Maritain and Postmodern Science

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All Thomists must by now realize that postmodern science poses a real challenge to Thomism, for the most serious philosophical implication of postmodern science strikes at the very heart of Thomist epistemology. That implication has been described by physicist and philosopher P. W. Bridgman in the following way: "[T]he structure of nature may eventually be such that our processes of thought do not correspond to it sufficiently to permit us to think about it at all. . . . The world fades out and eludes us, . . . we are confronted with something truly ineffable. . . . We have reached the limit of the vision of the great pioneers of science, the vision, namely, that we live in a sympathetic world in that it is comprehensible to our minds."[1]

Now given its obvious seriousness, every Thomist, then, must face the challenge of postmodern science, because no Thomist can in good conscience ignore science and its findings, or fail to take seriously the philosophical concerns of its most knowledgeable practioners. Nor can Thomists simply pretend that empirical science has no bearing on Thomistic metaphysics, for as St. Thomas and his most profound twentieth century interpreter saw, the knowledge disciplines, though apparently autonomous, in fact exist as interdependent members of a true hierarchy. This hierarchy includes the empirical sciences, mathematics, and mathematical physics, as well as the philosophy of nature, metaphysics, and natural and revealed theology. When working together and properly ordered, they make cosmology possible. But as *human* disciplines, each must ultimately be grounded in what is given to the intellect in sense knowledge. Consequently, any viable cosmology must also be grounded in the empirical sciences, since these are the disciplines which deal directly with the material world. If, however, the very sciences which supposedly ground the hierarchy of knowledge reveal to the intellect a

[1] Quoted in *Beyond the Postmodern Mind,* Huston Smith, (Wheaton, Illinois: Theosophical Publishing House, 1982), 8.

fundamentally incomprehensible world, then the entire knowledge superstructure is threatened with collapse.

Jacques Maritain understood this, and that is why he devoted so much of his intellectual energy to working out an epistemology that would be not only true to St. Thomas and the notion of the degrees of knowledge, but also to the spirit of contemporary science. For Maritain, any epistemology that claims to be inclusive must be able to accomodate science even in its most contemporary forms.[2] But he also knew that the empirical sciences necessarily seek completion in a higher wisdom, the philosophy of nature, which justifies and defends the principles of empirical science, without absorbing those principles into itself. Barring that completion, science is cut off from a higher intellectual light, while the hierarchy of knowledge is dispossessed of its empirical grounding. Thus, establishing the true relationship between the empirical sciences and the philosophy of nature is a most important, though most difficult one.

It is my belief that Maritain's philosophy of science provides the most successful account of that all-important relationship, and that when properly understood, is well able to overcome the epistemic conundrum in which postmodern science finds itself. What follows, then, is an attempt to show how Maritain's philosophy of science achieves this by laying out some of its most important themes, then defending it against some basic and fundamental criticisms.

MARITAIN'S PHILOSOPHY OF SCIENCE

According to Maritain, science, taken generally, is a perfect knowledge in which the intellect, under the compulsion of evidence, points out in things their reasons for being.[3] Hence it is a knowledge properly explanatory, and because perfect in mode, of that which is necessarily true. Science has, therefore, for its formal object intelligible necessities. Yet, because science bears on the material real, it also bears on the contingent, the singular. Consequently, science distinguishes between "thing" or material object, and intelligible formality, or proper "object," disengaged from the former through abstraction. Science, in effect, makes known essences and the necessary properties of essences realized in sensible singulars.

Essences, however, and the intelligible necessities immanent in them,

[2] Maritain's most important works along these lines are, *The Degrees of Knowledge* (New York: Charles Scribner's Sons, 1959); *Philosophy of Nature* (New York: Philosophical Library, 1951); *Science and Wisdom*, trans. Bernard Wall (New York: Charles Scribner's Sons, 1940); *Reflections Sur Intelligence* (Paris: Desclee de Brower, 1924).

[3] Jacques Maritain, *The Degrees of Knowledge*, 23.

manifest themselves concretely in terms of experimental constancies—the outward signs of those necessities. Indeed, experimental constancies provide the basis for the laws which science formulates, for scientific law captures the necessity inhering in such relations. But necessary relations derive their necessity from the fact that they have their locus in intelligibles, in essences. Science, then, in studying the essences of concrete existents, is bound to study not only the necessities immanent in natures, but also the concrete manifestations of these necessities inhering in experimental constancies.

It is for this reason that Maritain divides science into two kinds: sciences of explanation and sciences of observation. The sciences of explanation, like mathematics and philosophy, are purely deductive in nature, and make known in themselves the intelligible necessities immanent in their objects. Because they make known effects by principles or reasons for being, these sciences are explanatory in the proper sense of the term. The sciences of explanation, then, deal with essences as known, and the mode of intellection proper to them is called dianoetic intellection.

Sciences of observation, on the other hand, deal with essences as hidden, that is, as hidden in the experimental constancies manifest among concrete effects. In the sciences of observation, essences are known only in sign and symbol substitutes; they never uncover in themselves the intelligible necessities immanent in their objects. As such, they are strictly inductive in nature, being grounded in sense experience, and so are not explanatory in the proper sense of the term. Properly speaking, the sciences of induction are not real sciences, or are only imperfect sciences, and the mode of intellection proper to them is called perinoetic intellection.

Now, according to Maritain, the distinction between these two kinds of science is absolutely sharp; they cannot be reduced to each other.[4] Certainly the sciences of observation *tend* toward the sciences of explanation, for the former seek completion in the latter; that is, they seek completion in a properly explanatory science. The intellect obviously cannot remain content with a knowledge that does not penetrate to the essence, that does not apprehend real causes for being. Thus the sciences of observation and that science of explanation operative at the first degree of abstraction, namely the philosophy of nature, together constitute the realm of what the ancients called *physica.*

Nevertheless, though both sciences share the same material object (sensible being), they do not share the same formal object, for these sciences study sensible being from two entirely different standpoints. In other words, there is a real distinction between them. The inductive sciences focus on the sensible

[4] *Ibid.*, 34.

dimension of sensible/mobile being, while the philosophy of nature focuses on the being of sensible/mobile beings. For example, the scientist attempts to understand the behavior of matter through the formulation of laws derived from experimentation, while the philosopher of nature attempts to know *what* matter is.[5] In effect, the scientist proceeds from the visible to the visible, while the philosopher of nature proceeds from the visible to the invisible.[6]

Given, then, that the empirical sciences and the philosophy of nature, though interrelated, do not overlap in any fundamental way, the inductive sciences are free to operate unrestricted in their respective realms. It is the function of the philosophy of nature to explain and justify the principles of science, but science does not depend on the philosophy of nature for either knowing or using its own principles. Most importantly, however, this means that empirical science is relinquished from having to determine what is real, for its proper mode of intellection cannot tell us what is real, or how things really are, and cannot tell us what something is, or ultimately even resolve conflicts between equally viable but contradictory explanatory hypotheses.

Of course at this point one might be tempted to say that the history of science proclaims just the opposite, namely, that empirical science and the deductive sciences do overlap in a fundamental way, for is not the development of mathematical physics precisely the story of the joining of physics, which has for its object sensible/mobile being, and mathematics, which has for its object mathematical being? Certainly, but as a *scientia media* mathematical physics constitutes a special case which by its very nature cannot resolve the problem. Mathematical physics is very relevant to that problem, however, which is clearly revealed when considering the nature of that science.

As all Thomists know, physics and mathematics belong to two entirely different orders of being, for their formal objects have different degrees of remotion from matter. Physics retains common sensible matter in the definition of its proper object, and so studies beings which depend both for their being and their being known on sensibles. Mathematics, however, retains only common intelligible matter in the definition of its proper object, and so studies beings which depend for their being, but not their being known, on sensibles. Initially, mathematical abstraction abstracts its objects from concrete existents, but it reconstructs them formally and ideally in imaginative intuition. Through abstraction these objects of thought then become independent of their material matrix. Absolutely speaking, mathematical entities can exist only in the mind.[7] Once mathematics has established the ideal existence of its object, truths concerning it are deductively established through their formal intelligible

[5] *Ibid.*, 46. [6] *Ibid.*, 38. [7] *Ibid.*, 54.

relations. Consequently, mathematical judgments are verified either directly or indirectly in imaginative intuition, for the ideal existence of mathematical entities can be either of the nature of a possible existent like "square" or "line," or of the nature of a being of reason, like irrational number, imaginary number, or transfinite number.[8]

Now in mathematical physics, the physics is properly subalternated to mathematics. This means that though its material object is sensible being, its formal object and principles of explanation are taken from the higher science of mathematics.[9] It is mathematics which provides mathematical physics with its method of conceptualization.[10] Hence because physico-mathematics studies

[8] *Ibid.*, 140-144. The latter, of course, are based upon the former, and are constructed deductively therefrom, but remain unfigurable in imaginative intuition. All mathematical beings, however, are at least indirectly grounded in the imaginative intuition, because all are derived from the mathematician's special consideration of the accident quantity. The philosopher of nature, of course, considers quantity from the standpoint of the extension of concrete bodies; from the standpoint of actual divisibility. The philosopher of nature thus treats quantity as a real property of bodies. (It is in fact the first accident in bodies; all the others emanate through it.) The mathematician, however, disengages quantity from its material matrix by formal abstraction, and then treats what has been separated in the mind as something separate in reality. Being is, in effect, reconceived by the mathematician in terms of relations of order and measurement. Given, then, their very nature, these mathematical objects must, of course, be apprehended by an intuition, but an intuition which is neither purely sensory nor purely metaphysical. They must, rather, be apprehended by an imaginative intuition, an internal sense only indirectly dependent upon sensory intuition. Thus even though imagination presupposes sensory intuition, and even though quantity precedes quality in proper ontological order, imaginative intuition is able to penetrate to quantity precisely because imagination is free from the contingency of sensory experience. Mathematical beings are therefore free to manifest themselves in symbol substitutes independent of the contingency of sensibles. Some, such as the objects of Euclidean geometry and basic number theory, are directly figurable in imaginative intuition. Others, such as non-Euclidean geometries and imaginary and transfinite numbers, are not. In effect, mathematical quantity must be grounded in quantity as conceived by the philosopher of nature.

[9] The empirical sciences, as seeking completion in a science of explanation, must be subalternated to that science. Thus, empirical science is subalternated to either mathematics or philosophy. But a science is either properly or improperly subalternated to another science. A science is subalternated to another when it derives its principles from the other, the subalternant science. The subalternant science resolves its conclusions into first principles, which in turn become the principles of the subalternate science. The subalternate science then adds to the subalternant science an accidental difference, as in optics, where ther formal object is *visual* line. In proper subalternation (again, as in optics), there is subalternation both with regard to principles and object, but there can also be proper subalternation in regard to principles alone. (This is the case, says Maritain, with theology and the knowledge of the blessed; they share the same object, but theology borrows its principles from the latter.) In improper subalternation, which is best called subordination, the sciences share the same object, but view it under completely different lights. (This is the case with the non-empiriometric sciences—the

sensible being by transposing it mathematically, that is, by treating it mathematically and not as physically real (it reduces all of its concepts to the measurable, since only the measurable behavior of nature revealed by instruments of measurement is real for it), mathematical physics gives up the search for real causes, for the kind of causes which the philosophy of nature seeks.

This is certainly apparent in the ever more frequent use which physico-mathematical science makes of mathematical beings of reason. Given that mathematical beings of reason are unfigurable in imaginative intuition, the universe that mathematical physics constructs using these beings of reason in its explanations becomes as unfigurable, as unimaginable, as those beings themselves.

Indeed, the history of mathematical physics is the history of an ever increasing move away from ontology, away from the philosophy of nature, and toward the mathematical world of the preter-real. This is most important, for mathematical physics' hypothetical reconstruction of the physical real, based as it is on a network of mathematical relations which attempt to "explain" the measurements of experiment by utilizing beings of reason, leads to a divorce in science between the true and the real. As Maritain says (and here it is best to quote him in full):

> Physico-mathematical theory will be called true when a coherent and fullest possible system of mathematical symbols and the explanatory entities it organizes coincides, throughout all its numerical conclusions, with measurements we have made upon the real; but it is in no wise necessary that any ontological law in the world of bodies correspond determinately to each of the symbols and mathematical entities in question. The need for causal physical explanation still immanent to the mind of the physicist, finally issues (in the highest synthesis) in the construction of a certain number of beings of reason based on the real and providing an image of the world (or a shadow of an image) apt to support his mathematical deduction.[11]

In light of this definition of truth, there can obviously be many true or viable physico-mathematical theories, as long as these are mathematically coherent and do not violate the measurements and data taken from experimentation. Thus, it is conceivable that there be a number of conflicting physico-mathematical models of the physical real, each true because each coherent and consistent with the data, i.e., able to "save the phenomena."

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empirioschematic sciences—and the philosophy of nature.) Improperly subalternated, or subordinated sciences need the subordinant science as provider, not of its own principles, but of regulative principles. Improperly subalternated sciences do *not* form a *scientia media.* (*Philosophy of Nature,* 102-113.)

[10] Jacques Maritain, *Degrees of Knowledge,* 41-42.

[11] *Ibid.*, 62-63.

Certainly, the physico-mathematical scientist does not intend to forsake causal explanations, nor to completely sever his connection to the real (and for this reason causality enters obliquely into his science, as when a physically conceivable entity is used at the start of a new theory), but he is entirely indifferent to the distinction between real being and the being of reason, and so holds that as long as his explanatory entities are defined by theoretically realizable operations of measurement they are real, because they really describe the behavior of physical matter; measurements, of course, are taken from the real.[12] Indeed, that connection of measurment with the real is what enables mathematical physics to remain a physical science, for ultimately its judgments must be verified in the sensible.

There is, then, in physico-mathematics a kind of double movement of the intellect. Because its material object is the sensible singular, and because it is a physical science, mathematical physics attains the essence only obliquely and in its effects. However, because it is formally mathematical, what it attains of the essence is attained in mathematical sign substitutes, by reconstructing the ontological essence in terms of mathematical being; either a possible being or *ens rationis.* As such, physico-mathematics is never able to transcend the mode of perinoetic intellection.[13]

The development of relativity theory and quantum mechanics support Maritain's analysis of the nature of mathematical physics. For example, relativity theory has done away with absolute space and absolute time, absolute mass, and absolute systems of reference, by applying a non-Euclidean geometry to nature in such a way as to make a reconstruction or reconception of space and time in terms of that mathematical being of reason not only possible, but more satisfying for explaining the data in question. In effect, relativity theory substitutes a mathematical absolute for a real absolute. Indeed, special relativity theory says that nothing can travel faster than light. Here the numerical value of the speed of light has itself become an absolute, for light's velocity remains the same regardless of the systems of reference of its observers. In fact, the whole of relativity physics proceeds from a concern to make its *laws* absolute by making them independent of observers and their systems of reference. Thus in relativity theory the course of events in nature becomes relative, but its laws obtain absolutely.[14]

When considering quantum theory we find that the nature and behavior of subatomic particles have been completely reconceived in terms of mathematical

[12] *Ibid.*, 140.

[13] "Thus in a general fashion, within the whole empiriological register, the resolution of concepts is made in an infra-philosophical direction." *Ibid.*, 141.

[14] *Ibid.*, 156.

beings of reason, as attested by the general reconstruction of de Broglie's "matter waves" into "probability waves."[15] Though electrons were initially thought to have real wave properties, these properties were subsequently reconceived by Schroedinger and others strictly in terms of mathematical probabilities. Indeed, in the wave mechanics developed by Schroedinger, the energy of a system is related to a wave function in such a way that that system can have only certain allowed values—the four absolute quantum number limits. But the wave function itself merely represents the probability that a particle will be found within a certain volume. In fact, much of quantum physics has to do with the imposition of numerical limits on various subatomic energy systems. Nevertheless, because the electron does exhibit real wave-like properties, one outcome of quantum mechanics (Bohr's complementarity principle[16]) leads to the understanding that the behavior of such a particle is unfigurable in imaginative intuition—how can one imagine and/or think an entity that is both particle and wave at the same time? Yet, such a particle *is* entirely conceivable in terms of *ens rationis.* Thus seemingly contradictory explanatory hypotheses can account for the behavior of the same entity.[17] Of course, many other examples from physics could be brought forth to demonstrate the same thing.[18]

Postmodern physics, then, displays the contrary motion of an ever greater immersion in the physical real considered as quantity, and an ever greater absorption in non-real mathematical beings of reason. Both movements tend to sever empiriological science from the philosophy of nature, from any ontological concern. As Maritain says, at the same time that mathematical physics reconceives the real in terms of measurements and pointer readings, it

[15] Cf. Heisenberg's *Physics and Philosophy*, (New York: Harper and Row, 1958.)

[16] Bohr's principle of complementarity simply states that an electron may be described either in terms of particles or wave motion, and that these views are somehow complementary.

[17] According to E. Picard, "[S]ome wonder whether or not the electron does not have purely analytical existence, since it is only a center of vibration in a wave system to which reality really belongs. For others only the waves have an analytical existence; a fictitious continuous field has been substituted mathematically for a discontinuous surrounding field" (Quoted in *Degrees of Knowledge,* 62, footnote 1). But whether these competing views represent real causal entities or are mere mathematical reconstructions of the real is of no importance to the physicist, as long as they account for the data.

[18] For example, related to Schroedinger's probability mechanics is Heisenberg's uncertainty principle, which states that if both the position and the momentum of an electron cannot be established (since one must invariably disturb a system in the very act of observing it) then the physicist cannot be sure that the consecutive observations of what he takes to be the same electron do not in fact belong to two distinct electrons. Individual electrons, therefore, cannot be identified, and there is only a mathematical probability that a particle will be found within a given volume.

turns "[a]side from the ontological by declining to integrate into the scientific tableau of nature the absolute elements that philosophy and common sense recognize in the real and by replacing those elements with beings of reason elaborated according to the exigencies of the deductive system to be constructed."[19] And I dare say that in severing science from the imagery of common sense and its grounding in the real, as well as from the philosophy of nature which provides the ontology for the world of common sense,[20] postmodern physics, *regarded in isolation from philosophy*, truly places man in the epistemic situation lamented by P. W. Bridgman.

Yet, when considered from the standpoint of its being a *scientia media*, the history of mathematical physics has been nothing less than inevitable, for the rise of mathematical physics could only have led to the conflict between science and the philosophy of nature which in fact ensued upon its discovery.[21] There were two movements to this drama; the first resulting in the collapse of the philosophy of nature into physico-mathematics; the second resulting in the complete expulsion of the philosophy of nature and ontology from mathematical physics. The first movement culminated in the creation of the great system of Newtonian mechanics, which sought to use mathematical physics to give ontological explanations of the phenomena of nature. The second movement culminated in the overcoming of classical mechanics, science's recognition of its own nature, and its subsequent understanding that science cannot penetrate to the real as it is in itself.

But the expulsion of ontology and the philosophy of nature from empiriological science, when seen from the perspective of science, is not to be regretted, for it was precisely the development of mathematical physics and its post-Newtonian separation from the philosophy of nature that made science's great advances possible. Therefore, scientists need not regret the fact that science has become divorced from imaginative intuition, or that it presents to the intellect a welter of conflicting hypotheses each true (because each "saves the phenomena"), but none of which, or only some of which, or all of which indifferently represents the real, for science has finally recognized that its concern is not with the real, or at least not with the real as it is in itself.

However, when seen from the standpoint of wisdom and the philosophy of nature, from the standpoint of the intellect's desire to know, to be left with nothing but sign or symbol substitutes in place of real causes—to be left with nothing but contemporary science—is a catastrophe, for only a wisdom which

[19] Jacques Maritain, *Degrees of Knowledge*, 157.

[20] *Ibid.*, 159. Also, "The New Physics dissolves the imagination into a world of symbols . . ." Cf. *Degrees of Knowledge*, 159-160, quote from Eddington.

[21] Jacques Maritain, *Science and Wisdom*, 40-41.

penetrates to the very nature of the sensible real can satisfy the intellect's desire to know the reasons for being of the sensible real. Only a true wisdom, a philosophy of nature operative at the first degree of abstraction, can make such a knowing possible. Only a philosophy of nature which views the sensible from the ontological standpoint can decide among science's conflicting hypotheses, can determine which of its "true" theories correspond to the real, or best represents the real.[22] It is the philosophy of nature, not mathematical physics, that is capable of deciding, for example, if space is ultimately Euclidean or non-Euclidean;[23] if atoms are real; if there is a *telos* in nature; if there is vital principle in living beings which cannot be reduced to the physico-chemical constituents of their bodies; and what must be the true meaning of determinism in science. It is also, therefore, the philosophy of nature, and not contemporary science, which must choose among the images of science those which will best suit its proper cosmology; for that a cosmology must be grounded in some image or set of images is inevitable.[24]

[22] Jacques Maritain, *Degrees of Knowledge,* 50.

[23] Maritain's reflections on the relationship between Euclidean and non-Euclidean geometries are particularly interesting. From the geometer's standpoint all mathematically possible spaces are real; that is, all spaces are real as long as they are consistent and derivable from their basic axioms. The mathematical physicist builds on this notion and holds any space to be real which is mathematically possible and explains the phenomena at hand in a coherent and comprehensive way. The philosopher of nature, however, defines a space as real, when, as a mathematical being, its characteristics pertain to quantity as actually existing in the world of bodies. Thus, while all mathematically possible spaces are true, only a few, or one, will be real. Now, it is possible to tell if a mathematical being is real in two ways. First, the genesis of the notion must be analized to see if it is incompossible with extra-mental existence. Secondly, to be real the being must be able to be constructed in imaginative intuition. Imaginative intuition, of course, presupposses sense experience, for mathematical beings are real only because they are ultimately grounded in sense existence. Hence, only Euclidean space is real from a philosophical standpoint, since only Euclidean geometry can satisfy these conditions. As Maritain says, "It is only by the intermediary of this space that others can satisfy the conditions posited" (*Degrees of Knowledge*, 168, footnote 1). Einstein's space, therefore, saves the phenomenon of gravity by embodying peculiar geometric properties, which nevertheless lack reality. Real space and geometric space are irreducible. Euclidean space is the best geometric representation of real space.

[24] "For the philosophy of nature cannot do without a scientific imagery. It needs the image . . . or the symbol that the science of its day fashions of the world" (*Degrees of Knowledge*, 182). The image that physico-mathematics provides the philosophy of nature with is of a universe whose ultimate entities can only be reductively based in the figurable. Thus, though these sciences lead the imagination into a realm of shadow and confusion, they also remind the physicist that the elements which make up the concrete existents of nature need not be directly representable to our senses. In this way empiriometric science is then free to formulate hypotheses based on models contradictory from an imaginative standpoint. Nevertheless, mathematical physics remains grounded in the figurable, and so the cosmological image which the philosophy of nature chooses must remain true to that grounding.

MARITAIN'S CRITICS

Now as we have seen, Maritain believes that the philosophy of nature can achieve these goals only by rising above empiriological science, taken both in its pure sense and in the sense of mathematical physics. This is why he insists so strongly on the need to recognize that empiriological science and the philosophy of nature work with two distinct formal objects. Maritain's critics, however, maintain that he has made too hard and fast a distinction between the sciences of explanation and the sciences of observation,[25] and that furthermore, such a distinction, *as he makes it,* is impossible from a Thomistic standpoint. Maritain's philosophy of science, they say, hinges on there being a plurality of specifically distinct sciences *within* the same degree of abstraction, namely, the first degree of abstraction.[26] These critics claim that there can only be one science within the first degree of abstraction, the philosophy of nature, and that what Maritain calls the empirical sciences are nothing more than a dialectical extension of the real science that is the philosophy of nature. The only way to create specifically distinct sciences, they say, is to identify specifically distinct principles, but since the science which deals with the genus also deals with the species that fall under it,[27] the only way to formulate specifically distinct sciences *within the same degree of abstraction* is to bring in principles *ab extrinsico.* This is in fact what happens in physico-mathematics, but there we have a *scientia media* straddling two distinct degrees of abstraction, not a specifically distinct science within the first degree of abstraction.

In addition, complain the critics, Maritain's conception of the philosophy of nature incorrectly leads the intellect toward ever greater potentiality instead of actuality, by forcing the intellect of the philosopher of nature up the Porphyrian tree of generalities. The correct notion of the philosophy of nature, on the other hand, indicates that the intellect of the philosopher of nature must descend toward ever greater actuality. Thus for these critics the true philosophy of nature begins with generalities and ends in concretion; that is, ends in empirical or dialectical science, which, because immersed in the sensible singular, can at best give us only probable knowledge. Taken by itself, such dialectical science cannot be called true science.

Finally, the critics of Maritain maintain that by mistaking a difference in

[25] Benedict M. Ashley, "Thomism and the Transition from the Classical World View to Historical Mindedness," in *The Future of Thomism,* ed. Deal W. Hudson and Dennis W. Moran, (Notre Dame, Indiana: University of Notre Dame Press, 1992), 113.

[26] Bernard I. Mullahy, "Thomism and Mathematical Physics," Dissertation (Gregorian University, Rome, 1946, 105-120).

[27] *Ibid.*, 109.

degrees of generality for a real difference marking specifically distinct sciences, he has inappropriately applied what the Commentators call total abstraction, *abstractio totalis*, to the philosophy of nature. In light of this misapplication, Maritain's ontological analysis of the sensible real can end only in the being of reason, not real being.

Taking these criticisms in reverse order, however, one finds that Maritain's critics are wrong on all counts, and that Maritain has not made the mistakes his detractors accuse him of having made. First of all, the philosophy of nature, being at the first degree of formal abstraction, does not, obviously, operate via total abstraction, *abstractio totalis.* True, total abstraction leads to ever greater potentiality, since it identifies the universal precisely from the standpoint of the logical relations which it bears to its inferiors. But the type of abstraction operative at the first degree of abstraction, as Aquinas says, is *abstractio totius,* which abstracts the essential *ratio* of an individualized nature; abstracts, that is, the intelligible essence, the whole (a form/prime matter composite) of the concrete existent, from the individual matter (the particulars or parts) that shroud its intelligibility. Since *abstractio totius* does grasp the essential *ratio* of as concrete existent — which as a form/matter composite separated from signate matter may be likened to a form disengaged from matter *per se* — *abstractio totius* is nothing more than a special instance of *abstractio formalis.*

Of course, the function of this type of abstraction (formal abstraction) is to grasp precisely the actuality, the real essence of the existent, not from the standpoint of the logical relations which such an essence bears to its inferiors, but from the standpoint of intelligibility. The function of *abstractio totius* is, then, to abstract from matter as the principle of unintelligibility, not from matter as the principle of individuality. Thus the philosophy of nature, in using *abstractio totius*, does identify and deal with actualities; namely the real essences of concrete singulars. If it did not do this, it would not be a wisdom in the proper sense.[28]

Furthermore, it *is* possible to have specifically distinct sciences within the same degree of abstraction. Generically, sciences are specified by the way in which the abstractive operation withdraws from matter. For Maritain, there are three ways in which abstraction withdraws from matter, specifying the three great general degrees of abstraction. Non-generically, however, sciences are specified according to the way in which the abstractive operation constitutes the object at a determined degree of immateriality.[29] Hence the degree of

[28] Cf. Edward D. Simmons, "In Defense of Total and Formal Abstraction," *The New Scholasticism.* XXIX (1955): 427-440.

[29] Jacques Maritain, *Philosophy of Nature,* 89.

immateriality of the formal object founds the specific diversities between the sciences. There can be, then, specific differences between sciences which belong to the same generic degree of abstraction; geometry and arithematic in mathematics being the prime examples. In effect, the ultimate principle for the specification of the sciences is the mode of defining, the way of conceptualizing a science's proper object and of constructing its notion and definitions.[30]

It is true, of course, as Maritain admits,[31] that Aquinas and the Commentators saw the empirical sciences and the philosophy of nature as belonging to the same specific class wherein the differences have to do with greater or lesser degrees of concretion, not a difference between distinct formal objects. But, as Maritain says (and this seems to be fully born out by the history of science, which has witnessed science's unsuccessful attempts to both appropriate ontology and to exclude ontology), when comparing and contrasting the empiriological sciences with the philosophy of nature, it is not just a matter of seeing the same formal object under greater or lesser degres of concretion; it is a matter, rather, of conceiving the same material object in entirely different ways. The philosophy of nature studies that object from the standpoint of its being, while empiriology studies the relations between the material notes of such beings, as these signify intelligible necessities, and as those in turn signify essential connections, essences, and their properties. The first concentrates on the concrete existent as an intelligible being; the second focusses on the material effects which the concrete existent presents to the senses. Both disciplines withdraw from matter in the same way, but constitute their formal objects through entirely distinct conceptualizations. Empiriology thinks its object in terms of being *as* sensible. But being — even the being of the concrete existent — is not to be identified with matter. As he does in *Approches Sans Entraves,* Maritain would say that the philosophy of nature studies being from the standpoint of a being's being present-in-the-world, not from the standpoint of being *qua* being. Nevertheless, what is grasped in the philosophy of nature and in the basic existential judgment of existence operative at the first degree of abstraction is not merely the sensible, but being *as* sensible.

CONCLUSION

In conclusion, we find that not only can Maritain's philosophy of science meet the criticisms of its challengers, it can, more importantly, resolve the epistemic dilemma raised at the beginning of this paper. The empirical sciences

[30] *Ibid.*, 98. [31] *Ibid.*, 91.

do not penetrate to the essence of the sensible real, they impinge on it only obliquely and in terms of the mathematical reconstruction of sensible effects and experimental constancies whose epistemological status is at best that of probability. Mathematical physics, in particular, has replaced the ontological real cause with mathematical preter-real causes, and so has inevitably led the intellect away from mathematical physics' initial grounding in the concrete and the imaginative intuition's reconfiguration of the concrete, toward an ever greater dependence on ultra-abstract *ens rationis*. Mathematical physics, then, has led the way in expelling the philosophy of nature from science. Given the latter's immersion in the world of symbols and its distance from the real, it should surprise no one that postmodern physics finds itself in a state of epistemic chaos, for its ultimate concern is no longer with what is real, but what works in terms of coherence, consistency, and "saving the phenomena." If this means that the world presented by science is unthinkable because literally unimaginable, so be it. It cannot be otherwise, given the very nature of empirical science. Thus empirical science, when taken in isolation from the hierarchy of knowledge grounded in it, is clearly insufficient from a higher philosophical perspective.

But empirical science is not the end of the story, for though autonomous in terms of its principles, empirical science does not exist in isolation from the degrees of knowledge resting upon it. As we have seen, empirical science seeks completion in a higher wisdom that is the philosophy of nature (not metaphysics).[32] That wisdom, centered as it is in intelligible being and so in certainty, is the final arbiter when it comes to the great themes of nature. It tells us that there is absolute space and absolute time; that space is ultimately Euclidean; that all concrete beings are really divisible into matter and form; that living sensible beings are really divisible into body and soul; that there is a *telos* in nature. Yet, as a higher wisdom, the philosophy of nature is a science specifically distinct from the empirical sciences, and that is how it is able to accommodate the findings of science, and to allow them their freedom while at the same time justifying and defending their very principles. Only a philosophy of science which understands the special relationship between empirical science and the philosophy of nature can show how, *together*, these knowledge disciplines (with, of course, mathematics, metaphysics, and theology) make a true cosmology possible—a cosmology able to accommodate

[32] Nevertheless, for Maritain the philosophy of nature is a participation of metaphysics, for the first degree of abstraction participates the third (*Degrees of Knowledge*, 40, 178-179). Yet metaphysics studies being as being, while the philosophy of nature studies being as mobile, as sensible (Cf. *Philosophy of Nature*, 118-120).

change[33] and the most contemporary forms of science, but grounded in the imaginative intuition and common sense. Maritain's is that philosophy of science, and Thomists would do well to pay it more attention.

[33] Maritain's philosophy of science fully recognizes the contingent and the changeable, and makes a prominent place for these in its conception, for the world of concrete existents that empirical science comes in contact with is "[n]ot the world of pure intelligible necessities. Essences and natures exist within existing reality; from it they (or their substitutes) are drawn by our mind, but they do not exist there in a pure state. Every existing thing has its own nature, and amongst them there are encounters which are themselves not natures, the necessity for which is not prescribed in any nature. Existing reality is therefore composed of nature and adventure. That is why it has a direction in time and by its duration an irreversible history—these two elements are demanded for history, for a world of pure natures would not exist in time, there is no history for a world of Platonic archetypes" (*Degrees of Knowledge*, 26). This is also why probability plays an ever greater part in physics. As it does so, it thrusts the notion of causality into the background, particularly in the subatomic world where classical mechanics cannot account for the behavior of particles in such a way as to enable the physicist to say that they are completely determined at each instant. Hence Heisenberg's indeterminacy principle. Of course, as science divorces itself more and more from the philosophy of nature, it comes to rely more and more on probability.