issue in Section B, below. In the meantime, we will proceed with an interpretation that refers directly to Aristotle's elemental powers. Such an ancient reference might appear incompatible with a modern treatment of the question. Nevertheless, it is consistent with Aristotle's corpus in the philosophy of nature, as we will see below. In the long term, this approach appears to be the most reasonable, as we will see in the next subsection, along with our further developments in Chapter III.

c) Aristotle's Elemental and Mixed Powers

Aristotle's elemental powers include the active contrary powers of the hot and the cold, and their passive contrary counterparts, the dry and the wet. In *De Generatione et Corruptione,* and in the *Meteorologica,* Aristotle provides a thorough description of these elemental powers, along with their role in natural change, mixed powers, and mixed bodies.

Among the active powers, the hot separates the unlike and unites the like, and the cold separates the like and unites the unlike. [23] As interpreted here, these are the "power of action" and the "active powers" cited above in Aristotle and Aquinas' formulations of the doctrine of presence by powers. As for the passive powers, the wet is amenable to new determination, and

[22] Decaen, *Op. Cit.,* pp. 271-300.
[23] Aristotle, *Meteorologica,* IV, 1, 378b6-26.

the dry resists it. [24] The hot and the cold act on the dry and the wet, in various proportions and with various results. No single elemental power can be understood in isolation from the others.

For Aristotle, all natural or substantial change involves the work of these elemental powers. In the following account, the active powers of the hot and the cold are acting on the passive powers or "qualities" of the dry and the wet, which are referred to as the "matter:"

> True becoming, that is, natural change, is always the work of these powers and so is the corresponding natural destruction; and this becoming and this destruction are found in plants and animals and their parts. True natural becoming is a change introduced by these powers into the matter underlying a given thing when they are in a certain ratio to that matter, which is the passive qualities we have mentioned. When the cold and the hot are masters of the matter they generate a thing.(…). Destruction supervenes when the determined gets the better of the determining by the help of the environment. [25]

Aristotle specifies that the work of the hot and the cold includes the changes found in "plants and animals and their parts." Clearly then, the elemental powers are present in all substances and their changes, including the higher living substances.

The elemental powers combine to form mixed bodies or compounds by the mutual alteration of the elementary contraries, producing a mean. [26] The hot and the cold produce the "lukewarm," and the dry and the wet produce the "moist." [27] These terms can be understood figuratively: the "lukewarm" refers to a certain compromise between the separation and union of the unlike and of the like, and the "moist" refers to a certain mean between the dry – total resistance to change, and the wet – total amenability to change. Such mean powers explain the

[24] *Ibid*., IV, 1, 378b17-26.
[25] *Ibid*., IV, 1, 378b28-379a10.
[26] Is this mean a mathematical one? For a recent discussion of this question, see James Bogen, "Fire in the Belly: Aristotelian Elements, Organisms, and Chemical Compounds," *Pacific Philosophical Quarterly* 76 (1995), pp. 377-378.
[27] Aristotle, *De Generatione et Corruptione,* II, 7, 337b7-30.

characteristics of inanimate wholes, including minerals, metals, ice and mud, as well as the characteristics of homogeneous parts of living bodies, including bone, flesh and blood. [28]

Aquinas, in concurrence with Aristotle, holds that this mutual action of the elemental powers on each other leads to modified powers or qualities in the new mixed body. This is stated in the *Summa Theologiae*, in a question that treats of the human soul:

> Therefore we must say, in accordance with the Philosopher (*De Gener.* I. 10), that the forms of the elements remain in the mixed body, not actually but *virtually* (italics added). For the proper qualities of the elements remain, though modified; and in them is *the power* (italics added) of the elementary forms. This quality of the mixture is the proper disposition for the substantial form of the mixed body. [29]

The central role played by the elemental and mixed powers in the *De Generatione et Corruptione* and in the *Meteorologica*, along with direct references to these powers in Aquinas' related works, appears to support our interpretation of *dunamis* and *virtute*. Aristotle and Aquinas clearly refer to these powers in their formulation of the doctrine of presence by powers. The above developments therefore provide a description of the doctrine in inanimate things and certain parts of living bodies, as it appears to have been intended by Aristotle and Aquinas. We will now proceed to its application in whole living beings.

6. Presence by Powers in Whole Living Beings

In the *De Anima,* the doctrine of presence by powers is applied to whole living beings and their own specific powers – the vegetative, the sensitive, the locomotive and the intellective. Here, Aristotle first affirms that the soul is the unique substantial form of a living being. He

[28] Aristotle, *Meteorologica,* IV. This teaching is summarized in chapter 12, 390b3-13.
[29] Thomas Aquinas, *Summa Theologiae,* I, q.76, a.4, ad.4.

defines the soul as "the first grade of actuality of a natural body having life potentially in it." [30] The soul is not "added" to a substantial body already informed by a first form.

Aristotle then explains the manner in which the lower substantial forms of parts are present by their powers in the complex living substance, informed as it is by a single substantial form which is its soul. As per his habit, Aristotle proceeds by analogy: "The cases of figure and soul are exactly parallel; for the particulars subsumed under the common name in both cases – figures and living beings – constitute a series, each successive term of which potentially contains its predecessor, e.g. the square the triangle, the sensory *power* (italics added) the self-nutritive." [31]

As the square potentially contains the triangle, so the sensory *power* potentially contains the nutritive *power*. This series includes all of the powers of the living being, from the lowest to the highest. The elemental contraries are still involved in these living powers. For instance, the elemental power of heat is central to the power of nutrition. [32] As opposed to the elemental powers, however, the operation of the living powers does not lead outward to a new kind of substance. Rather, each of the nutritive, the augmentative, the reproductive, the sensitive, the locomotive, the appetitive and the intellective powers enriches the existing living substance while containing all of the lower powers within itself. Hence, the "lower" forms or souls are present by their powers in the whole.

Aquinas explicitly concurs with this position. In his commentary on the *De Anima,* he states that Aristotle, in his definition of soul, "…says primary act, not only to distinguish soul

[30] Aristotle, *De Anima,* II, 1, 412a28-29.
[31] *Ibid.,* II, 2, 414b28-32.
[32] *Ibid.,* II, 4, 416b28-29.

from its subsequent activities, but also to distinguish it from the forms of the elements; for these *retain their own proper activities* (italics added), unless impeded." [33]

7. Presence by Powers: A Summary

We can summarize our preceding developments on the doctrine of presence by powers in five points. First, every natural whole – mineral, plant, or animal – is composed of one substantial form united directly to prime matter. Second, the powers of natural wholes include the elemental – the hot, the cold, the dry and the wet – which combine into mixed powers in mixed bodies. Third, in living beings, higher powers are also present, such as the vegetative, animal and intellective powers. Fourth, the lower powers are present in the higher powers, as the hot is present in nutrition, and nutrition is present in sensation. Finally, in natural wholes, the substantial forms of the parts are not present by their proper act, but rather by their powers; the only substantial form present in act is the substantial form of the whole. All of this builds on the philosophical principles of substance, accident, act, potency, matter and form.

We will now examine attempts at applying the doctrine to the knowledge acquired through experimental science, since the last quarter of the XIXth century.

[33] Thomas Aquinas, *Commentary on Aristotle's De Anima,* transl. Kenelm Foster and Silvester Humphries (Notre Dame; IN: Dumb Ox Books, 1994), Lectio 1, 13, Cap. 229, p. 171.

B. *Applying the Doctrine*

1. Initial Difficulties: Ancient Terms, Ancient Powers

a) *The Issue of "Virtual Presence"*

Vocabulary has always been vital to scholarship, and the philosophical traditions of Aristotle and Aquinas are not immune to this reality. As noted above, translations from the original Greek and Latin texts have given us a number of expressions for *dunamis* and *virtute,* including "virtually" and "virtual presence." In today's English, "virtual" means "almost" or "just about." As pointed out by Christopher Decaen, this use of "virtual" introduces a vagueness corresponding to the contemporary meaning of the word. [34] "Virtually" does not convey the precise notion of powers, be they the contrary active and passive powers of the elements, or the vital powers of souls: the vegetative, the sensitive and the intellective.

This poses a major problem of interpretation. According to Decaen, "…many who purport to be explaining Thomas's account simply say that the elements are "virtually" in the mixed substance and leave it at that, as though the matter is thereby made clear." [35] Decaen lists and quotes William Kane, Bittle, Daniel Callus and R. Phillips, among many others. [36] He reports that an early-XXth century critic of the Thomistic position, Virgil Michel, was dissatisfied with the doctrine of virtual presence precisely because of its lack of clarity. According to Michel, neo-Thomists have "recourse to the obscure *virtual permanence* of the forms (of the elements).(…).(But) in the explanation of this phenomenon there is no common

[34] Decaen, *Op. Cit.,* pp. 271-300.
[35] *Ibid.,* p. 276.
[36] *Ibid.,* p. 276.

understanding among the authors. The attempts at an explanation of this virtual presence in general do not contribute to the honour of Scholastic clarity of thought, and are to some intelligible only when taken to be a vaguer way of merely saying that the old elements do as a fact reappear upon the corruption of the compound." [37] Christian Bonnet has also pointed out the vital need to specify the meaning of *virtute*. [38]

The English text of Aquinas' *Summa Theologiae,* taken from an authoritative current version, also gives us "…the forms of the elements remain.(…).not actually but *virtually*." [39] However, the notion of power is clearly explicitated in the rest of the passage: "…for the proper qualities of the elements remain, though modified; and in them is the power of the elementary forms." [40]

In an interpretation playing on the potency-act dichotomy, presence by powers is conceived as a certain kind of actual existence, in the sense that an effect is actually present in its cause. The whole here would be understood as the cause, and the recovered part – once recovered – would be understood as the effect. [41]

Overall, then, the English translation "virtually" for *dunamis* and *virtute* allows for a variety of interpretations of the doctrine of presence by powers. As we will see below, this complicates both the interpretation of the doctrine, and its application to experimental scientific knowledge.

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[37] Virgil Michel, "On the Theory of Matter and Form," *Ecclesiastical Review* 73 (1925), p. 252, as cited by Decaen, *Op. Cit.,* p. 276.
[38] Christian Bonnet, "The Unity of the Complex Individual Body," *The Modern Schoolman* 22 (1944), pp. 40-41.
[39] Thomas Aquinas, *Summa Theologiae,* I, q.76, a.4, ad.4.
[40] *Ibid*, I, q.76, a.4, ad.4.
[41] F.-J. Thonnard, *Op. Cit.,* pp. 446-447.

b) Outdated Elemental and Mixed Powers

The outdated elements and mixed bodies of Aristotle present a second key obstacle for the interpretation of the doctrine and its application to present times. This issue is closely related to the above difficulties regarding translation. The so-called "elements" of water, earth, air and fire, composed of pairs of elemental powers – the cold and the wet, the cold and the dry, the hot and the dry, and the hot and the wet – appear quite incompatible with the contemporary understanding of material reality. From the XVIth century onward, the experimental sciences of physics and chemistry have progressively consigned these ancient notions to the historical dustbin. As for the so-called mixed bodies – minerals, mud, ice, bone, flesh and blood – their explanation using mixed powers, has also been completely abandoned.

We now know that a whole living animal is made up of tissues, cells, organelles, macromolecules, simple molecules, atoms, electrons, protons and neutrons, all the way down to such "fundamental particles" as quarks and mesons. Gravitational, nuclear, electromagnetic, chemical and biochemical forces explain the functioning of these parts in whole organisms. [42]

Regarding the principles of substance and accident, the persistence of atomic nuclei in living beings and the retrieval of the same nuclei from these living beings – as evidenced by the use of radioactive tracers – seems to point to the ongoing existence of atomic nuclei *as such* and *in themselves*. They do not appear to be attributes of any other thing. They thus appear to enjoy substantial status as Aristotle defines it. Therefore, their substantial forms might very well be retained in greater wholes.

[42] As alluded to in our introduction, Atomism has a long history, stretching back to Democritus and his myriads of unbreakable minute entities, whence the term atom. Even prior to the discovery of modern chemical atoms, the scientific revolution saw the re-emergence of atomism as a philosophical doctrine, e.g. Pierre Gassendi and his atomistic ontology (see Robert Lenoble's "Origines de la pensée scientifique moderne," in Maurice Daumas, éd., *Histoire de la science* (Paris: Gallimard, 1957), pp. 507-509).

Radioactive iodine provides a classic example of such retention. When it is integrated into the thyroid of a living human being, the nucleus of this isotope continues to break down at the precise rate determined by nuclear physics. [43] Now radioactivity is overwhelmingly detrimental to life: it randomly destroys chemical bonds and molecules. This includes random mutations in the genetic material, which can result in disease and death of the organism.

This situation appears to be inconsistent with the presence by powers of radioactive iodine in the living body. If the doctrine was correct, the body's soul would possess all of the powers of the iodine atom, including its "radioactive powers." But how can the body's soul be expected to integrate powers that are so inherently destructive of life? Should not the part be altered as it is integrated into the whole, in such a way that it loses such lethal powers? Integrating the destructive power of radioactivity into the powers of the higher living form – the soul – appears contradictory.

There exist many other examples of parts that do not appear well suited to the living whole, and yet whose powers are retained. It would seem that disease in general points to the inappropriate retention of the powers of parts in the living whole. Cancer, which consists of the uncontrolled proliferation of cells, is a clear case in point.

Atomic, molecular, and even cellular parts seem to possess their own basic grade of existence and determination. Given all of the above, it might seem that obsolescence not only applies to Aristotle's elements and mixed bodies, but that it also applies to his ancient notions of hylomorphic substantial unity and presence by powers.

[43] The argument taken from George Salet, *Hasard et Certitude: Le Transformisme devant la biologie actuelle*, 2e édition. (Paris: Éditions Scientifiques Saint-Edme, 1972), pp. 451-455.

2. An Early Opponent: Félix Frédault

We will now explore the view that presence by powers is obsolete, and that matter actually possesses its own being, as per the vision of a late XIXth century critic of Aristotelian hylomorphism. This was a period of great ferment in the scientific and philosophical communities. The last decades of the century were the scene of profound transformation in physics, chemistry and biology, as electromagnetism, thermodynamics, organic chemistry and Darwinian evolution proposed bold new visions of material and human reality. These same decades were also marked by response to Leo XIII's Encyclical *Aeterni Patris,* calling catholic scholars back to Thomistic philosophical principles. The result was an intense dialogue between experimental scientists and philosophers.

Félix Frédault's contribution to the dialogue was acknowledged by leading Thomistic scholars of the period. [44] His criticism of the Aristotelian and Thomistic doctrine remains quite accessible, even at the beginning of the XXIst century. His particular merit was to formulate this critique in terms of the nascent chemical understanding of matter – an understanding that is still comprehensible today. In addition, his view on scientific scholarship since medieval times is still common.

Frédault took aim at the doctrine of a unique substantial form in the human being. According to him, the Catholic Church's insistence on Thomas' "unsatisfactory solution" had led to the isolation of Catholic philosophy from four hundred years of scientific development. Frédault saw an urgent need for the correction of the Aristotelian-Thomistic notion of substance

[44] Félix Frédault, *Forme et matière* (Paris: Emile Vaton, 1876). This work is cited numerous times by Albert Farges in *Matière et forme en présence des sciences modernes,* 5e édition (Paris: Berche et Tralin, 1900), pp. 164, 211, 219, 227, 228, 239, 241, 263.

so that this philosophy could reacquire its validity in the eyes of modern science and technology. [45]

Frédault's position can be summarized in three successive points: that matter has being of its own; thus, that the substantial form of a whole cannot eliminate or take over the being of matter; and finally, that the substantial forms of material parts are present in act in a natural whole, and not simply by their powers. In effect, he was adding fuel to the debate regarding the unicity or the multiplicity of substantial forms – a debate which had been quite intense at the time of Aquinas. [46]

Frédault affirmed that all things are combinations of material being and formal being. "Tout être naturel est composé de deux êtres unis dans l'unité: un principe de subsistance ou Forme substantielle, et un principe matériel de réalisation sensible." [47] For him, Aristotle's physics was fundamentally flawed precisely in its doctrine of presence by powers: "Malheureusement la science physique d'Aristote soutenait que les composants périssent dans le composé, et que les qualités matérielles seules subsistent." [48] He even saw a fundamental ontological injustice in Aristotle's doctrine. [49]

His criticism of the tradition was eloquent:

[45] Félix Frédault, *Op. Cit.*, pp. 3-6.
[46] See Callus, *Op. Cit.,* and F.-J. Thonnard, *Op. Cit.*, p. 843.
[47] Frédault, *Op. Cit.*, p. 259.
[48] *Ibid*., p. 265.
[49] *Ibid*., pp. 271-272. Frédault goes so far as to give a moral dimension to the issue: "Partout où peut régner le péripatétisme, l'inférieur, opprimé dans son être, demeure infécond dans ses propriétés, pendant que le supérieur ne vise qu'à opprimer, à écraser, à anéantir son inférieur pour le dépouiller de ses propriétés, mais aussi s'en servir sans les féconder; et de là, une lutte fatale entre tous les conjoints…" (p. 272).

> Demandez au chimiste, au physicien, au physiologiste, ce qu'ils pensent des composés, et ils vous témoigneront que les composants forment eux-mêmes le composé, que celui-ci est la résultante de leurs fonctions réciproques. Cherchez donc à faire entendre au chimiste, que l'eau ne contient pas l'hydrogène et l'oxygène qui la forment, et qui y sont représentés selon leur poids atomique; et que, dans tous les corps composés, il n'y a que les qualités des composants non leur être : il se demandera quelle mouche singulière vous a piqué.(…).quand vous diriez à un physiologiste que le fer, l'oxygène, l'azote, le charbon et les autres substances qui aident à former le corps, n'y entrent que par leurs qualités non par leurs substances, quand vous lui direz que sa science lui permet de parler des qualités, mais que la substance lui échappe et qu'il n'en peut rien dire, il vous répondra que le fer est du fer, et ainsi de chaque substance, et que récuser qu'il y ait du fer là où se montrent toutes les propriétés du fer, c'est de la pure déraison. [50]

The properties of iron are present, and so iron is present as a substance: what need have we for the presence of iron by its qualities? Clearly, Frédault's position is understandable in terms of contemporary chemistry, and it needs little if any updating to represent a typically contemporary objection to presence by powers.

3. Efforts to Apply the Doctrine, to Date

From the late XIXth century onward, in response to such positions as Frédault's, numerous attempts have been made to apply presence by powers to experimental scientific knowledge. [51] However, at the outset of the XXIst century, few if any of these attempts appear fully satisfactory. There are a number of reasons for this situation.

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[50] *Ibid*., p. 266.

[51] At the turn of the XXth century, a number of new philosophical journals were launched with the express purpose of promoting Aristotelian and Thomistic philosophy in the context of modern science. This included the *Revue Thomiste*, the *Revue de Philosophie* and the *Revue Néoscolastique de philosophie et de théologie.* The intent is quite evident in the opening article of the first issue of the *Revue Thomiste* (Paris: Lethielleux, 1893): «...notre intention formelle est...de remonter aux sources où S. Thomas lui-même a puisé, l'Écriture, la Tradition, l'Histoire, les sciences naturelles; de refaire, pour notre compte, la preuve de ses thèses, et de les soumettre, en les plaçant en face de l'objection des adversaires et des récentes découvertes de l'histoire ou de l'observation scientifique, à une critique sincère, mais respectueuse et impartiale.(...).les sciences...sont à nos yeux de précieux auxiliaires, et peuvent admirablement servir au philosophe...à préciser ses notions et à prouver ses thèses. » (p. 4).

In the first place, our understanding of atomic and subatomic processes has advanced rapidly throughout the XXth century. Absolute certitude regarding truly elemental powers has continued to elude us. Modern interpreters of Aristotle therefore cannot conclusively replace his outdated elemental powers. In such a setting, it appears easier to interpret the doctrine in terms of various grades of virtual or potential presence, as reviewed above. In this way, a comfortable distance can be established from elemental and mixed powers that clearly belong to a pre-scientific era. However, this has not excluded some attempts to apply the doctrine in terms of modern physical and chemical powers, as we will see below.

Late XIXth and early XXth century attempts at applying the doctrine, often present arguments in a complex format that can be difficult for the contemporary reader. Such arguments are juxtaposed with outdated scientific information. This would apply to the contributions of Albert Farges, Désiré Nys, Pedro Descoqs and Peter Hoenen. [52] Here again, we have equivocation between virtual presence, and some kind of potency. As noted by Decaen, Hoenen – through his translator – states that "…the forms of the elements are nor present in *pure potency* nor in act, but virtually." [53] There are also attempts to link the philosophical principles

[52] See Albert Farges' *Matière et Forme en présence des sciences modernes* and Chanoine Nys' textbook of *Cosmologie*, 4e édition (Louvain: Em. Warny, 1928). Both of these authors provide detailed arguments in favour of an Aristotelian and Thomistic understanding of inanimate matter, in conjunction with the physics and the chemistry of the times, including thermodynamics and crystallography. We must also note the critical *Matière et forme: quelques objections contre l'aristotélisme ancien et moderne,* by Augustin Périer (Paris: Librairie Paul Geuthner, 1923). Périer formulates a detailed critique of Aristotelian hylomorphism and of presence by powers, updating as it were the efforts of Frédault. In contrast, Fr. Pedro Descoqs' *Essai critique sur l'hylémorphisme* (Paris: Gabriel Beauchesne, 1924), which explores the question in great detail both philosophically and scientifically, defends traditional hylomorphism. This work is part of an ongoing series of exchanges dating back to the late XIXth century: Descoqs cites both Frédault and Périer. Peter Hoenen's *Cosmologia,* penned in Latin in the 1930's, is openly Thomistic. Presented in the form of complex syllogisms, it attempts to integrate some of the new findings in atomic physics. It has been partially translated into English as *The Philosophical Nature of Physical Bodies (the first and second parts of book 4 of the cosmologia),* transl. David J. Hassel (West Baden Springs, IN: West Baden College Press, 1955), and *The Philosophy of Inorganic Compounds: Part Three from Book Four of the Cosmologia,* transl. Paul Conen (West Baden Springs, IN: West Baden College, 1960). Finally, we cannot ignore Jacques Maritain's pronouncements on the question, which we will take up in some detail in Chapter II.

[53] Hoenen, *The Philosophical Nature of Physical Bodies,* p. 39, as cited, with emphasis added, by Decaen, *Op. Cit.,* p. 284.

of prime matter and substantial form directly to experimental scientific knowledge. This is problematic, since these principles exist well outside the scope of experimental science. Such approaches run the risk of producing inappropriate *concordism*es or *télescopages*. As we will see in Chapter II, Maritain is particularly concerned about this issue.

Although such a cursory treatment of these authors certainly does not do them justice – they can be quite convincing in their own right – it nevertheless appears as if their work would need to be presented anew for the contemporary reader. This would constitute a considerable task.

More recent applications of presence by powers do integrate scientific findings from the middle of the XXth century. Here, we find F.-J. Thonnard, Vincent Edward Smith, George Klubertanz and Jean Daujat. [54] However, the same challenges reappear: the use of the expression "virtual presence," and the attempt to link substantial form and prime matter directly to scientific evidence. For instance, V. E. Smith identifies prime matter with inertia, and substantial form with force and energy. [55] However, for his part, Richard Connell avoids altogether the notions of matter and form. [56]

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[54] F.-J. Thonnard, in his *Précis de philosophie en harmonie avec les sciences modernes,* provides detailed developments on the applicability of hylomorphism to the findings of modern physics, chemistry and biology. Vincent Edward Smith argues for the applicability of hylomorphism to modern physics, including thermodynamics and relativity, in a series of works including *Philosophical Physics* (New York: Harper, 1950) and *Science and Philosophy* (Milwaukee: Bruce, 1965). In his *Philosophy of Human Nature* (New York: Appleton-Century-Crofts, 1953), George Klubertanz argues for the unity of the human person as a substance, with a detailed treatment of the arguments in favour of multiplicity and unity. Jean Daujat also provides a general overview of the relation between scientific and philosophical knowledge, focusing on the compatibility of XXth-century physics and hylomorphism, in *Physique moderne et philosophie traditionnelle* (Paris: Desclées, 1958). He is cited in Georges Salet's *Hasard et Certitude: Le Transformisme devant la biologie actuelle*, a voluminous reply to Jacques Monod's *Hasard et Nécessité : Essai sur la philosophie naturelle de la biologie moderne* (Paris, France Loisirs, 1989).

[55] Vincent Edward Smith, *Philosophical Physics,* pp. 181-232.

[56] In *Substance and Modern Science* (Houston: The Centre for Thomistic Studies, 1988), Richard Connell argues for the existence of complex substances – inanimate, animate and intellective – in the tradition of Aristotle. In his introduction, he states that he is avoiding the terms form and matter in order not to confuse the issue in the light of modern knowledge.

Finally, some recent applications of presence by powers focus on the powers of natural wholes, as we understand them today. This includes the work of Wallace, Bobik and Storck. [57] Bobik and Wallace, in particular, propose contemporary equivalents to Aristotle's elemental powers.

Contemporary physics speaks of a number of elementary principles and particles involving contrariety and mutual action, as do Aristotle's elemental powers. In this context, it might appear reasonable to identify certain fundamental particles as elemental forms, since no further separation into any lesser entities appears possible. Bobik suggests quarks or mesons as candidates for elemental status. [58] Below this level, Wallace suggests that we would find the closest thing we can get to prime matter: "proto-matter" or mass-energy. [59]

With his "powers model" of natural wholes, which he applies to the whole range of entities from fundamental particles to human beings, Wallace offers the most comprehensive application to date of presence by powers to contemporary scientific knowledge. Here, the four basic forces of physics – the strong and the weak nuclear forces, the electromagnetic force and the gravitational force – are proposed as the elementary inorganic powers. [60]

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[57] Joseph Bobik provides a new translation of the key texts by Aquinas on presence by powers, along with an attempt at relating this teaching to particle physics in the late XXth century: *Aquinas on Matter and Form and the Elements: A Translation and Interpretation of the De Principiis Naturae and the De Mixtione Elementorum of St. Thomas Aquinas* (Notre Dame, University of Notre Dame Press, 1998). William Wallace, in *The Modeling of Nature: Philosophy of Science and Philosophy of Nature in Synthesis* (Washington: Catholic University of America, 1996), presents his "powers model" as a vast overview of the rising powers of inanimate, animate and human beings, in the Aristotelian and Thomistic traditions. Michael Storck provides detailed descriptions of natural powers, and an argument against atomism in modern chemical atoms, in "St. Thomas Aquinas on the Presence of the Elements in Living Substances" (draft Ph.D. diss., Catholic University of America, 2004).

[58] Bobik, *Op. Cit,* pp. 245-54.

[59] Wallace, *Op. Cit.,* p. 56.

[60] *Ibid.*, pp. 70-73. However, the potential contrary role of these elemental powers is not explored, and neither is the notion of a mean or average power. Joseph Bobik also departs from Aristotle's notion of the mean in his treatment of elementary contraries: "…it is not at all necessary for this mean quality to be anything at all like either of the extreme qualities; it may turn out to be a surprise of some sort, even a complete surprise." (Bobik, *Op. Cit.,* pp. 123-124). Christopher Decaen takes exception to this interpretation: "How a quality can be intermediate between two extreme qualities and yet be nothing like them is mystifying to me." (Decaen, *Op. Cit.*, p. 291). However, in defence of Bobik, we must note the ever-present problems of translation and vocabulary. The term "quality" does not convey the dynamic meaning of the powers of separation and unification, and of amenability or resistance to change.

As for the higher powers of plants, animals and humans, Wallace states that:

> A plant…does not have the powers of sensation and movement that are found in animals… Yet, as biochemistry has taught us, it cannot exercise its powers of nutrition and growth if it is not a physico-chemical composite endowed with the basic forces of the inorganic. Similarly, a brute animal…does not have the reasoning powers found in a human, but it cannot be an animal if it does not have vegetative powers as well as the physico-chemical powers on which the latter depend. And finally, the human being… requires all the powers…(mentioned to date) to carry out its life functions. The human substance is at once human, and animal, and plant, and inorganic. Thus the human form includes *virtually* (italics added) within itself an animal form, a plant form, and an inorganic form, and so it contains all their powers as power parts. [61]

As regards the interpretation of *dunamis – virtute*, Wallace, Bobik and Storck clearly favour a direct reference to the powers of natural wholes. This is evident in the above quote from Wallace. As regards Bobik's translation of Aquinas, Decaen states: "Bobik is the only translator to use the expression 'by power.'" [62] Finally, Storck provides lengthy developments in favour of this interpretation. [63]

In a recent article, John Keck identifies electromagnetic force with the contrariety at the foundation of natural change, making specific reference to Aristotle's *Physics*. [64] Bruno Webb, for his part, proposes gravity as tertiary matter and space as secondary matter. His account of gravity appears consistent with both Einsteinian physics and Aristotelian hylomorphism. [65] These are intriguing proposals, as they appear to speak of elemental active and passive powers.

Taken together, Wallace, Bobik, Storck and Keck apply the doctrine of presence by powers to the most recent scientific understanding of material reality. In particular,

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[61] Wallace, *Op. Cit.,* pp. 32-33.
[62] *Ibid.,* p. 275. Decaen is referring to Bobik, *Op. Cit.,* p. 122, and Wallace, *Op. Cit.,* pp. 70-73.
[63] Storck, *Op. Cit.*, pp. 38-39. Storck also develops the analogical aspect of the notion of presence by powers, pp. 60-63.
[64] John W. Keck, "The Natural Motion of Matter in Newtonian and Post-Newtonian Physics," *The Thomist* 71 (2007), pp. 529-54.
[65] Bruno Webb, "Hylomorphism, Gravity and Tertiary Matter," *The Thomist* 24 (1961), pp. 23-46.

contemporary equivalents are proposed for Aristotle's elemental powers, yielding a complete series of cumulative powers in natural wholes.

4. An Outstanding Issue

Although the latest efforts at applying presence by powers to experimental scientific knowledge appear promising, a fundamental question still remains. What is the specific principle that explains the assumption of the powers of lower forms, by higher forms? As put recently by Gordon Barnes, "…the Thomist has no explanation...(he) must leave all the particular, dateable assumptions of the powers of lower forms by higher forms as a brute, inexplicable fact. It just happens. That is tantamount to saying that it happens without a cause, and that is unacceptable." [66] This objection is in the same line as that formulated by Frédault,

[66] Gordon P. Barnes, "The Paradoxes of Hylomorphism," *The Review of Metaphysics* 56 (March 2003), p. 519. Barnes and Michael Storck are currently engaged in an exchange regarding virtual presence or presence by powers. According to Barnes, the presence of the powers of lower forms necessarily entails the continued presence of their own substantial forms. He holds that a number of substances coexist in complex natural wholes. "It is not one and the same substance that is said to have a plurality of substantial forms. Rather, what is claimed is that there exists a plurality of substances in the same time and place, each with its own substantial form." (*Ibid.,* p. 520). In the case of an atom inside a human being, he states that "In the very same region of space with such an atom, there is also something else, an atom-configured-part of a human being. This atom-configured-part of a human being is informed only by the substantial form of a human being. So, in summary, there is nothing that has more than one substantial form. Rather, there are two distinct but coincident entities that have two distinct substantial forms. What is the connection between these two coincident entities? Here is a suggestion: they share the same basic matter. So I am suggesting that one and the same "parcel" of basic matter can be informed by two distinct substantial forms and thereby compose two distinct substances." (*Ibid*., p. 520, note 25). In this way, there would be one substance – an atom; and another substance – the human being. Barnes' basic matter would be informed by a great number of substantial forms all at once. The substantial forms of the parts would not have to disappear in a complex whole. This sort of simultaneous substantial coexistence would extend to every level of being: from fundamental particles to atoms, to molecules, to cells, to organs, and finally to whole organisms. There would be no requirement for only one substantial form for all of these entities, and thus no need for a doctrine of presence by powers. Such a reading involves a number of conceptual and linguistic problems. What is the atom-configured part? What is this basic matter? According to Storck, this interpretation turns hylomorphism on its head, granting actual existence to a principle of pure potency (Storck, *Ibid.,* p. 185). Félix Frédault is not so far from us, in the end. Storck provides a recent reply to Barnes in "Parts, Wholes, and Presence by Power: A Response to Gordon P. Barnes," *The Review of Metaphysics,* 62 (2008).

more than a century earlier. In fact, Barnes ends up proposing a notion of basic matter that is quite similar to that of Frédault. [67]

In our own reading of Wallace, Bobik, Storck and previous authors on the subject, we have failed to unearth a conclusive answer to Barnes' fundamental objection. The cumulative nature of the powers of natural wholes is evident: the chemical powers are in the vegetative, and the vegetative in the sensitive. But why exactly do they all come to belong to the one substantial form of the whole? It is not sufficient to simply state that they are all the accidents of the one substance. How do they come to be such accidents, when they were evidently the powers of other forms when they existed in such separate wholes as molecules of water, or in living plants consumed as food? The general explanation of substantial change – with one substantial form taking the place of another – does not provide the detailed answer required here.

Cast in this light, it would seem as though Aristotle and Aquinas' philosophical formulations of the doctrine are either incorrect or incomplete.

C. Recent Alternative Readings of Presence by Powers

We will now consider alternative readings to the doctrine of presence by powers. A number of such readings have been developed in the wake of XXth-century science, with its significant advances in quantum physics, organic chemistry and molecular biology.

The three readings which we will explore each offer an alternative principle of material unity in living and non-living beings. The first reading proposes a superior, unifying form as a principle of unity; the second, structure; and the third, "subsidiary form." As in the case of

[67] Basic matter would be in some way a substance, if only an incomplete one (Barnes, *Op. Cit.,* pp. 515-17).

Frédault, these authors advance principles that seem more accessible to confirmation via scientific experience and observation.

1. Superior Forms as Immanent Principles of Organisation

The coexistence of a myriad of apparent substances within inanimate and animate wholes might lead one to seek a unifying principle that would reach beyond the traditional doctrine of matter and form. Jean Daujat and Georges Salet offer such a view.

Does the substantial form of the whole really end up taking on all of the powers of all of the substantial forms of the parts? As Salet puts it, it seems an astonishing feat for the human soul to assume the role of all of the substantial forms of all of the parts of the living body, even to the point of taking on the role of "déterminant physico-chimique" with respect to prime matter. [68]

According to Salet, the best meaning for the unity of substantial form would be that all of the parts of the composite are completely ordered to one superior end. The purposes of the parts would become the components of a superior purpose – that of the whole. [69] The purposes of the parts would no longer be supreme in their own right; they would be subordinated to the purpose of the whole.

Therefore, as regards the doctrine of presence by powers,

[68] Salet, *Op. Cit*., Appendice: "Un débat six fois centenaire," pp. 469-470.
[69] *Ibid.,* pp. 468-473.

> Les constituants sont bien réellement présents dans le composé avec leurs caractères propres mais ils sont assumés dans une organisation de leurs interactions sous la forme supérieure qui est le principe immanent de cette organisation et inclut en elle toutes leurs formes en les liant entre elles. Je ne crois pas que l'on puisse dire que la forme supérieure assume le «rôle» des formes des composants comme si elle l'exerçait à leur place mais elle assume en son organisation complexe les formes mêmes des composants qui n'exercent leur rôle que liées entre elles en cette organisation plus complexe dont la forme supérieure est le principe immanent. [70]

This position would resolve the problem of the ongoing presence of atomic and molecular parts, by affirming the continued existence of their substantial forms. These would not act independently but only insofar as they were linked together by the higher form. The lower forms would no longer play the role of ultimate formal principles of unity. That role would be played by the substantial form of the whole.

This is an interesting proposal in the context of an Aristotelian or Thomistic world-view, since it gives a key role to purpose or final cause. Such an approach presupposes that *telos* is at work throughout material reality. [71]

2. Structure and Substantial Form

Thanks to experimental science, we are gaining an ever-better understanding of the inner structure of material beings, from complex living organisms all the way down to fundamental particles. Structure appears to hold a key place in explaining unity. In this context, the unity of

[70] Jean Daujat, personal communication reported by Salet, *Op. Cit.*, p. 473.

[71] However, many would claim that the rejection of final causes in the physical sciences has been well underway since Descartes. This rejection spread to the life sciences with the success of Darwin's theory of evolution, and the elucidation of the biochemical nature of heredity in the mid-XXth century. In *Le hasard et la nécessité*, Jacques Monod insists on the fundamental role of randomness in life. He points out how the transfer of genetic information occurs via a seemingly random assignment of nucleic bases to individual amino acids (pp. 137-38, p. 177). He also emphasizes evolution via random mutation and blind natural selection. His work concludes with: "L'homme sait enfin qu'il est seul dans l'immensité indifférente de l'univers d'où il a émergé par hasard." For Monod, fundamental particles, atoms and molecules have combined in a random fashion over the course of billions of years, blindly evolving into successively higher forms of existence.

complex beings might be considered to be reducible to special structural relationships between their parts. These parts would be naturally moved from within to enter into these structures. [72]

In such a scenario, there would be no need for any overriding substantial form to assume the powers of all lower forms. Substantial unity would simply correspond to a natural and seamless structural integration, in which all of the structures and powers of the parts would be brought to bear in the structures and powers of the emergent whole. Given the proper conditions, each successive structure with its proper powers would naturally emerge from the proper combination and interaction of lower structures and powers. Such a situation would extend all the way up from the most fundamental entities to the whole under consideration.

It would appear that this is the view proposed by Patrick Chalmel. [73] Chalmel's intent is to demonstrate the applicability of Thomistic hylomorphism to the findings of modern biology, with particular emphasis on evolution and the cybernetics of biological organisms. He argues that there is no necessary gap between inanimate substance and living substance, but only a question of sufficient complexity and interiority. In one particular development, he states that the structure of the living being can be identified with its substantial form. [74]

Chalmel also draws on Salet and Daujat's developments on the unity of purpose in a complex whole, as cited above. The three affirm the importance of purpose or *telos* in the world; in this, they are united in their opposition to Jacques Monod. The emphases on unifying form and structure would naturally complete each other, in that particular structures are naturally associated with particular ends – a basic tenet of the biological sciences.

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[72] In spite of his emphasis on randomness, Monod himself focuses on the astonishing self-organizational power of macromolecules, in every chapter of his *Le hasard et la nécessité.*

[73] Patrick Chalmel, *Biologie actuelle et philosophie thomiste* (Paris: Téqui, 1984).

[74] *Ibid*., p. 128.

Overall, these two last readings, emphasizing organisation and structure, might be seen to work together as potential alternatives to the doctrine of presence by powers.

3. Nichols' Subsidiary Forms

With his "subsidiary forms," Terence Nichols recognizes the importance of unity in wholes, as well as the determining power of parts in these wholes. [75]

According to him, reductionism – the view that the parts explain the whole – has failed as an explanatory model in modern science. His key example is that of quantum non-locality, a phenomenon involving paired photons and their spin. Even when a large distance separates these photons, once one of them is observed, the other instantaneously acquires the same spin. For Nichols, this calls for some sort of holistic cause – a principle of unity. [76]

Nichols also wishes to recognize the active role of parts in the whole. He points out that the very nature of a living being appears to be determined by one of its parts: DNA.

In order to resolve the question of the parts and the whole, Nichols draws on Arthur Koestler's notion of nested wholes, involving the "holon: that which is both a part of a larger whole and itself a quasi-autonomous whole." [77]

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[75] Terence Nichols, "Aquinas's Concept of Substantial Form and Modern Science," *International Philosophical Quarterly* 36 (1996), pp. 303-318.

[76] *Ibid.,* p. 307. Nichols points out that modern physicists use language similar to Aristotle's to describe the situation. For instance, Werner Heisenberg states that "The probability wave introduced by Niels Bohr and others to describe the development of a quantum particle before interaction was a quantitative version of the old concept of 'potentia' in Aristotelian philosophy. It introduced something standing in the middle between the idea of an event and the actual event, a strange kind of physical reality just in the middle between possibility and reality (*Physics and Philosophy* (New York: Harper Torchbook, 1958), p. 41, as quoted by Nichols, *Op. Cit.*, p. 308). In Gary Zukav's words, "the quantum leap is from a multifaceted *potentiality* to a single *actuality*." (*The Dancing Wu Li Masters: An Overview of the New Physics* (New York: Bantam, 1975), p. 75, with italics by Nichols, *Op. Cit.*, p. 308).

[77] Nichols, *Op. Cit.,* p. 313. He is drawing from Koestler's "Beyond Atomism and Holism – the Concept of the Holon," in *Beyond Reductionism,* ed. Arthur Koestler and J.R Smythies (Boston: Beacon Press, 1969), pp. 192-227.

Nichols proposes an alternative to Aristotle's unique formal principle: he offers us the notion of a hierarchy of "subsidiary" forms: [78]

> I would propose, in light of modern research on the relation of wholes and parts, that his (Aristotle's) philosophy could be "creatively completed" in the direction of what might be called *subsidiarity*.(…). I propose that a third category be added to the categories of substantial and accidental form, namely, that of *subsidiary form.* A subsidiary form would inform a subsidiary whole.(…). Such a form would stand part way between a truly substantial form, which informs an independently existing substance, and an accidental form, which inheres in another. Such would be the form of those organs that are wholes yet also parts (the heart, liver, eye, etc.), of the water molecules in the body, and of the DNA molecules in the cells. As the example of water shows, a form may function either as a substantial form or as a subsidiary form, depending on whether its composite, water, exists as an independent substance or as an inclusion in a more comprehensive form. [79]

With subsidiary forms, there would no longer be any need for the virtual presence of lower forms: they would be actually present, precisely as subsidiary forms. This would apply to a "vast range of entities." [80] Virtually all forms would be subject to subsidiary status, except for the forms of the higher plants and the animals.

Although it appears to offer concurrence with contemporary scientific knowledge, this solution involves some basic ontological issues:

> Such a project may well entail a modification or replacement of substance-accident language in order to achieve a more precise conceptual system. For substance-accident language, which is based on common sense, is not really adequate to describe fully the complex relation between parts and wholes which modern science has exposed. Is the water in the blood (1) a separate substance, (2) a part of the substance of the body, or (3) an accident? If we hold (1), we have destroyed the unicity of substantial form in the body and made it into an aggregate. If (2), then we have to maintain that the water has undergone a substantial change and become something else, which clearly is not the case. If (3), again we have to argue that the water has become something else, a part of another. Similar problems arise in explaining the action of a gene. [81]

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[78] *Ibid.,* pp. 309-314.
[79] *Ibid*., pp. 315-316.
[80] *Ibid*., p. 316.
[81] *Ibid.,* p. 316.

The suspension of substance-accident language has serious implications. We will return to this issue in Chapter III.

4. Science Appears to Challenge Philosophy: What of their Relation?

The above applications, critiques and alternate readings of presence by powers represent attempts to articulate the doctrine in the light of modern scientific knowledge, from the late XIXth century onwards. In some of these efforts to understand the role of parts in wholes, some central philosophical notions are brought into question.

As we saw above, Aristotle posits substance and accident as fundamental modes of being for material existence. His material substances are composed of prime matter and substantial form, related as potential being to actual being. If one substance is one being, there can be no other substantial forms "in act" – by definition. The lower forms of parts are therefore not present in act, but rather "by their powers."

This doctrine remains problematic. Even in the recent case of Wallace's "powers model," there does not appear to exist a detailed answer to Barnes' objection regarding the "brute, inexplicable fact" of the assumption of lower powers by higher forms.

We have explored the critical position of Frédault, as well as the alternative positions of Daujat, Chalmel and Nichols. Essentially, these readings pose a direct challenge to the doctrine's philosophical underpinnings. In particular, the substantial form of the whole is no longer in an exclusive relation of actuality with respect to prime matter. As for substance-accident language, it is found inadequate, as stated explicitly by Nichols.

All of this brings up some difficult questions. Can such philosophical doctrines as substance and accident, act and potency, and matter and form be swept aside by the evidence produced by experimental science? The underlying issue appears to be that of the relation between an Aristotelian philosophy of nature and modern experimental science. This will therefore constitute the focus of Chapter II.

Chapter II. Philosophy of Nature and Experimental Science

Introduction

In this chapter, we will explore the relationship between philosophy and science, in response to the challenge posed to the doctrine of presence by powers by a certain reading of modern scientific knowledge.

During the XXth century, with ever-greater developments in the natural sciences, scholars have addressed the issue of the pertinence of a philosophy of nature. Questions such as the following have been raised: does the philosophy of nature, as a properly philosophical discipline, still have its place? What is its relation to metaphysics and to science? In particular, to what extent are philosophy of nature and experimental science connected or distinct, and how do they relate to each other? In response to this last question, we might identify three possible relations: competition, incommensurability, and applicability.

The philosophy of nature and experimental science share the material world as their common object, and sense observation as their common source. One might therefore conclude that they offer competing views of the world. Given the evident fruitfulness of experimental science, the latter might be expected to prevail on certain detailed questions. Philosophy would then be expected to modify certain of its positions and formulations. Such a view is reflected in the critical and alternative readings of the doctrine of presence by powers reviewed in Chapter I.

Alternatively, one might emphasize the difference between the philosophy of nature and experimental science, as radically distinct modes of intelligibility. There would be little point in trying to relate their findings. In fact, such efforts would run the very real risk of producing

unfortunate *téléscopages.* Such an emphasis challenges our project of a discourse on presence by powers and modern science. Still, the effort to distinguish first in order to unite later, might throw vital light on the question. We will therefore explore this position as expressed by its leading XXth century Thomistic proponent, Jacques Maritain.

Finally, one might emphasize the applicability of Aristotelian philosophy to the findings of experimental science. This was the position of the River Forest School: there is "no contradiction between an essential and a structural explanation of substance." [1] We will pursue this third approach in the works of Benedict Ashley and William Wallace.

In this chapter, we will first explore the general relation between philosophy and modern science. In Section A, we will note the dependence of science on metaphysical underpinnings, as emphasized by Duhem and Meyerson. We will review the Aristotelian theoretical sciences, again noting the role of metaphysics. We will then build on De Koninck's distinction between absolute philosophical definitions and operational scientific ones. We will conclude that philosophy underlies science by defining the latter's "givens" in absolute and universal terms.

In Section B, we will explore the relation between philosophy and science in terms of their knowledge of the nature, accidents and powers of a substance. We will review Maritain's distinction between "dianoetic" and "perinoetic" knowledge and compare this to the River Forest position, as represented by Ashley and Wallace. Although we will not resolve this argument, we will make the point that both philosopher and scientist know natural wholes through their powers: the vegetative, animal and intellectual.

We will conclude that a discourse on presence by powers need not abandon its philosophical foundations and definitions, and that a further conceptual effort may yet yield the

[1] William Wallace, "Hylomorphism," *New Catholic Encyclopedia* (Washington: 1967), Vol.7, p. 284.

key to the satisfactory application of presence by powers to contemporary scientific knowledge. This further effort will constitute the focus of Chapter III.

A. Philosophy and Experimental Science in General

1. Philosophy, Science and the Role of Metaphysics

Over the past five centuries, experimental science has progressively gained its independence from metaphysics and the philosophy of nature. By the end of the XIXth century, a mechanistic, reductionist and positivist approach seemed on the verge of relegating metaphysical inquiry to the historical record. However, the relevance of such inquiry was maintained; it was affirmed with new vigour at the turn of the XXth century, both within the neo-Thomistic movement and at its periphery. The latter included scholars such as Pierre Duhem and Émile Meyerson.

Duhem, a historian of science, argued that the ancient Aristotelian tradition had actually nourished the scientific revolution, and that scientific enquiry depends on philosophical underpinnings. "Pour trouver les titres qui établissent sa légitimité, la théorie physique les doit réclamer de la métaphysique…La croyance en un ordre transcendant à la physique est la seule raison d'être de la théorie physique." [2] Meyerson, for his part, held that "La métaphysique pénètre la science toute entière, pour la raison bien simple qu'elle est contenue dans son point de départ… Tout en professant souvent en théorie un positivisme rigide, les savants dans leurs

[2] Charles Duhem, *La théorie physique: son objet et sa structure* (Paris: Chevalier et Rivière, 1906), pp. 453, 509.

exposés impliquent en réalité toute une métaphysique." [3] These authors emphasized that science is in no position to evaluate itself, and that it necessarily builds on philosophical and logical principles such as existence, identity, and the principle of non-contradiction. [4]

These positions are akin to those of the Thomistic tradition, inspired as it is by Aristotle. The Stagirite defined three theoretical sciences: natural science, mathematics, and metaphysics:

> (…). the sciences are concerned with *forms,* and the hierarchy of the sciences corresponds exactly to the hierarchy of forms in the real world in various degrees of separation from matter. Thus natural science studies the forms of bodies along with the bodies themselves in which they exist. Mathematics studies, apart from matter, forms of bodies that must exist in matter (e.g. lines, circles, numbers). Theology studies forms that are entirely separate from nature (e.g., God). [5]

Natural science, according to Aristotle, would correspond to abstraction from the individual case, while still dealing with sensible matter. This is the study of changeable being as changeable. Mathematics would correspond to abstraction from the sensible qualities into the realm of quantified substance. This is the study of being as quantifiable, but still not separable from matter. We note today that mathematical physics would correspond to a mixed discipline between natural science and mathematics. Aquinas was aware of this kind of knowledge, citing optics as an example. Finally, theology – understood by Aristotle as the study of being as being – would correspond to abstract objects of thought that exist separate from both matter and quantity, and thus separate from sensible qualities. [6]

Incidentally, this comprehensive view of the theoretical sciences allows us to see how they might operate together. The metaphysician and the philosopher of nature would both agree

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[3] Émile Meyerson, *Identité et réalité* (Paris: Payot, 1912), p. 349, p. 515. See also *De l'explication dans les sciences* (Paris: Payot, 1921).
[4] The contributions of Duhem and Meyerson are highlighted throughout Jean Daujat's *Physique moderne et philosophie traditionnelle* (Paris: Desclées, 1958).
[5] Armand Maurer, *St. Thomas Aquinas: The Division and Methods of the Sciences*, 4th revised edition (Toronto, Pontifical Institute of Medieval Studies, 1986), pp. XV-XVI.
[6] *Ibid.,* p. XXXII.

that the ontological principles of substance, accident, matter and form cannot be evacuated from any true understanding of a natural whole and its powers. These metaphysical foundations must remain present to the intellect. Therefore, we might best carry out a reflection on substance and powers in the light of metaphysics. The recourse to metaphysics offers the distinct advantage of rooting our reflection in a properly philosophical terrain, something that Maritain saw as eminently necessary. [7] In addition, a metaphysical reflection in the Aristotelian tradition inevitably leads to the central question of definitions, which we will now take up as such.

2. Charles De Koninck on Definition

In his reflection on the particular problem of presence by powers, Georges Salet laments that "Ce qui engendre des frictions et des malentendus, c'est le *langage* des philosophes qui n'est pas toujours celui de la science." [8]

For Charles De Koninck, the situation is clear: the languages of philosophy and science are different because they use different kinds of definitions. In mathematical physics, definitions are either interpretations of symbols chosen, or descriptions of how the measure-numbers are obtained, e.g. "…length is when we take a measurement of…" [9] These could be called operational definitions. By contrast, philosophy seeks to tell what a thing is absolutely, and not

[7] As we will see in the next subsection, Jacques Maritain held that the proper philosophical terrain was a vital condition for progress on these questions.
[8] Georges Salet, *Hasard et certitude: le transformisme devant la biologie actuelle* (Paris: Éditions Scientifiques Saint-Edme, 1972), p. 458.
[9] Charles De Koninck, "Random Reflections on Science and Calculation," *Laval Théologique et Philosophique* 12 (1956), p. 85.

merely what a name or symbol is intended to stand for. This distinction is essential, and "…it lies hidden to the scientific view which is satisfied with operational definitions." [10]

We can now see how the terms form, substance, matter and power can be so problematic. Under the influence of Francis Bacon, the physical sciences have come to focus on measurable observation and operational definitions for these terms. For instance, form is associated with measurable relationships. We can operate on nature thanks to such relationships. Matter and substance, for their part, can be conflated with quantifiable mass. Thanks to the science of dynamics, mass can be operationally defined and measured in terms of resistance to acceleration under a force. This occurs in the scientific object expressed by the formula " F = ma " which is Newton's second law of motion. Likewise, work is defined as force applied over a distance, and energy as the capacity to do work. Even the term power has been granted an operational definition: it is the energy expended per unit of time.

All of these operational definitions take change, measurement, time and causality for granted. Now metaphysics offers what appear to be absolute definitions for these givens. These definitions can be understood by strict deduction from such basic ontological principles as act and potency.

For instance, "The fulfillment of what exists potentially, in so far as it exists potentially, is motion." [11] This definition covers all manner of change from the substantial to the purely cosmetic, including local motion, increase and diminution. As for quantity or measure, it is defined as that which can be understood in terms of the unit. The definition of time is then derived from change and measure: it is the measure, or the "number of motion in respect of

[10] *Ibid.,* p. 85. A similar position is developed by Émile Simard in his *Nature et portée de la méthode scientifique* (Québec: Presses de l'Université Laval, 1958), p. 43: "Une entité physique…est donc définie par la description de son procédé de mesure."
[11] Aristotle, *Physica,* III, 1, 201a11.

'before' and 'after.'" [12] As for causality, in the field of *ens mobile*, it consists of two couples: the material and the formal, and the efficient and the final. Each member of each pair can be related as potency to act, with the final cause designated as the "cause of causes." [13] Key metaphysical definitions can thus be derived from basic ontological principles, for the realities that are assumed by experimental science.

The above development implies that philosophy offers a foundation for experimental science; that it consists of a distinct mode of knowledge; and that it is a more universal and ultimate mode of knowledge than experimental science.

The universal notions of experimental science, e.g. matter and energy, are only universal in a qualified sense. They are ultimately defined by reduction to physical measurements, and in order to measure, one must assume change, time and spatial extension. By contrast, such philosophical principles as act and potency are universal in an unqualified sense. The understanding of act and potency, although it is based on the experience of change, time and space, requires no return to experimentation to confirm measurements or the calibration of instruments. When metaphysics explores the concept of being, abstract notions such as change can be developed via deductive reasoning without the need for experimentation. By contrast, experimental science must continually verify its course by direct recourse to experiment – which combines both experience and measurement.

Given these distinctions, we can be confident that philosophical notions possess their own validity, in that they under gird the work of experimental science. Properly developed, such notions should not be toppled by evidence from the experimental sciences. Given this

[12] *Ibid.*, IV, 2, 219b2.
[13] Thomas Aquinas, *Commentary on the Metaphysics of Aristotle* (Notre Dame, IN: Notre Dame University Press, 1998), Lesson 3: "All Causes Reduced to Four Classes," Par. 782, p. 288.

conclusion, we can now return to the powers of natural wholes in the context of philosophy and modern science.

B. Knowledge of Natures, Substances, Accidents and Powers

1. Maritain's Distinction: Dianoetic Versus Perinoetic Knowledge

As regards the relation between an Aristotelian or Thomistic philosophy and experimental science in the XXth century, the contribution of Jacques Maritain is *incontournable*. His "dianoetic-perinoetic" distinction affirms a fundamental difference between philosophy and experimental science. [14] Maritain holds that philosophical knowledge can penetrate to the essence of things, while experimental scientific knowledge cannot reach this essence. He therefore calls the former "dianoetic" and the latter "perinoetic."

In the following quote from Maritain, we note the central role played by the powers of natural wholes. The powers of rationality and sensitivity are used as examples of properties and accidental forms. Maritain contrasts proper accidents, which would be accessible to philosophy, to common accidents, which would be the object of experimental science:

> When the mind holds a property in the strict and philosophical (ontological) sense of this word, a difference of being is attained, an accidental form is seized in its intelligibility, and, by it, the essence (as human nature by rationality, or animal nature by sensitivity). That is what happens in dianoetic intellection. But in the other case the properties in the strict sense remain inaccessible. Clusters of sensible accidents (common accidents), grasped exclusively as observable or measurable, are taken *in their place* (like the descriptive "properties," density, atomic weight, melting point, boiling point, spectrum of high frequency, etc., which serve to distinguish bodies in chemistry). These descriptive

[14] As noted in our introduction, Jacques Maritain's principal developments on this question are found in *La philosophie de la nature,* (Paris: Téqui, 1935, 2e edition) and in *Distinguer pour unir, ou Les degrés du savoir.* In the latter, the applicable material is found in the early sections and chapters. This work is available in G.B. Phelan's translation, *Distinguish to Unite or The Degrees of Knowledge* (New York: Charles Scribner's Sons, 1959).

> characters are given the name "properties," but the import of the name is here quite different and no more philosophical (ontological) than that of the word "substance" in the usage of chemists. They are at once exterior signs and masks of the veritable (ontological) properties. They are empiriological properties, substitutes for properties properly so called. The mind cannot decipher the intelligible in the sensible, it makes use of the sensible itself in order to circumscribe an intelligible core that escapes it. It is then that we say that the form is too immersed in matter to fall within the grasp of our intelligence. It is impossible by such properties to attain in any degree whatever the substantial nature in itself or in its formal constitutive. It is know not by signs which manifest it, but by signs which hide it. That is what happens in perinoetic intellection. [15]

For Maritain, the philosophical properties of the substance truly manifest its essence, whereas the common scientific properties end up masking the essence. Scientific knowledge therefore cannot attain the essence and must remain outside of it – hence the term "perinoetic." Chemists only know common properties, which substitute for the philosophical properties. [16]

In the same line of thinking, one might say that the chemist as chemist does not seek an essential understanding of the human being as one being; neither can he achieve such knowledge. The chemist as chemist is therefore uninterested by the doctrine of hylomorphic substantial unity or presence by powers. [17]

Given such a situation, the project of exploring the applicability of the doctrine of presence by powers – a philosophical doctrine – to our modern knowledge of molecules and their "empiriological" properties, appears doubtful. Such a project appears to be ill thought-out, ignoring as it does such a basic distinction between the dianoetic and the perinoetic: the knowledge of proper accidents versus the knowledge of common accidents. In addition, Maritain reminds us that below the level of human nature, a Thomistic philosophy of nature itself

[15] Jacques Maritain, *The Degrees of Knowledge* (New York: Charles Scribner's Sons, 1959), pp. 206-207.
[16] *Ibid.*, pp. 205-206.
[17] George Klubertanz, *The Philosophy of Human Nature* (New York: Appleton-Century-Crofts, 1953), pp. 26-27.

cannot reach to the knowledge of any natures. [18] If we cannot grasp atomic substantial forms, how will we ever be able to explore their presence by powers in higher beings?

Maritain points out that hylomorphism and its related doctrines cannot be evaluated on modern scientific grounds:

> It is.(…).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 pseudo-confessions from them! Let them never be cajoled! Yet let them be interrogated.(…).it is only by relating them to philosophical knowledges already acquired from another source and with philosophical principles, that an intelligible content appropriate for philosophy can be drawn from them. Only then is it possible to discover and judge whatever ontological value they may possess and to use them either to put the conclusions of philosophy in contact with sensible verifications and the latest results of experimental science, or to confirm or establish properly philosophical facts – the starting points of philosophical demonstrations. [19]

The above passage is consistent with his earlier work on the subject, *La philosophie de la nature*, where he provides more details on hylomorphism and science*:*

> C'est une illusion de croire qu'en faisant appel à des faits scientifiques sans les assumer dans une lumière philosophique on pourra dirimer un débat philosophique. C'est là, me semble-t-il, l'erreur du Père Descoqs dans son livre sur l'hylémorphisme. Il a recueilli avec une érudition très méritoire un grand nombre de faits scientifiques, mais de ces faits tels quels il a voulu tirer des conclusions philosophiques. Les faits scientifiques bruts ne disent rien sur la question de la matière et de la forme; si donc on les laisse à l'état brut, la seule conclusion honnête c'est de dire qu'on ne sait rien, puisqu'ils ne disent rien; il n'est pas étonnant que l'enquête du P. Descoqs débouche sur des résultats décevants. [20]

Although Maritain is dismissing a much more complex and complete body of work than he makes it appear to be – Descoqs develops at length the distinction between science and philosophy – Maritain's point remains: scientific facts must be philosophically treated in such a

[18] Maritain, *Op. Cit.*, p. 177.
[19] *Ibid*., p. 58.
[20] Maritain, *La philosophie de la nature,* pp. 136-137. He is commenting on Pedro Descoqs' *Essai critique sur l'hylémorphisme* (Paris: Gabriel Beauchesne, 1924).

way that they take on a philosophical significance. The task would be to draw intelligible content appropriate for philosophy from scientific notions such as molecules and atoms, by relating these to philosophical notions such as substance and accident, already acquired through philosophical reflection.

2. River Forest: Experimental Science Attains Natures

The River Forest School, active in the 1950's and 1960's, provides a different Thomistic view on the relations of the philosophy of nature and experimental science. The School emphasizes the common nature of these disciplines. We will explore this point of view through the works of Benedict Ashley and William Wallace.

Ashley holds that the philosophy of nature and experimental science constitute one unique science of nature. The experimental scientist studies natural units, e.g. the quasar, the blackbird, the bacterium or the proton. He seeks causal explanations of natural structure and natural function:

> (The) questions which a scientist asks in trying to describe something are nothing other than the famous 'four causes' of Aristotle. What is called 'structure' (with its correlative 'composition' and 'organization') is the material and formal causes. What is called 'function' (with its correlative 'agent' and 'product') is the efficient and final causes. I am sure I will be accused of 'concordism' in making these equations. No doubt there are differences in connotation (I have already indicated the mechanistic overtones of the modern terms), but are not the relations named by these terms the same? [21]

The four causes would yield an understanding of change in the natural unit. Therefore, the principle of change in that whole – its nature or essence – would be the ultimate target of the scientist.

[21] Benedict Ashley, "Does Natural Science Attain Nature or Only the Phenomena?" in *The Philosophy of Physics,* V.E. Smith, ed. (Jamaica, NY: St. John's University Press, 1961), p. 73.

According to Ashley, the scientific mind is interested in, oriented towards essential causes having to do with the nature of things. Furthermore, since natural units are sought out, the question of unity would be of interest; and so a general philosophical explanation of unity would be of interest to the scientist as a thinker.

Ashley comments on Maritain's dianoetic - perinoetic distinction as follows:

> It is easy to invent distinctions; harder to justify them.(…). Just what is this perinoetic intellection? Clearly it is not mere knowledge of the phenomena by the senses, since it is intellection.(…). Maritain is insistent that perinoetic knowledge does somehow signify the existing nature precisely because he knows that if it did not somehow attain the ontological reality it could not be intellection at all. Nor could it merely be an insight into the phenomena as phenomena, because Maritain understands very well that it is the very nature of sensible accidents that they have their existence only in a substantial nature without which they cannot be or be understood. Thus perinoetic knowledge ought to be described as an understanding that a nature exists without knowing what it is.(…). Now Maritain wishes us to believe that the modern scientist somehow suspends his intellectual inquiry at this point as regards the nature of the thing he studies, and then proceeds to deal with the phenomena as phenomena. Why should the scientist frustrate in this way the natural drive of his mind to understand nature? [22]

Ashley holds that experimental science reaches the nature of things through qualities that do not mask the essence of the thing, but rather express it. This expression may be unclear and imperfect; it may be irreducible to a compact definition such as "rational animal;" but it is still the expression of the essence of the thing. [23] On this particular point, Ashley criticizes Maritain in the interpretation of their common master Thomas Aquinas. Ashley insists that we use common accidents to define things; that these common accidents are accessible to science; and that they speak of the essence:

[22] *Ibid*., p. 76.
[23] *Ibid*., pp. 76-82.

> St. Thomas makes quite clear, in a text which Maritain quotes but fails to apply, that the human mind does not know the essence of anything sensible (including man apparently) except through its *common accidents* which are not properties in the strict sense. The properties in the strict sense are known only *after* the thing has been defined and through the definition. Nevertheless, these common accidents (color, shape, size, and especially activity) taken as a group are sufficient to be equivalent to a property because they are a sign of the essence revealing it to our intelligence. [24]

We note Ashley's emphasis on what he refers to as the common accident of activity. This accident speaks directly of powers, which are proper accidents of a substance. Might we not thereby gain access to the nature of the substance, as per the ancient adage, *agere sequitur esse*?

Evidently, a random list of the physical and chemical characteristics of a chemical body – as per Maritain' lines on perinoetic versus dianoetic knowledge, quoted above – does not provide an essential definition of such a body. But Ashley holds that a unified explanation of these characteristics by proper causes does move us towards an essential definition. In describing the way in which the nuclear and electronic structure of silver atoms determine their interactions, which are manifested in such properties as melting and boiling points, crystal structure, electrical conductivity, thermal conductivity, density, etc., we are moving towards the identification of the principles that determine silver as silver. If this is not knowledge of inherent causes, or a kind of knowledge of the nature and the essence of silver, then what is? [25]

Ashley's position is shared by a number of earlier francophone thinkers friendly to the Thomistic tradition. Jean Daujat states: "le chimiste moderne parvient à reconnaître des essences

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[24] *Ibid.,* p. 78. In note 22, Ashley cites from Thomas Aquinas' *Commentary on the Posterior Analytics,* 13, n.7: "… since essential forms are not known to us *per se,* it is necessary that they should be manifested through some accidents, which are signs of such a form, as is evident in *Metaphysics VIII.* However, it would not do to take accidents proper to that species, since it is necessary that such (accidents) should be demonstrated through the definition of the species; but the form of the species must be made known through other more common accidents; and thus the differences so taken are called as it were "substantial," because they are used to declare the essential form; they are however more common than the species, because they are taken from certain signs which follow on the superior genera."

[25] *Ibid*., p. 79.

ou natures déterminées, celles des corps purs, comme l'a bien vu M. G. Bachelard (*Le pluralisme cohérent de la chimie,* p. 40): « (…) On ne pourra…dominer le caractère individuel des corps matériels saisis dans l'expérience commune que si l'on arrive à les classer en essences séparées bien assurées de fonder solidement en dépit des approximations de l'expérience les propriétés qui les distinguent. » " [26] Daujat continues with: "Meyerson le dit nettement (*Cheminement de la pensée*, pp. 164, 168): « …ce à quoi tend la physique moléculaire (…) on est obligé de supposer une pénétration réelle de l'essence des corps telle qu'elle est représentée dans la physique moderne par la notion de structure moléculaire ou atomique. » " [27]

Ashley is "sure that there are some philosophers who will still be completely dissatisfied with this sort of knowledge of the nature of silver. Perhaps they are touched by that Cartesian *angelicism* which Maritain long ago so brilliantly exposed as characteristic of the modern mind. For such a mind knowledge is true only when it has the clarity of mathematics, a clarity sufficient to be the basis of a *deductive* system." [28]

Ashley affirms the value of scientific knowledge in spite of its initial lack of clarity and deductive explanatory power. He affirms the common nature of scientific and philosophical enquiry:

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[26] Daujat, *Op. Cit.,* pp. 67-68.

[27] *Ibid*., pp. 69-70.

[28] Ashley, *Op. Cit.*, p. 79. In fact, Maritain distinguishes dianoetic knowledge from perinoetic knowledge on the very basis that philosophy is essentially deductive, while experimental science is essentially inductive. (Maritain, *The Degrees of Knowledge*, pp. 32-33). Philosophy and mathematics are deductive sciences that proceed from causes to effects: "These sciences are properly called sciences of explanation…*propter quid est*, in the terminology of the ancients. They reveal to us intelligible necessities immanent in the object; they make known to us effects by principles, or reason for being, by causes." (p. 32). By contrast, the experimental sciences are assigned to the inductive domain: they make causes known by their effects, "and so these causes or reasons are not made known in themselves but in signs which, for us, are substitutes for them…they fall short of explanation properly so called." (p. 33). However, shortly thereafter, Maritain severely qualifies this deductive-inductive distinction. He grants that "philosophic knowledge.(…).does not lay hold of substantial essences by themselves but through their proper accidents.(…).it only proceeds deductively by being constantly revitalized by experience (the "analytic-synthetic" method)" (p. 33).

> We are dealing, therefore, not with an absolute difference between one kind of human knowledge in which is attained a perfectly ordered knowledge of a nature (dianoetic intellection) and another which knows nothing of nature except its existence (perinoetic intellection), but rather with a type of intellection proper to man by which he knows at first confusedly and then more and more clearly as he continues his investigation of both the existence of a natural unit and its nature.[29]

At this point, we might make a comment regarding the historical settings of Maritain and Ashley's reflections. Chemistry and physics progressed significantly from 1900 to 1960; during this time, the scientific understanding of natural molecular and atomic wholes improved considerably. Maritain could not appreciate this improvement to the same degree as his River Forest successors: his basic position was forged in the 1920's, while theirs was developed in the 1950's. This historical difference might help to explain their different viewpoints.

In any case, the drive to philosophical knowledge is clearly acknowledged by Maritain, who agrees that the mind is not satisfied with purely descriptive, quantitative knowledge: "Obviously, such knowledge remains by essence insufficiently explicative. The mind cannot rest content with it." [30]

Ashley summarizes his own view as follows:

> The whole of man's effort to understand the natural world forms one integrated enterprise and flows from one single *habitus* of the intelligence, because although we are studying many different kinds of natural units, we understand them all only as they are made known to us by their sensible changes and stabilities. Whether it is a man, an oak-tree, or an atom of silver that we study we know them only as we see them develop and endure. The individual scientist selects one or another area of nature to study, but *if he is well-trained and reflective* (italics added) he sees the thing he studies as a particular type of changing thing intelligible in the light of its own essential nature and of wider characteristics common to all things that change. [31]

[29] Ashley, *Op. Cit.*, p. 78.
[30] Maritain, *The Degrees of Knowledge,* p. 174.
[31] Ashley, *Op. Cit.*, p. 81.

Finally, Ashley addresses mathematico-deductive science, which is of great concern to Maritain. Ashley affirms that this is not a new kind of natural science, but rather an instrument used by the natural scientist. In other words, it does not define a new kind of knowledge. [32] The activity of the natural scientist would not be bound or defined by quantified observation. Therefore, he can still move to seek an understanding of natural units through essential causes.

Ashley's focus on causes brings to mind an earlier principle of distinction between natural philosophy and experimental science: ultimate, unobservable causes versus proximate, observable ones. [33] But what is it that would link these two kinds of causes, along with the realms of philosophy and experimental science?

3. The Powers and the Application of Philosophy to Scientific Knowledge

With respect to our original concern regarding the doctrine of presence by powers, it is important to note that the disagreement between Maritain and Ashley is expressed in terms of the powers of natural wholes: intellection, sensation, etc.

In *The Modeling of Nature,* William Wallace addresses these powers throughout the hierarchy of natural wholes, with his aptly-named "powers model." In the following text on the formation of table salt from sodium and chlorine, he speaks of the powers of sodium and chlorine, and concludes with a position similar to Ashley's:

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[32] *Ibid*., p. 81.

[33] James A. Weisheipl, ed., *The Dignity of Science: Studies in the Philosophy of Science presented to William Humbert Kane, O.P.* (Washington: The Thomist Press, 1961), p. xxv. Weisheipl reports that at the turn of the XXth century, Cardinal Mercier distinguished between proximate and ultimate causes, and that this position was influential in the Thomistic tradition. It has been recently expressed by Michael Augros in "Reconciling Science with Natural Philosophy," *The Thomist* 68 (2004), pp. 105-41.

> Natural forms at the level of the inorganic have activities in this sense, and so they can be regarded as agents or efficient causes. Properly speaking, however, they do not act directly but rather through the powers or potentials with which the elements are equipped. A particular gravitational potential, as manifested in the atomic weight of 23, and a particular electric potential, as modeled by the single electron in its outermost shell, serves to explain the natural activities of sodium. These also help us understand why the specific nature of this or that element is not an empirical concept, although it is readily grasped by anyone who has experience with the element. The characteristics and properties of the inorganic result from the potentials that produce them; such potentials are inferred directly, and with them, the unifying form that lies at their root. This form, or nature, is then revealed progressively and more fully as one gains greater familiarity with the activities and reactivities that originate from it.[34]

In general, the powers or "potentials" of a natural whole appear to be known to the experimental scientist. These would include the powers of living wholes, as identified by Aristotle: nutrition, growth, reproduction, sensation, locomotion and intellection. In fact, the same natural powers might receive both a philosophical and an experimental scientific definition.

In philosophical terms, nutrition is known as the taking in of a different substance and transforming it into one's own substance, for the purpose of maintaining one's own substantial existence. In terms of experimental science, it appears as if the same power is defined as the taking in of specific chemical nutrients across the cell membrane for the purpose of maintaining cellular metabolism, homeostasis and life. As for reproduction, it is philosophically defined as the bringing into existence of a living substance of like kind, while it is scientifically defined as the production of viable, fertile offspring of the same kind as the parent(s). Sensation's classic philosophical definition is as follows: "the power of receiving into itself the sensible forms of things without the matter." [35] In terms of experimental science, sensation can be defined as the collection of information about the environment through physical and chemical media, e.g.

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[34] William Wallace, *The Modeling of Nature* (Washington: Catholic University of America, 1996), pp. 52-53.
[35] Aristotle, *De Anima,* II, 12, 424a17.

sound waves, radiation and molecules, via specialized sensory organs and neural impulses. Locomotion and intellection can receive a similar pair of definitions.

Clearly, philosophy and science would be dealing with the same powers, but in different terms, using different definitions: ontological versus operational, as per De Koninck's distinction.

At this point, we should note that Maritain is not rigidly camped in a position that denies any common ground between philosophy and experimental science. His "empirioschematic" sciences provide an understanding of biological powers that draws the knower towards philosophical knowledge. According to Maritain, biology is able to do this insofar as it remains synthetic and non-mathematized. [36] This synthetic and non-mathematized biology was that of Aristotle. Maritain himself states that such an empirioschematic science could therefore provide the critical juncture between philosophical knowledge and mathematized science. [37]

We can conclude this chapter with two key statements. First, that philosophy can hold its own in terms of absolute or ontological definitions that subtend the work of science. And second, that the powers of natural wholes, as the common objects of philosophy and science, hold great promise as the point of application of the former to the latter. We can therefore return to our original concern: the application of the philosophical doctrine of presence by powers to the facts of experimental science. In the following chapter, we will therefore re-examine in what way lower forms might remain by their powers, within scientifically known natural wholes.

[36] Maritain, *La philosophie de la nature,* pp. 108-111.
[37] *Ibid*., pp. 127-131.

Chapter III. Presence by Powers and Contemporary Science: A Proposed Resolution

Introduction

In this third and final chapter, we return to the question of the relationship between the philosophical doctrine of presence by powers and the contemporary scientific understanding of natural wholes.

As seen in Chapter I, in spite of longstanding efforts to apply the doctrine to scientific knowledge, certain authors consider that the doctrine is inadequate. The critical and alternate positions we reviewed cannot be easily dismissed. Frédault insists that material entities – especially the atomic – possess a substantial existence of their own. Barnes, for his part, objects to the inexplicable assumption of the powers of lower forms into higher forms. In response to such criticism, Chalmel, Daujat and Salet focus on structure and higher form as unifying factors for complex wholes. Lastly, Nichols proposes subsidiary forms for parts that retain their formal role within a complex whole. As a whole, such contributions appear to constitute a significant challenge to the philosophical doctrine of presence by powers.

In response to this challenge, we addressed the relation between philosophical and scientific knowledge in Chapter II. We noted that philosophy's definitions can under gird the operational definitions of experimental science. We also explored the question of the modes of knowledge of philosophy and science: do both reveal the essence or nature of a substance? Although we did not resolve this issue, we noted that the classical powers of animate bodies – the vegetative, the animal and the intellective – are known to both philosophy and experimental

science, and therefore that these powers might constitute a vital point of application of philosophy to scientific knowledge.

In this final chapter, we will note the existence of an ontological explanation for the doctrine of presence by powers; we will apply this explanation to the hierarchy of powers in natural wholes; and we will suggest answers to the issues and positions outlined in Chapter I.

In Section A, we will return to subsidiary forms, which call for the suspension of substance-accident language. We will suggest that subsidiarity applies to the powers of natural wholes. We will then note that Aquinas states that these powers, considered as accidents of substance, exist in a relationship of mediated inherence. We will adopt this position, and thereby retain both subsidiarity and substance-accident language. We will also provide an answer to the objection regarding the taking up of lower powers by higher forms.

In Section B, we will apply mediated inherence to the powers of natural wholes, as they are understood by contemporary experimental science. We will note how mediated inherence is consistent with proximal formal and material relations between the powers. We will then outline these relations in some detail in the human being. In the case of biochemical and lower powers, we will follow in the line of William Wallace, adopting contemporary equivalents to Aristotle's elemental and mixed powers. We will also recognize that such an adoption involves certain epistemological and historical issues.

Finally, in Section C, we will see how the application of mediated inherence to the contemporary powers of natural wholes casts further light on the critiques and alternate readings reviewed in Chapter I, as well as on some specific issues encountered in Chapter II. We will provide specific replies to the critiques, including the arguments put forward by Frédault, Daujat, Salet and Chalmel, as well as Nichols' further arguments in favour of subsidiary forms.

A. The Mode of Existence of Powers in Natural Wholes

1. Subsidiary Forms and Substance-Accident Language

Among the alternatives explored in Chapter I, we noted that Nichols' notion of subsidiary forms constitutes a promising avenue: it appears to accommodate the recent findings of physics and cellular biology. Meanwhile, in Chapter II, we reviewed the relation of philosophy and science, emerging with some confidence that philosophical definitions can under gird science.

This confidence in philosophy is tested precisely by Nichols' subsidiary forms. Indeed, as noted in Chapter I, these entities introduce an intermediate ontological state between the fundamental categories of substance and accident. "A subsidiary form.(...).would stand part way between a truly substantial form, which informs an independently existing substance, and an accidental form, which inheres in another." [1] Subsidiary parts would exist both in themselves and in the greater whole.

This is not a new move: it is akin to that of Averroes, the medieval interpreter of Aristotle. In his own attempt to understand the presence by powers of elements in mixed bodies, Averroes also proposed an intermediate kind of form for the elements, somewhere between substance and accident: "Being close to prime matter, they are an imperfect sort of form.(…). They are, so to speak, substantial forms that behave like accidental forms when they are in a compound." [2] Even Albert the Great, Aquinas' mentor, was partial to this solution. [3]

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[1] Terence Nichols, "Aquinas's Concept of Substantial Form and Modern Science," *International Philosophical Quarterly* 143 (1996), pp. 316-317.

[2] Steven Baldner, "St. Albert the Great and St. Thomas Aquinas on the Presence of Elements in Compounds," *Sapientia* 54 (1999), pp. 51-52. In note 33, p. 53, Baldner refers to a promising text in Spanish on this topic by Mario Enrique Sacchi: *Contrariedad y equilibrio en la naturaleza de las substancias materiales*. (Buenos Aires: Basileia, 1997), pp. 97-107.

[3] *Ibid*., p. 52.

Unfortunately for Nichols, Averroes and Albert, there is no possible intermediate between substance – that which inheres in itself, and accident – that which inheres in another. This point of logic is emphasized by Aquinas in his response to Averroes in the *De Mixtione*, [4] and also in the *Quaestiones de Anima*: "Nor is there anything which is intermediate between a substance and an accident, as Averroes also supposed." [5]

Nichols suggests that in order for subsidiary forms to be conceivable, substance-accident language would have to be modified or replaced, "For substance-accident language, which is based on common sense, is not really adequate to describe fully the complex relation between parts and wholes which modern research has exposed." [6]

Granted, the findings of modern research must be reckoned with, but the replacement of substance-accident language is a very high price to pay, both logically and ontologically, in ancient and modern times. Substance-accident language appears to provide an essential philosophical foundation for scientific knowledge. How is it possible to structure and classify knowledge – including scientific knowledge – without distinguishing a subject from its qualities?

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[4] Thomas Aquinas, *De Mixtione Elementorum,* as cited in Baldner, *Op. Cit.*, p. 52. Aquinas' counter to Averroes is also taken up in the contemporary context by Lawrence Dewan, in "The Importance of Substance," in *Form and Being: Studies in Thomistic Metaphysics* (Washington: Catholic University of America Press, 2006).

[5] Thomas Aquinas, *Questions on the Soul (Quaestiones de Anima),* transl. James H. Robb (Milwaukee, Marquette University Press, 1984), q.9, ad.10, p. 133.

[6] Nichols, *Op. Cit*., p. 316. Nichols himself refers to the medieval problem of the unicity or plurality of substantial form: "Perhaps it was on account of the inadequacy of substance-accident language that medieval thinkers could not solve the problem of whether the number of substantial forms in a body is one or many. For if they argued that they are many (as Scotus did), they were open to the charge that the unity of the whole is then merely accidental, as is the case with aggregates. But if they argued that there is only one substantial form (as Thomas did), they had to argue that, when the body dies, it then has a different substantial form (or set of substantial forms) and is therefore a different substance (or collection of substances) and no longer the same body." (p. 316).

2. The Mediated Inherence of Powers

a) An Answer to the Challenge of Subsidiary Forms

Subsidiarity sheds important light on the parts and the whole, while substance-accident language is indispensable. We propose to retain both of these aspects of reality, as follows.

First, we would suggest that subsidiarity applies not to the forms of parts, but rather to the very powers of natural wholes. As seen in Chapter I, these powers exist in a closely related series. Whether we speak of the ancient power of heat, or of a contemporary analogue such as electromagnetism, this lower power appears to exist both in the part – whether it be termed a mixed body or an atom – and in the greater whole that possesses the power of nutrition. Likewise, the vegetative power of growth appears to exist both in the parts of an animal, and in the whole animal that possesses the higher power of sensation. In general, the powers of natural wholes exhibit subsidiarity: lower powers exist both in a part, and in the higher powers of the whole. [7]

Second, we propose that the subsidiarity of these powers expresses a relationship of mediated inherence. In such a relationship, the powers all remain as accidents, and there is no need to posit a third, intermediary mode between substance and accident.

With regard to the relationship between the powers of a natural whole, Aquinas states: [8]

[7] In Chapter I, we reviewed Aristotle's understanding of cumulative powers, according to which the sensory power contains the nutritive, etc.

[8] We are indebted to David P. Lang for the following three citations, which he points out in his "Aquinas and Suarez on the Essence of Continuous Physical Quantity," *Laval Théologique et Philosophique* 58 (2002), p. 574.

> …a subject can be modified by one accident through the intermediary of another accident, as a body has the accident of color through the medium of its surface. And thus one accident arises from its subject through the mediation of another; and one power arises from the essence of the soul through the mediation of another power. [9]

As regards the order in which the powers arise from the soul, Aquinas first distinguishes between the order of perfection and the order of generation: "The order of a soul's powers is consequent upon the order among their objects. But order can be considered from two points of view: either with reference to the level of perfection, as intellect has a priority over sense; or with reference to the mode of generation, and in this way sense has a priority over intellect…" [10]

He further elaborates on this distinction, as follows:

> Now the dependence of one power on another can be taken in two ways: according to the order of nature, forasmuch as perfect things are by their nature prior to imperfect things; and according to the order of generation and time; forasmuch as from being imperfect, a thing comes to be perfect. Thus, according to the first kind of order among the powers, the intellectual powers are prior to the sensitive powers; wherefore they direct them and command them. Likewise the sensitive powers are prior in this order to the powers of the nutritive soul. In the second kind of order, it is the other way about. For the powers of the nutritive soul are prior by way of generation to the powers of the sensitive soul; for which, therefore, they prepare the body. The same is to be said of the sensitive powers with regard to the intellectual. [11]

This distinction, between the order of perfection or nature and the order of generation or time, provides a central key to the whole problem of presence by powers. In the first place, it provides an ontological explanation for presence by powers. According to the order of nature, the higher powers mediate the presence of the lower powers within the natural whole, and a single substantial form can therefore possess all of the powers of the whole without resorting to additional forms. Secondly, the distinction corresponds to the difference between philosophical and scientific knowledge, as understood by Maritain. Philosophy yields knowledge regarding

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[9] Thomas Aquinas, *Op. Cit.,* q.13, ad 8, p. 170.
[10] *Ibid.*, q.13, ad 10, p. 170.
[11] Thomas Aquinas, *Summa Theologiae,* I, q.77, a.4, body.

the order of nature, in which the whole is prior to the part, and the perfect is prior to the imperfect. Experimental science, for its part, tends to follow the order of generation and time, in which parts unite to form wholes, and in which a thing, "from being imperfect, comes to be perfect." Finally, the orders of perfection and generation account for the role of the whole and the role of the parts, which are both required for the proper understanding of complex wholes, as emphasized by Nichols.

Aquinas states that the more perfect powers mediate the inherence of the less perfect. This is expressed in terms of accidents in general: "For the more perfect accidents are closer to substance, and through their mediation the other accidents are in substance." [12] This is the case even though the imperfect precedes the perfect, as potency precedes act, in the order of generation. The underlying principle – that act precedes potency in the order of being – is taken from Aristotle. [13]

The mediation of lower powers by higher powers is not explicitly stated in the basic texts on the doctrine of presence by powers. Nevertheless, mediation, as presented by Aquinas, provides an ontological explanation for the way in which the powers relate to each other, to the substantial form, to the soul, and to substance. With respect to the ranked powers of a human being as seen by Aristotle and Aquinas, the intellectual power mediates the inherence of the sensitive; these higher powers in turn mediate the inherence of the vegetative; and the inherence of the mixed and the elemental powers proceeds likewise.

[12] Thomas Aquinas, *Commentary on Aristotle's Physics*, transl. Blackwell, Spath, Thirkel (Notre Dame, IN: Dumb Ox Books, 1999), Book III, Lecture 1, par. 280, p. 142. Aquinas is speaking here of the less perfect accident of relation, which is in a subject by the mediation of the more perfect accidents of quantity, action and passion.
[13] Aristotle, *Metaphysics,* IX, 8.

With mediated inherence, since all of the subsidiary powers of the whole remain as accidents, there is no need for subsidiary forms somewhere between substance and accident. We can therefore preserve substance-accident language.

b) An Initial Answer to Barnes and Frédault

The ontological principle of mediation offers a first answer to Gordon Barnes and Félix Frédault's criticisms of the doctrine of presence by powers, which we reviewed in Chapter I.

Barnes and Frédault both wonder how it is that the powers of a lower form – e.g. water – are "brutally" assumed into the powers of a higher form – e.g. the soul of a bacterium. What is the precise explanation? Mediated inherence provides the answer. Expressed in modern terms, the chemical powers of water do not come to belong directly to the bacterial soul, but rather by the mediation of the appropriate higher powers of that soul. The powers of reproduction, growth and nutrition would mediate the inherence of these chemical powers of water. There would be no further need for the substantial form of water, because the powers of water would be in the bacterium by the mediation of proximate, appropriate higher powers. Substantial change would thus proceed by gradual steps, and not by huge, inexplicable and violent bounds.

The notion of lower powers existing through the mediation of higher powers can appear counter-intuitive. This is because lower powers such as chemical bonding appear more permanent than higher powers such as nutrition and reproduction. When an animal dies, the power of chemical bonding remains in action, while the animal's nutrition and reproduction are evidently no more. But this is in the order of time and generation. Considered in terms of the order of perfection, when the animal dies, a substantial change occurs; the animal soul and its

higher powers are no more. A new chemical substantial form has come into being, and the lower chemical powers are now the characteristic, highest powers of that new form. These chemical powers have not subsisted per se apart from substance. They are now the most characteristic accidents of a new chemical substance, which is informed by a new chemical substantial form.

Likewise, when lesser wholes become the parts of greater wholes, the lower powers are no longer the powers of the parts per se, but rather the powers of the one substantial whole and its substantial form, through the mediation of appropriate powers. There is no longer a need for the lower forms of the parts. We therefore have a solution to the problem of "orphaned" lower powers in higher wholes, and of the seemingly unjustified disappearance of the lower forms. The lower forms are present by their subsidiary, and mediatively inhering powers, in the substantial whole.

In the following sections, we will pursue the application of presence by powers and mediated inherence, to the powers of natural wholes as we understand them thanks to contemporary science.

B. Mediated Inherence and Contemporary Powers

1. The Powers of the Human Being: Formal and Material Relations

Mediated inherence speaks of an intimate relationship between the powers of a natural whole. In terms of formal causality, one would expect that a higher power would have an immediate determining effect on the lower powers whose inherence it mediates. Conversely, a

lower power would be expected to provide the proximate matter – the immediate means and field for determination – to the higher power through which it inheres. [14]

In terms of the ancient understanding of powers, such formal and material relationships appear to be present among the powers of natural wholes. As per Aquinas, in the order of perfection, formal relations are present: "the intellectual powers are prior to the sensitive powers; wherefore they direct and command them." [15] On the other hand, in the order of generation and time, "the more imperfect powers are principles with regard to the others; thus the soul, according as it has the sensitive power, is considered as the subject, and as something *material* (italics added) with regard to the intelligence." [16] For his part, Aristotle held that lower powers – viz, heat – were materially necessary for the higher powers – viz, the vegetative powers. [17]

The general sequence of human powers known to Aristotle and Aquinas consisted of the intellective, the animal, the vegetative, the mixed and the elemental. Granted, the ancients' precise explanation of formal and material influences between these powers – through the various humours and the mixed powers of the lukewarm and the moist – have long been abandoned. However, the experimental sciences identify many of the same powers in the human being, and these sciences provide us with proximal formal and material relations between these powers. In turn, these relations are consistent with the mediated inherence of the powers. We will explore this situation in the following pages.

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[14] In Aquinas' example of mediated inherence in the *Commentary on the Physics*, cited above, the accident of relation is the proximate matter for the more proper accidents of quantity, action and passion, just as these three have a determining effect on relation.
[15] Thomas Aquinas, *Summa Theologiae,* I, q.77, a.7, body.
[16] *Ibid.,* I, q.77, a.7, body.
[17] Aristotle, *De Anima,* II, 4, 416b28-29.

We have chosen to follow a downward sequence of powers. This constitutes a more philosophical progression: from the whole to the part, according to the order of nature. This is the sequence followed by George Klubertanz in his *Philosophy of Human Nature.* [18] We note that in the *De Anima,* Aristotle proceeds in the opposite direction, progressing from the vegetative powers through to the animal and the intellective. He has previously addressed the elemental and mixed powers in the *Meteorologica* and *De Generatione et Corruptione.* This is also the direction followed by Wallace in the development of his "powers model" in *The Modeling of Nature.* Nevertheless, the downward sequence best emphasizes the unity of the natural whole, and the mediating role of the higher powers on the lower.

The contemporary sciences of psychology, biology, chemistry and physics provide us with a detailed downward sequence of natural powers in the human being. With respect to the highest powers, contemporary science has no quarrels with the ancient listing. The sequence starts off with the intellective power, along with its own appetitive power. These powers formally influence the powers of sensation, which therefore provide the proximate matter for thought and love. [19] The powers of sensation, which we share with the other higher animals, include memory, imagination and the common sense, which unifies the particular senses of sight, smell, taste, touch and hearing. [20] We can also speak of psychological powers involved in such activities as dreams, which Aristotle also treated, although we will not review his contribution on this matter.

The sensitive powers in turn formally influence, and materially depend on a host of other animal powers which we identify today according to their system: the endocrine, the cardiovascular, the immune, the respiratory, the digestive, the musculo-skeletal, the reproductive,

[18] George Klubertanz, *The Philosophy of Human Nature* (New York: Appleton-Century-Crofts, 1953), pp. 336-343.
[19] *Ibid.*, pp. 336-338.
[20] *Ibid*., pp. 338-343, citing the *Summa Theologiae,* I, q.78 and q.80.

etc. These systems make use of particular organs such as the endocrine glands, the heart, the lungs, the stomach and the individual muscles of the body. From the organ level we then proceed downward to cells, in which we find the five particular powers of vegetative life. These include reproduction, growth and nutrition, as originally specified by Aristotle. To these, Wallace suggests we add metabolism and homeostasis, in line with XXth century science. [21]

Below the five vegetative powers of cells, we plunge into the lowermost powers of the human being. These correspond to Aristotle's ancient mixed powers of the lukewarm and the moist, which arise from the interaction of his elemental powers. The situation today is much more complex than in his time: we have unearthed many levels of such "mixed powers," prior to reaching tentative candidates for elemental status. We will explore these powers in some detail, as follows.

According to cell biology, the five higher cellular powers – reproduction, growth, nutrition, metabolism and homeostasis – are in a direct form-and-matter relationship with the biochemical powers of cellular organelles. For example, the crowning power of reproduction materially depends on information storage in the chromosomes, located in the cell nucleus. Reproduction also depends on growth, metabolism and homeostasis, which in turn materially depend on respiration in the mitochondria, protein synthesis in the ribosomes, and lipid synthesis in the Golgi apparatus. [22] Within each organelle, the formal and material relationships continue downward. For example, respiration makes use of the Krebs cycle and the electron transfer chain, which in turn make use of the powers of specific macromolecules such as enzymes.

Moving further down, the powers of macromolecules formally influence and materially depend upon the lower powers of chemical bonding. These include so-called hydrogen bonding,

[21] William Wallace, *The Modeling of Nature: Philosophy of Science and Philosophy of Nature in Synthesis* (Washington: Catholic University of America, 1996), pp. 80-87.
[22] Bruce Alberts et al., *Molecular Biology of the Cell* (New York: Garland Publishing, 1983), pp. 16-17.

covalent bonding and ionic bonding. For example, hydrogen bonds materially influence the overall structure of proteins and DNA, while covalent bonds play a key role in the detailed structure of these macromolecules. In turn, the power to form such chemical bonds materially depends on the atomic power to form and to complete electronic orbitals. For example, in the formation of a water molecule, the half-filled electronic orbitals of individual oxygen and hydrogen atoms provide the material basis for the bonds that form the molecule.

Finally, the atomic power of orbital formation materially depends on the lower power of electromagnetism: orbitals consist of negatively charged electrons, which remain in close proximity to their positively charged atomic nucleus. At this scale of matter, electromagnetic powers tend to overshadow gravitation, which is another of the fundamental forces linking all material entities in our universe.

In terms of contemporary physics, gravitation and electromagnetism appear to have no smaller components. For instance, gravitation is not reducible to lower powers, and electrons do not split into smaller particles. These forces might therefore qualify as elemental as per Aristotle's own definition. [23] As noted above in Chapter I, William Wallace has proposed that gravitational and electromagnetic powers are reasonable candidates for elemental status in a contemporary hierarchy of natural powers.

The cumulative unity of all of these human powers is reflected by the recent emergence of a new discipline: psychophysics. This specialty focuses on the link between the mind's activities and electromagnetic phenomena. Materially speaking, electromagnetic events are clearly necessary for human thought. But electrons and protons per se are not capable of intellection and love; neither are they capable of nutrition and reproduction. In this context, mediated inherence provides an alternative to strict reductionism. In the order of nature – by

[23] Aristotle, *Metaphysica,* V, 3, 1014a27; as cited above in Chapter I.

which powers inhere in the soul – the highest and most characteristic human powers are irreducible to the lower powers. Conversely, in the order of time and generation, the lower powers are recognized as materially indispensable to the higher powers.

2. Epistemological Issues

The integration of the lower powers – biochemical, molecular, atomic and subatomic – into the powers of the human soul, presents some epistemological problems. In the first place, we know such powers through scientific models. This is not the case for the higher powers of intellection, sensation and reproduction, whose results fall within the grasp of our senses, and which are therefore directly subject to philosophical abstraction. If we only know the lower powers via models that are subject to revision, can such powers be treated, philosophically, with the same confidence as powers that are known directly through our senses?

The biochemical, molecular and atomic powers include the powers of enzymes to participate in biochemical change via their molecular powers, and the powers of atoms to form molecules via atomic orbitals. In this first decade of the XXIst century, these powers are known to us in sufficient detail, and with sufficient confidence, to be considered established. Our biochemical, molecular and atomic models are no longer subject to fundamental revision. In addition, the use of such models does not invalidate the observation of these powers in action, using sophisticated instruments that extend the reach of our senses. Therefore, such a situation should not pose a radical problem in terms of philosophical abstraction. [24]

[24] This brings us back to the Maritain-Ashley issue. Maritain, along with other modern scholars, would insist that the recourse to scientific models cannot hope to substitute for the knowledge of the thing in itself. « …l'usage des modèles a en sa faveur l'efficacité que ne possède pas la recherche de ce qui est propre à la chose. C'est que le perfectionnement des modèles, grâce à des nouvelles données mathématiques ou technologiques, permet de nous rapprocher progressivement de la connaissance d'une chose, à condition de ne pas verser dans l'illusion (transcendantale, comme dirait Kant) de l'identité du modèle et de la chose. » (Lambros Couloubaritsis, « La

As regards the most elemental powers of contemporary physics – mass and gravitation in relation to space-time; mass and its own relation to energy; etc. – the situation is different. Our understanding of these phenomena is clearly under constant revision. Discoveries have been made throughout the XXth century, and they continue apace in the XXIst, along with the evolution of basic explanatory models. Therefore, we cannot claim to identify truly elemental powers in an absolute sense. However, we can still identify the most elemental powers known to physics – gravitation and electromagnetism – as "quasi-elemental" powers, in recognition of the fact that lower powers might one day be discovered.

Further epistemological issues have to do with the distinction between philosophical and scientific knowledge, and with the historical difference between medieval and contemporary thought. Our attempt to fashion a "unitary" discourse – to wrap today's scientific knowledge into an ancient philosophical framework – runs the risk of conflating philosophy and science, something that was of great concern to Maritain, as seen in Chapter II. It also runs the risk of

philosophie antique à la croisée des chemins» in Catherine Collobert, dir., *L'avenir de la philosophie est-il grec ?* Collection Noesis (Montréal: Fides, 2002), p. 181) Certainly, the scientific model is not the real thing. But the real thing being studied has real powers, and even using a scientific model, these "lower" powers can be understood to a sufficient level of certainty to be integrated into the hierarchy of powers of natural wholes; a hierarchy that we are adapting from Aristotle. The power of electrons to repel each other is not simply a scientific object. This real power is observable using scientific instruments: particle accelerators, bubble chambers, galvanometers, etc., that extend the reach of our senses. Likewise, and with even more historical experimental evidence, the chemical powers of different atoms to form new compounds with new properties, are very real powers. As for the biochemical power of the haemoglobin molecule, to carry individual oxygen molecules from the lungs to the cells, this is also a very real and verifiable power, in terms of scientific experimentation. This is also the case for the power of chlorophyll to capture photonic energy and transform it into electronic activity, and ultimately into the new bonds of new molecules of sugar. All of these powers are totally beyond doubt, in terms of their reality. The fact that the precise scientific models – the quantum physics equations, the orbital configurations, the biochemical geometry, the models of cellular metabolism – can still be modified, does not take away from the reality of these physical, chemical, biochemical and cellular powers. Again, that our knowledge of these lower powers is not at the same level of certitude as philosophically known higher powers, such as intellection and sensation, is true. But this difference does not invalidate the integration of these powers in an Aristotelian hierarchy of natural powers. The heterogeneity of these powers – the merely scientifically-known subatomic, atomic, molecular, biochemical and cellular powers, versus the philosophically-known sensitive and intellective powers – this heterogeneity is not sufficient to invalidate the unity of the chain of powers in natural wholes such as human beings.

ignoring the history of science and philosophy from Aquinas's era to our own, a history marked by the contributions of Descartes, all the way to Thomas Kuhn and beyond.

Instead of delving any further into these complex issues, we offer our proposed contemporary interpretation of the doctrine of presence by powers, precisely as a proposal, to be evaluated on its own merits. Is it consistent? Does it conform to the tradition which it claims as its own, to contemporary scientific knowledge, and to the basic rules of logic and common sense? This third chapter, in conjunction with our first two, offers evidence to the effect that our proposal meets all of these criteria.

We will therefore proceed with our project. In particular, we will hold to our interpretation of Aristotelian principles and contemporary scientific knowledge, according to which we can integrate contemporary biochemical, molecular, atomic and quasi-elemental powers into the powers of the human soul.

3. Mediated Inherence: Concluding Remarks

We have now applied the notion of mediated inherence throughout the powers of human beings, as they are understood by experimental science.

What of the issue of natural wholes that might be greater than human beings? Dynamic, self-regulating systems exist at the ecosystem, planetary, stellar and galactic levels. However, they do not appear to display intellection and free will. There is no conclusive evidence for a thinking, feeling planetary entity named "Gaïa." [25] In fact, contemporary science is making ever-greater headway towards explaining such systems by recourse to inanimate powers. In line with

[25] Even James Lovelock, originator of the Gaïa hypothesis, is opposed to a notion of an intelligent planet Earth. See Laura Landen, "A Thomistic Analysis of the Gaïa Hypothesis: How New is this New Look at Life on Earth?" *The Thomist* 56 (1992), pp. 1-17.

Aristotle and Aquinas, we consider the human being to be the most complete natural material whole in existence. We will therefore limit our upper exploration of the mediated inherence of powers in natural material wholes, at the level of the human being.

We can therefore rejoin the ancient discourse of Aristotle and Aquinas, formulated in terms of substance, accident, matter and form. The powers, considered as accidents, are in the substance by a process of mediated inherence. The unity of this mediated inherence is consistent with one formal principle of determination for the whole, rather than a multiplicity of formal principles corresponding to each power. Each natural whole therefore only requires one principle of determination, or one substantial form, which can be directly united to the radical principle of determinability – prime matter. This provides an explanation for the doctrine of presence by powers, according to which the substantial forms of the parts are not said to be present per se, but rather by their powers, in the complex whole.

The doctrine of presence by powers can thus be applied to contemporary scientific knowledge, but only if the latter is understood in the light of the related philosophical notion of mediated inherence, and only if all of this is expressed in terms of the basic philosophical principles of substance, accident, matter and form. In so doing, we have attempted to satisfy Jacques Maritain's requirement for the interpretation of scientific knowledge, as cited above in Chapter II: "it is only by relating (scientific facts) to philosophical knowledges already acquired from another source and with philosophical principles, that an intelligible content appropriate for philosophy can be drawn from them." [26]

[26] Jacques Maritain, *The Degrees of Knowledge* (New York: Charles Scribner's Sons, 1959), p. 58.

C. Response to the Critical and Alternative Readings of Presence by Powers

We are now in a good position to comment more fully on the critical and alternative readings of the doctrine of presence by powers as explored in Chapter I, and also on some of the science-philosophy issues addressed in Chapter II. This will be in addition to the answers we have already provided regarding the issue of subsidiary forms and substance-accident language, and regarding the upward assumption of lower powers by the form of the whole.

We might first note how the application of mediated inherence relates to each specific position, in general terms. With respect to Frédault and his material substance, we propose that lower powers subsist, rather than material being. As regards Salet, Daujat and Chalmel and their focus on structure and unifying form, we propose structural unity as a result of unified powers, and the mediated unity of powers rather than the unity of many forms under a superior organizing form. Finally, as regards Nichols and his subsidiary forms, we have already proposed that subsidiarity applies to powers and not to forms.

Prior to taking these positions up in detail, however, we will address the first issues mentioned in Chapter I, including radioactivity and disease, as well as some issues brought up in Chapter II.

1. The Problems of Radioactivity and Disease

The uptake of radioactive atoms into living beings appears to constitute a serious challenge to the doctrine of presence by powers. How do we account for this seeming integration of improper lower powers into the living whole?

The principle of mediated inherence can provide some indications of a solution to this problem, even though we have not explored the realm of the nuclear powers – the strong and the weak nuclear forces – nor have we delved into the phenomenon of disease in general.

Radioactive atoms such as Iodine-131 and Uranium-238 can be taken up into living beings. When radiation from these atoms interacts with the living being's own atoms and molecules, ionization occurs: electrons are stripped away from their orbitals. The resulting free radicals – electrically unbalanced remnants of molecules – react violently with other molecules and ions in order to re-establish electrical neutrality. [27]

Radiation therefore releases intense forms of quasi-elemental electromagnetic powers. The power to separate electrons is magnified to an extreme degree, scarcely mediated by the contrary power to unify them, as is the case in stable electronic orbitals. Radiation disrupts the coordinated system of electronic orbitals upon which all biochemical powers are based, and it therefore disrupts all higher living powers. Such disruption can lead to immune suppression, cancer, reproductive harm and even death of the organism.

However, the vegetative powers of healthy organisms can counteract these disruptive effects. The powers of nutrition and metabolism are able to distinguish, segregate and eliminate radioactive isotopes. [28] In addition, these vegetative powers can marshal free-radical scavengers such as vitamins A, C, E and selenium, cleaning up the immediate disruptive effects of radiation. [29] Finally, a healthy immune system is able to identify and eliminate damaged and cancerous cells. [30]

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[27] Sara Shannon, *Diet for the Atomic Age* (Wayne, NJ: Avery Publishing Group, 1987), pp. 39-41.
[28] *Ibid*., pp. 148-149.
[29] *Ibid*., p. 42.
[30] *Ibid*., pp. 82-83.

In the organism's radio-protective abilities, the higher vegetative powers appear to be choosing among bundles of lower powers vying for inherence. This could be the general manner in which living beings nourish themselves and ward off illness and decay: through the selective uptake of beneficial combinations of lower powers, and the rejection or transformation of harmful combinations. Living organisms would thus be engaged in a constant process of control and reaction to the intake of harmful combinations of powers.

In summary, the higher powers of living organisms appear to maintain health by keeping each of the lower powers in a proper state, formally speaking. Such a situation is in line with formal-material relations between powers, and is therefore consistent with their mediated inherence in natural wholes, as well as with the doctrine of presence by powers.

2. The "Odour of Substance"

We will now focus on a particular aspect of mediated inherence, which may help to explain some of the issues encountered in Chapters I and II. Insofar as lower powers are present, so to speak, in higher powers, and insofar as accidents inhere in substances, the inherence of lower powers via higher powers might give the latter the "odour of substance." This odour would also belong to the part characterized by the higher power in question. Finally, the odour of substance would grow stronger as the number of lower powers increased.

In general, this does appear to be the case. Subatomic particles are considered to be barely substantial, whereas chemical atoms and molecules, with their combination of powers, are commonly termed substances, even inside living organisms.

Frédault and Nichols may have perceived this odour, each in his own way. Although they were separated by more than a century of fundamental discoveries, both thinkers were struck by the powers of atoms and molecules. Frédault knew that characteristic qualities of the atom, such as mass, were conserved in molecules and higher wholes. Could it be that the odour of substance in atoms brought him to affirm their subsistence, with powers and substantial forms intact, in conjunction with the formal existence of a greater whole? [31] In a similar vein, Nichols held that the many formal powers of water and DNA gave these some sort of substantial status. He thus adopted the notion of subsidiary forms, which affirms the substance-like status of water and DNA inside living beings. We will return to Frédault and Nichols in dedicated subsections, below.

3. Mediated Inherence, Maritain and Ashley

Mediated inherence might cast useful light on the Maritain-Ashley debate, given Maritain's distinction between the empiriometric and the empirioschematic sciences. According to him, the former deal with quantifiable objects, while the latter, which deal with qualitative objects, are of a closer mode of abstraction to that of the philosophy of nature. [32]

It is clear that the lower, more common powers at the physical and chemical levels are more amenable to quantification than the higher, more proper powers of living organisms. Elegant and compact mathematical formulas can describe the relations between quasi-elemental powers, as in the case of Newton's universal law of gravitation: " $F = Gm_1m_2 / d^2$ ". By

[31] Frédault, *Forme et matière* (Paris: Émile Vaton, 1876), p. 259.
[32] Jacques Maritain, *La philosophie de la nature,* 2e édition (Paris: Téqui, 1935), pp. 108-111.

comparison, the power of reproduction, immeasurably more complex, appears quite resistant to mathematization.

Now the unity of these physical and biological powers – the objects of the empiriometric and the empirioschematic sciences – occurs in living wholes by mediated inherence. Such natural wholes, the human being in particular, can help us appreciate both Maritain's and Ashley's positions. According to Maritain, the empiriometric sciences cannot yield up knowledge of the nature or essence of a human being. However, the empirioschematic sciences certainly move us much closer to that goal, since their highest object – the intellectual power – gives us the essential definition for man: "rational animal." Now, insofar as the objects of the empiriometric sciences – the lower physical and chemical powers – are in the human being by the mediation of the higher powers, the pursuit of a full understanding of these lower powers in the human being will necessarily lead the quantitative scientist into the empirioschematic realm. The existence of the human being is therefore an open invitation to the empiriometric scientist to move towards the philosophical mode of intelligibility. Ashley might not have been altogether correct in blending experimental science and philosophy, but he appears to have been correct in terms of their common object: complex natural wholes such as the human being.

Having addressed some general issues regarding presence by powers, we will now return to the particular readings reviewed in Chapter I, starting with Félix Frédault, and concluding with some final comments on Terence Nichols' subsidiary forms.

4. Mediated Inherence and Frédault's Material Existence

a) Scientific Progress and Issues of Vocabulary

As seen in Chapter I, Frédault insists on the subsistence of material existence in itself quite apart from formal existence. In his view, this is the only way to explain the evident subsistence of material atoms in complex wholes such as chemical compounds and living beings.

Mediated inherence, for its part, focuses on the powers of a substance. For instance, in a molecule such as water, the characteristic power to form hydrogen bonds is materially dependent on the power to form orbitals, and this power is in turn materially dependent on the quasi-elemental electromagnetic and gravitational powers. All of these powers belong to the one substantial form of the molecule, by mediated inherence. The situation would be similar for a living whole. There would therefore be no need for the survival of lower formal principles, or for independent material existence.

Such detailed knowledge of atoms and molecules was not available to Frédault at the end of the XIXth century. Chemistry had theoretically established the existence of modern chemical atoms and compounds, but electronic orbitals were not to be discovered until the early XXth century. Aware of the conservation of atomic mass in compounds, but having no grasp of proper atomic and molecular powers, Frédault could be understandably incredulous regarding the replacement of the atomic substantial form by a new molecular one.

Once again, translation and vocabulary may have played a key factor in the interpretation of the Aristotelian doctrine. The term "powers" is much more specific than the term "qualités"

used by Frédault. [33] "Qualités" can mean superficial qualities such as colour or texture, just as it can mean radical powers such as the power to form electronic orbitals. Clearly, superficial atomic qualities do not survive in the molecule. They cannot account for the survival of iron in the compound of iron oxide, much less in the cell or in the human body.

With mediated inherence, qualities understood as powers can account for iron's survival in greater wholes. These powers include the atomic power to generate orbitals, and the quasi-elemental electromagnetic power. Such lower powers subsist in successively greater wholes via the mediation of successively higher powers: hydrogen bonding, biochemical, vegetative and animal powers. All of these powers are qualities of the one substantial form of the whole; accidents of the one substance.

b) Frédault on Matter, Form, Act and Potency

Frédault is opposed to the doctrine of presence by powers, because he sees it as affirming the mere potential presence of parts in an actual whole. In his insistence that the parts are actually present, Frédault goes so far as to grant actual existence to matter, denying its merely potential existence. He objects to the destruction of this material actuality by a new form for the new whole. [34] As seen in Chapter I, it is the incomplete translation rendering "virtually" for *virtus* that introduces the notion of potential presence for the parts.

Frédault's position leads him to deny the roles of prime matter and substantial form as principles of potency and actuality. He is therefore hostile to the Aristotelian notion of substantial change. However, such a position is not shared by all of his contemporaries in the

[33] Frédault, *Op. Cit.*, p. 266.
[34] *Ibid.,* pp. 266-272.

scientific community. According to Albert Farges, Kékulé himself, one of the fathers of organic chemistry, held that "les transformations de la matière sont le passage de l'état potentiel à l'état d'acte, et il en fait l'objet spécial de la chimie." [35]

5. Mediated Inherence, Structure and Superior Forms

a) Unity of Structure and Superior Forms

As we saw in Chapter I, Chalmel proposes material structure as the equivalent to substantial form – at least for inorganic beings and living beings excluding humans. This poses certain philosophical problems. [36] In response, we would propose that structural unity, instead of being a formal principle, is rather the result of unified powers, enjoying intimate formal and material relationships through mediated inherence, and determined by a single formal principle.

b) Cumulatively Mediated Powers Instead of Forms

Chalmel joins Daujat and Salet in proposing the superior purpose of superior forms as a key to substantial unity in complex wholes. Daujat states that the substantial form of the whole gives unity by assuming existing forms upwards into a new organization. This means that the

[35] Albert Farges, *Matière et forme en présence des sciences modernes* (Paris: Berche et Tralin, 1899), p. 203 (translated from Pesch in his *Institutiones*).

[36] In his book review of *Biologie actuelle et philosophie traditionnelle,* Bernard Hubert states that "l'auteur identifie l'organisation de la matière avec la forme substantielle non subsistante." **(***Revue Thomiste* 86 (1986), p. 167). This is indeed problematic in terms of Thomistic doctrine, but it does not take away from Chalmel's valuable contribution to bridging the gap between Thomistic principles and the modern findings of biological cybernetics and evolution – as endorsed by the zoologist Pierre-Paul Grassé in his preface to the work (Patrick Chalmel, *Biologie actuelle et philosophie thomiste* (Paris: Téqui, 1984), pp. 9-14).

substantial form of the whole does not grant the parts existence, but only their unity. This description of the organizational and teleological relations between lower and higher forms is problematic.

As noted in Chapter I, Aquinas specifies that "whatever comes to a thing after it is complete in its being, comes to it accidentally, since it is outside that thing's essence. Now, every substantial form makes a being complete in the genus of substance, for it makes a being in act, and this particular thing. Therefore whatever accrues to a thing after its first substantial form will accrue to it accidentally." [37] In Daujat's explanation, the parts are already complete in their being. If we follow Thomas' reasoning, this means that the form of the whole is not substantial but accidental; the whole is therefore not a substance.

The mediated inherence of powers resolves the difficulty. It would be lower powers as accidents, and not parts with substantial forms, that would be assumed into the whole. Daujat's description of the relationship between lower and higher forms corresponds to how the *powers* relate to each other through mediated inherence. We might therefore re-express his position as follows, with substituted terms in italics: "The best meaning for the unity of substantial form would be that all of the *powers* of the composite are completely ordered to one superior end. The purposes of the *lower powers* would become the components of a superior purpose – that of the *highest power, which is the purpose of the* whole." [38]

The purposes of the lower powers would no longer be supreme in their own right; they would be subordinated to the purpose of the highest power – the purpose of the whole. The whole would therefore remain a substance: many powers and one substantial form.

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[37] Thomas Aquinas, *Summa Contra Gentiles,* II, cap. 58 (tr. by James F. Anderson) as cited by Farmer, "Matter and the Human Body according to Thomas Aquinas" (Ph.D. diss., University of Ottawa, 1997), p. 157.
[38] As adapted from George Salet, *Hasard et certitude: le transformisme devant la biologie actuelle*, 2e édition (Paris: Éditions Scientifiques Saint-Edme, 1972), p. 473.

6. Mediated Inherence and Subsidiary Forms: Final Comments

At the outset of this chapter, we granted that subsidiarity was a real phenomenon. However, in order to maintain substance-accident language, we proposed that subsidiarity applies to the many powers of the whole rather than to the formal principles of the parts. We will now address Nichols's detailed concerns regarding the consistency of Aquinas's philosophy, the interrelation of substances, and the role of parts in wholes, especially in the cases of water and DNA.

a) The Consistency of Aquinas' Philosophy

Commenting on presence by powers as presented in Aquinas' *De Mixtione*, Nichols states: "It seems, then, that the qualities of an element in a composite body remain, but the form does not. But this does not seem to be consistent with Aquinas's philosophy at other points where he holds that qualities and powers inhere in a substantial form and flow from it. I think, however, that this is as close as he comes to acknowledging the influence of subsidiary parts on a whole, although the notion is not well developed or integrated into the rest of his system." [39]

In the first place, the doctrine of presence by powers is consistent with Aquinas's philosophy. His notion of mediated inherence specifies the manner in which qualities and powers flow from the single substantial form of the whole. Likewise, his hierarchical theory of forms specifies that the powers belong to the one higher form of the whole: "…one form constitutes matter in corporeal existence only.(…). But another and more perfect form constitutes matter in corporeal existence and confers vital existence in addition; and yet another

[39] Nichols, *Op. Cit.,* p. 315.

form confers both vital existence on matter while giving it sensory existence as well; and so it is with other forms." [40]

Secondly, the influence of parts on wholes is well developed and integrated in the thought of Aquinas. As seen in Section A of this chapter, he specifically applies the principle of mediated inherence to the powers of the soul, both in the *Summa Theologiae* and in the *Quaestiones de Anima.* In the order of generation, the lower powers are matter for the higher powers. The powers of a part, whether this be heat in a mixed body or sensation in the eye, play a vital material role in the powers of the whole – for instance, intellection. We will return to this issue further below, and we will examine it in terms of the contemporary understanding of powers.

b) The Interrelation of Substances

Nichols claims to identify a key difference between Thomistic substantial form and the holistic cause of modern science, regarding the interrelations between substances. "Whereas traditional Thomistic thought, with its emphasis on the unity of form and substance, tended to minimize the interrelation of substances, recent holistic thought stresses the fact that every entity exists within a network of interrelationships with other entities." [41] According to Nichols, this is a critical problem for Thomism. This commentary is understandable if we focus solely on substantial form.

However, if we recall the ancient elementary powers of the hot, the cold, the wet and the dry, and the universal role ascribed to them by Aristotle in all natural change, we note that here

[40] Thomas Aquinas, *Questions on the Soul,* q. 9, p. 128.
[41] Nichols, *Op. Cit.*, p. 312.

are profoundly relational powers. Their contemporary analogues – electromagnetism and gravitation – are also extremely relational. In Section B above, we proposed in some detail how such contemporary relational powers might be present in such natural wholes as human beings. These powers result in gravitational and electromagnetic relations between all natural wholes. We have seen how a Thomistic notion of substantial form determines the mediated presence of such relational powers within natural wholes. Therefore, this notion of substantial form certainly recognizes interrelation at an elementary level.

In Nichols' defence, interrelation does not appear to receive much emphasis by Thomas. In a frequently quoted passage on presence by powers, Thomas does not name Aristotle's elemental, relational powers – the hot, the cold, the dry and the wet. [42] In addition, as noted in Chapter I, these ancient powers are dismissed out of hand in the modern context, and the literal meaning of powers can be occulted by the translation "virtual."

c) Parts and Wholes: The Case of Water

Regarding the relation of parts to wholes, Nichols focuses on the case of water in the human body: "Modern Thomists will typically argue that water is not present *as such* (that is, as a separate substance) in the body. Rather, water is said to be 'virtually present,' as St. Thomas affirmed." [43] However, water appears to remain as a substance operating as a solvent for salt and a carrier for platelets, etc. Why would water not retain its own formal principle? [44]

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[42] See Chapter I above, subsection A. 5, regarding the *Summa Theologiae,* I, q.76, a.4, ad.4.
[43] Nichols, *Op. Cit.,* p. 313. Nichols is citing George Klubertanz, *The Philosophy of Human Nature*, pp. 27-28. He also refers to Aquinas' *Summa Theologiae,* I, q.76, a.4, ad.4.
[44] *Ibid.,* pp. 312-313.

Once again, the solution is to focus on the actual powers at work. In the living body, water's power to form hydrogen bonds, the atomic power to form orbitals, and the quasi-elemental electromagnetic powers would not act in water molecules only. The very same powers would interact with their correlates in sodium and chlorine ions, producing a salt solution. Moving upward to living cells, these powers proper to water, sodium and chlorine would be taken up by mediation through the biochemical powers, and then through nutrition, growth and reproduction. In this way, we can see water molecules as a particular step in a series of subsidiary, nested powers that inhere via higher cellular powers. Likewise for water in a living human being, and its own higher powers. Therefore, water need not exist as a substance in the cell or in the human being. Water can exist there as a complex bundle of powers: accidents of the one substantial whole, determined by one substantial form through the principle of mediation.

d) The Challenge of DNA

DNA, or deoxyribonucleic acid, serves as Nichols' prime example of a part determining the whole. Modern genetics clearly suggest that chromosomes direct the reproduction and development of cells and organisms. What does this really mean in terms of formal influence? Once again, we need to examine the specific powers involved.

DNA serves as the repository for the "construction information" for all of the cell's proteins, which act as enzymes and structural members of the cell. [45] According to the principle of mediated inherence, DNA's characteristic power of information storage mediates the

[45] Alberts et al., *Op. Cit*., pp. 98-102.

inherence of such lower powers as hydrogen bonding, covalent bonding, ionic bonding, orbital formation, and the quasi-elemental powers of gravitation and electromagnetism.

In accordance with the information found in DNA, cellular operation and reproduction are limited to very specific processes and outcomes. DNA's power certainly appears to be formal: it leads to a highly consistent and determined outcome for all cellular powers. But in which direction does ultimate formal causality operate? Do the cell's higher vegetative powers formally determine DNA, or does DNA formally determine these powers?

Certainly, the cell's five highest vegetative powers – nutrition, growth, metabolism, homeostasis and reproduction – cannot do without DNA. However, none of these powers can be found in, or reduced to, the powers of DNA per se. The DNA molecule cannot feed itself by its own powers. Neither can it grow itself. It certainly cannot maintain vital cellular operations and conditions in real time – the powers of metabolism and homeostasis. And as for reproduction, DNA is indeed reproduced, but this only occurs under a higher coordinating power, involving the participation of many other molecules including enzymes and nucleic acids, interacting in the proper conditions and with the appropriate energy source: [46] "…living organisms…duplicate their DNA accurately…speed and accuracy are achieved by a multienzyme complex of several different proteins that *guides the process* (italics added) and constitutes an elaborate 'replication machine.' " [47] Such a dynamic situation is found only in a whole living cell, one which possesses the powers of nutrition, growth, metabolism, homeostasis and reproduction. Finally, the fact that viruses must highjack the replication powers of a living cell in order to reproduce their kind, indicates that viral DNA – and, by extension, DNA in general – does not possess the power of reproduction.

[46] *Ibid*., pp. 221-232.
[47] *Ibid*., p. 221.

Clearly then, it is the living cell's highest powers that formally determine DNA, and not the other way around. These highest powers mediate the inherence of DNA's powers. We may thus affirm that it is not DNA that reproduces itself like some kind of perfect internal parasite, but rather the living cell that nourishes, maintains, grows and reproduces itself by means of DNA, and by means of many other parts and material causes. The inanimate powers of DNA, culminating in the power of information storage, can be said to provide matter for the highest living powers of the cell, and not the other way around.

If we consider DNA as coded information, we come to a similar conclusion. "Coded information as such cannot be reduced to the medium in which it is inscribed.(….). If DNA is genetic information, then we must look for a more fundamental cause of the growth and development of an organism, the cause responsible for inscribing and interpreting the coded information." [48] This cause would be a source of higher information or greater determination – a more formal cause, rather than a more material one which would express greater determinability. Ultimately, this formal cause would be the substantial form of the plant or animal. We might then say that "…it is the plant or animal form that encodes itself in the DNA, and that the form is what the DNA serves to communicate." [49]

The principle of mediated inherence explains how DNA's powers can subsist, rather than DNA's subsidiary form. This macromolecule's information-carrying power is admittedly near the top of the cell's powers, but precisely because it is materially necessary for them, it would still be formally mediated by these highest powers of nutrition, metabolism, homeostasis, growth and reproduction. All of the cell's powers would belong to the living organism and to its one substantial form, and not to the DNA.

[48] John Goyette, "Substantial Form and the Recovery of an Aristotelian Natural Science," *The Thomist* 66 (2002), pp. 526-27.
[49] Robert Sokolowski, "Formal and Material Causality in Science," *Proceedings of the American Catholic Philosophical Association* 69 (1995), p. 64.

e) The Need for Unity

There is a final problem with Nichol's model: the absence of an ultimate unifying principle. There does not seem to be a reason for the culminating role of the form of the whole. What makes the top form no longer a subsidiary form? Is it simply the absence of suitable partners for unification into a yet higher form? In such a case, there would be no ultimate inner principle of completion and unity. There would be an inherent ontological instability in all natural wholes. On the other hand, if there were an agent causing the subsidiary form to be transformed into superior status, that formal agent would be exterior to the new whole.

Mediated inherence avoids this problem altogether. All of the powers are united in the substance under the formal action of one substantial form. One single determining principle – one substantial form – is at once responsible for all of these powers, and for their unity by mediation.

f) Subsidiarity: Final Comments

In the opening section of this chapter, we addressed subsidiarity's most far-reaching challenge to the doctrine of presence by powers: the questioning of substance-accident language. In this last subsection, we have addressed the remaining issues related to subsidiarity. Mediated inherence recognizes the relationality of natural wholes, and the agency of parts such as water and DNA, while retaining a single substantial form. The doctrine of presence by powers therefore appears applicable to contemporary scientific knowledge, as the latter is presented by Nichols.

Conclusion

A. Synopsis of the Thesis

In this thesis, we have explored the relationship of Aristotelian and Thomistic philosophy with contemporary experimental science, focusing on a central point of difficulty: the ancient doctrine of presence by powers. We have drawn on the texts of Aristotle and Aquinas, as well as on the essential contributions of Nichols, Ashley, Maritain, Wallace and their Thomistic and Aristotelian colleagues and critics of the past one and a half centuries.

In Chapter I, we undertook a first exploration of the doctrine as formulated by Aristotle and Aquinas. This led us through such properly philosophical notions as substance, accident, act, potency, substantial form and prime matter. We then examined the doctrine's application to modern experimental scientific knowledge, from the late XIXth century to the present. We noted Félix Frédault's early critique of presence by powers; the difficulties involved with the interpretation of *dunamis* and *virtute*; and the challenge presented by Aristotle's outdated elemental and mixed powers. We provided an overview of attempts to apply the doctrine to scientific knowledge throughout the XXth century, concluding with William Wallace's promising "powers model." However, we noted Barnes' objection to the "brute, inexplicable fact" of the assumption of the powers of lower forms by higher forms.

We then considered a number of alternative readings that attempt to adapt the doctrine to the facts of modern science. Patrick Chalmel proposed structure, Daujat and Salet proposed superior forms, and Terence Nichols proposed subsidiary forms as alternative principles of unity, apparently more in keeping with the physical and biological sciences. Finally, we noted that

these attempts at reconciliation appeared to challenge the doctrine's philosophical foundations. In particular, Terence Nichols' notion of subsidiary forms led to the questioning of substance-accident language. Such challenges seemed to call for a re-thinking of an Aristotelian or Thomistic philosophy of nature.

In Chapter II, we addressed this challenge by exploring the relation between philosophical and scientific knowledge. We paid particular attention to Duhem, Meyerson, Charles De Koninck, Jacques Maritain, Benedict Ashley and William Wallace. We noted that philosophy and science are distinct, yet intimately related: the definitions of philosophy provide a foundation for experimental science. We explored the question of whether experimental science can attain to the natures of natural wholes, focusing on the powers of these wholes. Finally, we noted the potential point of application of philosophy to scientific knowledge in these very powers.

In Chapter III, we returned to the issue of presence by powers. Responding to Terence Nichols' challenge to substance-accident language, we suggested that subsidiarity applies to the powers of natural wholes. We noted Aquinas' view that these powers exist in a relationship of mediated inherence, according to two orders: the order of nature, and the order of generation. This view offers an explanation for presence by powers, as well as for the upward assumption of lower powers by a higher form. It also retains substance-accident language and the unity of substantial form.

We then applied the principle of mediated inherence to the contemporary scientific understanding of the most complex natural whole: the human being. We first noted that mediated inherence is consistent with the fact that each higher power enjoys an immediate formal-material relationship with the next lowest power. We then followed this series of

relationships through the descending powers of the human being. We started with the intellectual powers, moving on to the sensitive powers, the physiological powers, the cellular powers such as reproduction and homeostasis, the biochemical powers of organelles, the chemical powers of molecules and atoms, and the nearly elemental fundamental physical powers. As per William Wallace, we adopted contemporary equivalents to Aristotle's mixed and elementary powers, while recognizing the epistemological and historical issues involved in such an adoption.

In the last section of Chapter III, we returned to the outstanding objections and alternatives of Chapter I. We showed how mediated inherence could resolve these challenges to the doctrine of presence by powers. We discussed disease and radioactive contamination; the "odour of substance" of atoms and molecules; material existence as an independent entity; structure and superior forms; and further issues related to subsidiary forms, including relationality and the specific role of DNA in the living being.

Our application of mediated inherence has been brief and incomplete. If our approach has value, much remains to be done to explore further applications to the philosophy of nature, and to the many disciplines and sub-disciplines of psychology, physiology, cell biology, biochemistry, chemistry and physics.

B. The Continued Relevance of Ancient Views

In summary, we have argued that the ancient philosophical doctrine of presence by powers, based as it is on substance, accident, form and matter, and seen through the principle of mediated inherence, is applicable to the contemporary scientific understanding of natural wholes.

An Aristotelian and Thomistic philosophy of nature would then still be relevant to the contemporary world. This would be in spite of a succession of new paradigms throughout the modern age, both in the experimental sciences and the philosophy of science.

Bacon, Descartes, Kant, Comte, Darwin and Heisenberg, among many others, have profoundly influenced the modern view of science. As a result, many contemporary voices affirm the incommensurability of ancient and medieval knowledge with the cumulative achievements of modern experimental science. In particular, certain epistemological issues are involved in the use of scientific models, and the knowledge derived thereby.

Yet, William Wallace and others before him have pursued the integration of ancient principles with contemporary scientific knowledge, including the findings of modern biochemistry, chemistry and physics. Wallace is confident in such integration so far, along with future progress:

> Thomism is sufficiently analytical to be acceptable to the scientific mind.(…). Thomists must be encouraged to become increasingly concerned with, and enlivened from their contact with, the specific problems of the physical, biological, psychological, social and political sciences. Such a renewal will benefit not only Thomism but also the sciences it can serve to integrate. In so doing it will meet the needs of modern man and his society. [1]

As noted above in our introduction, Terence Nichols affirms that for such a situation to obtain, the recovery of a scientifically compatible notion of substantial form would be necessary. [2] In this thesis, rather than speaking of scientific compatibility, we have spoken of the applicability of philosophical notions to experimental scientific knowledge, in the specific case of the doctrine of presence by powers. We have identified a number of conditions for such an application. First, that we follow Maritain's specification that scientific facts be analyzed using

[1] William Wallace, "Thomism and Modern Science: Relationships Past, Present and Future," *The Thomist* 32 (1968), pp. 80, 83.
[2] Terence Nichols, "Aquinas's Concept of Substantial Form and Modern Science," *International Philosophical Quarterly* 143 (1996), pp. 303, 306, 318. On page 306, Nichols draws from Wallace's "Nature as Animating: The Soul in the Human Sciences," *The Thomist* 49 (1985), pp. 612-48.

properly philosophical notions. Second, that we interpret "presence by powers" as referring directly to the powers of natural wholes. Third, that we adopt contemporary equivalents to the Stagirite' outdated elemental and mixed powers. And fourth, that we apply Aquinas' mediated inherence of the powers of natural wholes to these powers as we understand them today.

C. Philosophy of Nature: Maritain's Ideal

As developed in our final chapter, Aquinas' mediated inherence of powers appears to provide a unifying framework for scientific knowledge, in the light of properly philosophical principles. This framework might therefore constitute a step towards the realization of Maritain's ideal of the philosophy of nature, as expressed in the final lines of his work on that subject:

> Délivrant, parce qu'elle l'éclaire d'une lumière philosophique, dans l'univers des sciences une intelligibilité que les sciences elles-mêmes ne peuvent nous montrer, et décelant dans l'être sensible connu en même que muable comme des amorces analogiques des réalités et des vérités plus profondes qui sont l'objet propre de la métaphysique, la philosophie de la nature, sagesse précaire et *secundum quid,* exerce dès le premier degré de visualisation abstractive, dans la sphère d'intelligibilité la plus proche des sens, déjà l'office ordonnateur et unificateur de la sagesse; elle accorde, médiatrice indispensable, le monde des sciences particulières, qui lui est inférieur, au monde de la sagesse métaphysique, qui la domine. C'est là, dès la base et dès le départ de notre connaissance humaine, au sein du multiple sensible et changeant, que commence à jouer la grande loi d'organisation hiérarchique et dynamique du savoir dont dépend pour nous le bien de l'unité intellectuelle. [3]

Such a philosophy of nature would play a key mediating role, harmonizing the realm of metaphysics with the realm of the particular sciences. As Maritain notes, this intellectual unity is a vital necessity. In this context, it is our hope that this thesis might contribute to renewed

[3] Jacques Maritain, *La philosophie de la nature*, 2e édition (Paris: Téqui, 1935), p. 146.

confidence in the applicability of Aristotelian and Thomistic philosophical notions to contemporary scientific knowledge.

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