Maritain's "Middle" Philosophy of Science in *The Degrees of Knowledge*

I believe that Maritain gave us the only hope for sanity in the philosophy of science. The debates between realism and instrumentalism in science, as well as the debates about whether science does or does not "explain," are based on false dichotomies and false premises that Maritain can show us how to avoid. But a lot of work needs to be done for his philosophy of science to fulfill its promise. One of the most important things that needs to be done is to solve some problems about his philosophy of science that have so far not been solved.

1.

Maritain's theory deserves a much more realistic interpretation then is usually the given it. He is much more of a scientific realist then he sometimes appears to be. And I am thinking even of his theory of mathematical physics. Why more realist? (1) because perinoetic knowledge in general, of which mathematical physics to species, is a way of knowing the natures of things. Mathematical physics knows laws which express the way natures behave as well as empirioschematic sciences do. (2) because beings of reason, in general, are ways of conforming the mind to the real for Maritain (whether or not he justifies this view). (3) because there are degrees of ideality in beings of reason themselves. Atoms and electrons really exist for Maritain. (4) because mathematical physics is not symbolic as such for Maritain. It is indifferent to the use of beings of reason or real beings.

At least that is true of the position he takes in "The Degrees of Knowledge," "The Philosophy of Nature," and his unpublished MS on Major Logic. On p. 163 of DOK, near the bottom, he says that in science symbolism and realism are indissolubly united. (See also the end of the footnote on p. 43.) This distinguishes him clearly from traditional analytic instrumentalism. On p. 164, he explains why he is more realistic than Eddington. He goes on from there are to explain how his theory is a realism even though it talks about symbolism at the same time.

But taken alone, his later articles "Science and Philosophy" in "Scholasticism in Politics," "Philosophy and the Unity of the Sciences," and perhaps his references to science in "On Human Knowledge" in "The Range of Reason" (which I am not checking now) can appear to give a much more instrumentalistic picture of science. Some of his writings prior to "The Degrees of Knowledge" can also be read as more negative toward science's relation to the real.

To avoid becoming embroiled in historical and textual questions, I will focus on the positions of DOK, which I call Maritain's "middle" philosophy of science in deference to the possibility that he held different positions before and after DOK. But because his later articles can appear to be strongly instrumentalistic, I will begin with some remarks intended to show why the later articles may <u>not</u> reflect a change from DOK.

xxx after reading "philosophy and the unity of the sciences," June 8, 2005
This is from proceedings of the American Catholic philosophical Association, 1953. Maritain here speaks as if modern science is "symbolic as such" to use the phrase from "the degrees of knowledge" where he denies that science is symbolic as such. If he does not explicitly affirm that all science is symbolic, he certainly can be interpreted as if he thinks that. The articles in "scholasticism and politics" and perhaps in "the range of reason" can be interpreted that the same way.

Four things to keep in mind about these articles. First, they are summaries of the positions of "the degrees of knowledge." Those positions are subtle and complex. Summaries cannot be expected to capture all the subtleties and complexities. Summaries cannot do justice to them. And it is precisely the subtleties and nuances that allow the positions of DOK to avoid the pitfalls of other philosophies of science that have much more negative views toward the realist and explanatory nature of science.

Second, these articles were written after Maritain became aware of the work of the logical positivists. There is no evidence that he was familiar with them at the time of "the degrees of knowledge." And it is clear from the chronologically first of these articles that Maritain was very interested in underscoring the points of agreement between his positions and those of logical positivists. Emphasizing the similarities between his views and the logical positivists can only make his views appear more instrumentalistic than they were in DOK.

Third, in these articles Maritain may have intended to emphasize those things that are specific to science as opposed to philosophy even if they are not universal to science. Science often uses explanatory beings of reason in place of natures; when philosophy uses beings of reason, on the other hand, it does not do so as substitutes for the knowledge of nature, of essence. But while that way of using beings of reason is specific to science, it does not follow that science always uses beings of reason or is "symbolic as such." (Similarly, when Aquinas talks about "separation" in the commentary on boethius, nothing in his text requires us to attribute any more to him than the view that, while the philosophy of nature and mathematics never use separation, metaphysics sometimes does. That is, separation sometimes occurs in metaphysics [the via negativa] but never in other fields.)

Fourth, in these articles Maritain may have intended to emphasize his contributions to the Thomistic philosophy of science, things that make his philosophy of science a needed addition to previous Thomistic philosophy of science. His explanation and justification of the use of beings of reason (BORs) in mathematics and, therefore, in mathematical physics, certainly is such a contribution and a very important one that deserves emphasis. But the fact that he may have been concerned to emphasize that contribution need not imply that he came to consider mathematical physics symbolic as such.

For these reasons, there is at least some hope for the interpretation that Maritain still believed that empirical science is not symbolic as such. For that position, the position of the "degrees", is certainly the more accurate position and more faithful to the principles and arguments that Maritain used in the "degrees". One of the great virtues of his positions there is that they are balanced and nuanced; they do not oversimplify; they do not push a particular point of view to an extreme.

From one legitimate point of view, in fact, we can call the position of DOK a realist defense and justification of the use of mathematical BORs in science, a defense of their use that is based on realist principles and justifies calling mathematical physics a way of knowing the natures of things. This is not the only point of view that we can take on the DOK. But it is a legitimate one that has been almost entirely overlooked and provides a needed balance.

January 15, 92

Maritain's later language and formulas concerning science tend to be more negative than his own principles justify. Simon brings this out, implicitly, in his article on Maritain's philosophy of science, by using more balanced formulas which, though more balanced, are strictly consistent with Maritain when taken literally. We should stick to what follows from Maritain's principles. Or at least I am only interested in what follows from his principles.

2.

In any case, to understand DOK’s apparently negative comments about empirical science in general and mathematical physics in particular, we have to understand that when he makes those comments he is contrasting empirical science to another mode of knowing, philosophy. He had in mind specific examples of what he calls ontological analysis and his negative comments about science are basically saying that science does not achieve the kind of cognitional relation to what things are that ontological analysis achieves. He is taking ontological analysis as the standard, comparing science's analyses to that standard, and saying that they are not equal to that standard.

But to say that a mode of knowing does not come up to a certain standard is not to say is not to say that it is not a way of knowing what things are that is legitimate in itself and on its own terms. Maritain’s whole point is that science has a way of knowing what things are but a different way of knowing what things are from the gold standard of philosophy. Maritain's way of speaking does not always make this clear. For example, he speaks of science knowing what things are blindly. He has other such phrases for this that I am not going to look up now. Someplace else he speaks of knowing by way of not knowing. I don't think he uses that phrase in the context of science but it makes the same point, that is, this example makes the same point that I want to make about his language describing science.

Such phrases are ½ of what Simon calls analogical sets. One part of an analogical set is the double affirmation of the common ground. For example, knowing by way of knowing. The other part is an affirmation together with an apparent denial of the common ground. For example, knowing by way of not knowing. Analogical sets are all over the place in Maritain. Another example that comes to mind now, but there are many others, is practically practical as opposed to speculatively practical. Contrary to Simon, who thought he found analogical sets in mathematics, I argue in causal realism that analogical sets are specific to ontological analysis. (Maritain also thought you could find analogy in math, DOK, p. 169.) In any case, to say that science knows what things are blindly is a way of "denying," by diminishing, the common ground, knowledge, at the same time that we affirm it. But the affirmation is still an affirmation that science is a way of knowing what things are. In the degrees of knowledge, p. 164, and about the middle of the p., he precisely affirms that the reason he can recognize the realistic value of scientific knowledge is that he has another way of knowing, namely, the philosophical way that there are substances and natures in the physical world.

This is true of the mathematical physical sciences as well as of other physical sciences. But the way Maritain talks about mathematical physics can make it appear that it is a much more tenuous way of knowing what things are than he thinks it really is. I have just reread his chapter on time in "Theonas." Consider the last sentence on page 99 in

"Theonas." It contrasts relative measures to the absolute realities that they presuppose. So he is referring back to the analysis of absolute time that he has just given in that chapter. That analysis is an examples of what we will later call ontological analysis. If it isn't, what is? At the end of that sentence he says that physics cannot represent that which is directly. Well, by this time in the chapter we know what he means by "directly." He means the kind of knowledge that his analysis of absolute as opposed to relative time has illustrated. But he certainly does not mean that scientific measurements of relative spaces are not truths about what things are. In fact, he clearly means the opposite.

But science's way of knowing is a different way from philosophy's, which he here describes by the word "directly." What does the mean by "directly?" The kind of knowledge of what things are that philosophy gives, here a knowledge of time, or of what time is absolutely as opposed to relatively. Physics can only objectify what quantities of time and space are by relating one quantity to another as equal to it, lesser than it or greater than it. Still, this is true knowledge of what real quantities are. So if we keep in mind a concrete example of what he means by directly as opposed to not directly, we see that physics is just a lesser way of knowing what things are but still a way of knowing what things are. He has a standard for what a direct representation of reality is. And he compares the goal that physics achieves to that standard.

On page 101 he considers it to be a logical possibility, though practical impossibility, to harmonize the mathematical interpretation of nature with the philosophical. In the degrees of knowledge he denies this possibility. That denial may appear to be more negative toward science. But really it is more positive. What he is saying later is that physics has its own autonomous value as a way of knowing reality. Physics needs to be completed by philosophy but not in its own order. Distinguish to unite. The approach of physics the does not satisfy the human intellect, so the human intellect also needs philosophy. But physics does not need philosophy, except implicitly as I will explain later, to be a valid way of knowing of the real.

xxx McCool, January 25, 91

In "from unity to pluralism" there is a good description of perinoetic knowledge in the section on LeBlond, page 218. “Most concepts are no more than a group of schemes ... a collection of sensible representations that serve as a provisional label used to designate an essence." Almost exactly Maritain's view. Only of man and things of man do we know specific essences. Yet McCool ignores this and accuses Maritain of the opposite on page 220.

xxx perinoetic knowledge and essence, March 28, 89

In "formal logic," page 24, Maritain explicitly states that what he later calls perinoetic knowledge grasps essence.

Does Maritain think two parts hydrogen/one part oxygen expresses the essence of water? Yes. See Simon's article, the "essence" section. Maritain even says in "the degrees of knowledge" that the philosopher must consider chemical differences substantial differences. But when we look more closely at how science conceptualizes the atom, we see this is not ontological knowledge of essence.

Pages 42 and 43, note two, last paragraph: he seems to classify the symbolic knowledge of mathematical physics with perinoetic knowledge by signs. But the last sentences here show that mathematical physics is not always symbolic. (Against Duhem.)

Page 59, top: again, mathematical physics is not always "fictional" or symbolic. (Against Duhem?)

Page 133: beings of reason do not deserve the name essence, since essence is the capacity for existing. But (page 134, second paragraph) beings of reason are means of conforming to the real.

Page 135: good examples of how beings of reason, since founded on the real, can make manifest that which exists outside the mind, for example blindness or is-seen as in "Neptune is seen by me" (compare the last to the fact that we objectify the intrinsic quantities of things by relating them to other quantities). To know the real we must construct beings of reason like blindness. (To the extent that it makes use of a being of reason, negation, a concept of infinity is a being of reason. What is objectified, the word function of "infinite," is identical with what some real being is. But it's mode of objectification does not conform to what exists. So beings of reason can be ways of objectifying real existents.)

Also, good examples of degrees of reality and unreality in the beings of reason by which the real is manifested to us.

Page 147, note two: not only does perinoetic knowledge grasp observable reality but constructed beings of reason grasp observable reality also. An affirmation of realism in Maritain's theory.

Page 141: the explanatory entities of science are beings of reason in various degrees, especially atoms and electrons. But the implication of that is that to the degree that they are not beings of reason they are real beings. So the explanatory entities of science are real beings, or can be real beings, in varying degrees. (Against Duhem?)

“The Philosophy of Nature, page 101: in the mathematical sciences the real is conceptualized by beings of reason "at least in the most theoretical parts of such sciences." So they are not totally sciences of mathematical symbolism. And this remark may also distinguish him from Duhem.

3.

Now I will focus on the discussions of physics in chapter two of the degrees of knowledge. I have deliberately refrained from re-reading chapter 4 at this time because I believe it gives an even more clear version of a kind of scientific realism than does chapter 2. So if we must attribute a kind of scientific realism to Maritain in chapter 2, we must certainly do it in chapter 4.

On page 43 he refers to fictional causal entities whose sole function is to serve as support for mathematical deduction. This is reminiscent of page 100 in the chapter on time. But in the earlier place he had said that the sole function of an entire theory was to provide support for the imagination at the and of the chain of mathematical reasoning. Now he goes on to say that those very fictive causal entities "come to include a detailed account of empirically determined real causes or conditions." (The English has "cases" where it should have "causes.") Of course this raises the question of what justification Maritain has for referring to real causes here. But let us go on.

On page 44 he criticizes Duhem's saying that physics usually makes use of pure mathematical symbols without attempting causal explanation or the constructing of figurative hypotheses. And he adds that the mathematical symbols the physicist uses are just waiting the chance to leave the realm of pure analytical forms and become explanatory entities. What does he mean by explanatory entities here? Does the mean fictive causes or real causes?

Before answering that question, I need to comment on his use of the word "symbol". In a very important passage on p. 164 he says that physical theory is not symbolic as such. There he means by symbols beings of reason that he contrasts to *real* causal entities. So, as the passage on Duhem indicates, his use of the word "symbols" need not be in contrast to causal entities of any kind.

As to whether the causal entities that the symbols of page 44 are waiting to become are real or fictive, I next want to quote from page 61. There he is talking about physics being formally mathematical and materially physical. He says that physics is oriented towards physical reality and physical causes as the terminus of its investigation. But it does not aim to grasp their inner ontological nature itself. Note the word "ontological." This is a hint that he is contrasting physics to ontological analysis as two different ways of knowing the real, but still ways of knowing the real.

The fact that physical causes are the terminus of science's investigation is another important point. Again, the context is the distinction between being formally mathematical and materially physical. In that context the word "terminus" refers to that which is known as opposed to that by which is known. See the quote from Aquinas that begins the second paragraph of footnote two on page 42. So that by which physics knows is mathematical but that which it knows is physical. This is a clear affirmation that that which physics knows is physical reality and physical causes.

It may be that the symbols of page 40 are just waiting to become fictive causal entities. But this referred to what physics is formally not materially. So that by which physics knows real causal entities may include fictive causal entities. But as page 164 said, not all the theoretical entities of physics need be fictive. (But how is it possible to *know* real causes by way of fictive causes? What does it even mean to say this? Again, the ontological nature is hidden. Ontological knowledge is the gold standard for knowledge, but not the only kind of knowledge. To the extent that a mode of knowing falls short of this standard, it may make use of BORs. More below on how BORs allow us to *know* reality.)

The second paragraph on page 61 parallels the discussions of absolute and relative dimensions in the chapter on time in "Theonas." Or I should say that we should have the chapter on time in mind when we read that paragraph. Of significance is the fact that he here uses the word "ontological" which I do not recall him using in the time chapter. So when he says that it is to the measurable that physics reduces all its concepts, we should think of the contrast of absolute and relative dimensions, because we should think of concrete examples of the distinction between the way ontological analysis works and the way science works, or between the way ontological analysis knows and the way science knows. For example when he says that for physics only the measurable has meaning, we should recall what he said about absolute dimensions not having meaning for the physicist.

And when the last sentence says that physics only demands that numerical results coincide with measurements, we have to think back to the discussion of Duhem on page 44 where he says that science can use pure non-explanatory symbols. It therefore only demands numerical agreement strictly speaking. But when he says that the mathematical relations that are the formal object of physics undoubtedly need to be completed by a certain hypothetical reconstruction of the real, we have to think back to the remark on page 44 about symbols just waiting to become fictive explanatory entities. (As examples of non-explanatory symbols that have become explanatory, he gives energy and the atomic number.)

This reading should give that last sentence, appropriately, a more realistic cast. The scientist desires to know reality. Its way of knowing, by measurements, does not reveal to it absolute dimensions as such. But it's measurements are real and are a way of knowing that which is as-a-matter-of-fact absolute. Quantitative relations are the formal object of physics, that is, the means by which physics knows that which it knows its material object, physical causes. And the normal way for its theories to deduce those mathematical relations is by postulating entities that fictively represent real causes.

The final paragraph on page 61 and carrying over to 62 introduces another important analogical set by giving the definition of truth for science that constitutes a secondary analogate of truth to philosophical truth. The last paragraph of footnote 1 on page 62, the paragraph that carries over to the next page, makes some crucial comments. The paragraph is about Duhem's theory of saving the appearances. The second sentence of that paragraph states, against Duhem, that theories that save the appearances are true causal explanations. But he goes on to contrast scientific truth to metaphysical truth, which he calls absolute. So metaphysical truth is the primary analogate of an analogical set. As a member of an analogical set, the second member is a diminished yet still genuine instance of the analogue.

Next he says that from that point on it becomes a secondary question whether the theory has a value of a causal explanation in a scientist's mind. That sounds like a very instrumentalist, as opposed to realist, statement. But first, notice the phrase "from that point on." What point? The point at which we know that these are causal explanations, contrary to Duhem, in the sense that Maritain has just stated that they are. And that sense is, by the implication of the words "secondary question," the primary question. The original sentence continues after a semicolon. The word following the semicolon is "for" (I am not checking the French at this time). So what follows the parenthesis is meant to be an explanation of what preceded the parenthesis. The reason why it is secondary whether a scientist considers as causal what has already been identified as causal in the primary question is that what is causal in the sense that is primary for a discussion of saving the appearances still does not have a directly "ontological" significance.

Again, we find the word "directly" that we saw in the chapter on time as distinguishing the way the philosopher looks at the intrinsic nature of things and the way the scientist does. But now the word directly modifies the word ontological which is put in quotation marks. There follows immediately a reference to the specific discussion of ontological analysis vs. empiriological analysis in chapter 4. So we have here an explicit explanation of what he means by the word "directly" and an explicit statement that he is not using the word "ontological" in just a general sense. Rather, he has in mind his own original theory of ontological analysis.

So we have an explicit statement that his negative sounding statements toward scientific realism are to be understood precisely as saying that scientific knowledge does not come up to the standard of ontological knowledge. And that is what he has implied in the sentence preceding the "secondary question" reference, where he calls metaphysical truth absolute and contrasts scientific truth to it. So again, science is a way of knowing real causes and natures, but a way that falls short of the ontological gold standard.

Going backwards to page 45, we find in the middle of the page the statement that science has given up the "direct" search for real causes "in themselves." We should now know that such statements are not intended as outright denial of scientific realism.

(When Maritain's meaning for perinoetic versus dianoetic knowledge of essences and real causes "in themselves" has been purified of all the misunderstandings, someone who knows Kant better than I do should compare what Maritain says to what Kant says about not knowing the "ding an sich." Both Maritain and Kant say that science does not know things "in themselves." In going beyond that to deny that we can *ever* know things in themselves, is Kant just denying the validity of the kind of knowledge Maritain calls ontological? That would support the interpretation of Kant as an "empirical realist" but "transcendental idealist." But Maritain could supply what this interpretation of Kant is lacking: a clear account of what knowledge of things in themselves would be in terms of ontological, rather than "transcendental" analysis.

Reflexions, 214, n. 2: "Apparent' time lengthening and spatial shortening does not mean subjective appearance. It means beings of reason constructed by science on the basis of sensible observations. Corresponds to Kant's distinction between Schein and Erscheinung.")

4.

The following comments come after re-reading chapter 4 of the degrees of knowledge, up to the section on the philosophy of nature, and chapter 6 of reflections on intelligence. On p. 182 of the latter, he makes a very important statement about what he means by the knowledge of "what things are" that the scientist cannot obtain but that the philosopher would like to obtain. He says that physics abstains by definition from considering in things anything other than what mathematics considers, and therefore it ceases to seek directly the knowledge of that which things are and by consequence knowledge of true principles of sensible reality. What does the mean by "directly?"

He immediately notes that all speculation on the nature of things would be for such a science an auxiliary hypothesis. A more or less convenient auxiliary, arbitrary, and accessory hypothesis designed to hold the imagination. He could not say in a much stronger way that the kind of philosophical analysis of what things are that he would like to have, the kind he describes as knowing the nature in itself when he states that science cannot know the nature in itself, is not something that science would like to have but cannot get. That is, it is not something that the scientist as such would like to have but cannot get.

So examples of that kind of knowledge would be scientifically irrelevant. Such would be the answer to the question of whether there is more than one substance in the universe. The scientists could not care less. Knowing that there was would not help the scientists at all. One implication of this is that philosophical truth is not going to affect the scientist on her use of beings of reason at all. Knowing a philosophical truth will not change the need for being of reason A as opposed to being of reason B.

So when he sounds as if he is disparaging science because science does not know nature in itself, we must keep in mind these kinds of examples. He is only saying that science cannot obtain that kind of knowledge. And when we look at the kind of knowledge he is talking about, we see that there is nothing at all wrong with the fact that science does not obtain that kind of knowledge. There is nothing at all wrong with that fact especially from the point of view of science. The kind of knowledge of what things are attained by philosophy or commonsense is not a better scientific answer to the question what things are.

Still it is crucially important for his philosophy of science that Maritain has this other kind of knowledge to compare science with. In fact, as compared to other contemporary philosophies of science which have no standards to appeal to other than the empirical and logical, Maritain's philosophy of science must seem to them to be an hypothesis that is at best auxiliary, accessory, arbitrary, and having value only for the imagination.

Consider the issue of scientific realism itself. If science is our only kind of knowledge, if there is no other kind of knowledge that provides a standard for questions about what is realism and what is not, how can there even be an issue about scientific realism? Must not whatever science says about anything be the only standard for what is real and what is not? Or, if someone does not want to talk about scientific realism, isn’t the most they can say something to the effect that there is no such thing as realism? Either that or they do not want to use the only possible standard for realism as a standard for realism.

The following would not be an adequate reply for an analytic philosopher to make to this objection: “we define scientific realism as the affirmative answer to questions like does science require us to believe in the truth of statements like ‘atoms exist’." To see that this is not an adequate answer compare" atoms exist" to "En-lil's roar occurred" (if I recall correctly, that’s a Babylonian or Abyssinian way of saying that it thundered. See Ed MacKinnon’s book “Truth and Expression”). The truth of the latter would imply that En-lil exists. But compare "En-lil exists" to "Peter Pan exists". Neither En-lil nor Peter Pan exists. But when we say that En-lil's roar occurred, we do have knowledge of the existence of something, something other than En-lil whose existence En-lil is postulated to explain. So even though we have an incorrect answer to the question "what is it?" for this "something", we know that the senses give us evidence for an affirmative answer to the question "is it?" or the question "does something exist?" So that we need some explanation of the kind that En-lil's existence was meant to provide us with.

So En-lil's existence provides us an example of what Maritain means when he talks about our knowledge not being “symbolic” as to the existence of atoms but symbolic as to the nature of that which exists when atoms exist. If we do not have correct knowledge of the nature of atoms, still we certainly are correct in thinking that our concept of atoms is an attempt to describe something that does actually exist, like our concept of En-lil's roar and unlike our concept of Peter Pan.

But could an analytic philosopher of science make this kind of distinction and so save his defense of calling his inquiry an examination of scientific realism? Without the kind of alternative standard that Maritain has for knowledge of what exists, I do not think so.

We cannot have knowledge that something answering to some word, whether a name or predicate or pronoun, exists unless we have at least some true knowledge of what it is that exists. We cannot know bare unspecified existence; we can only know the existence of something. But can someone like Quine make the kind of distinction that Maritain could allow between knowing whether En-lil exists and Peter Pan exists? Both of these assertions are false. And they are false because of what it is that is asserted to exist. And since all kinds of knowledge for Quine are really forms of the same kind of knowledge, namely, empirical knowledge, falsehood in this respect would leave no room for truth in another respect.

So Maritain's "unrealism" is almost the antithesis of, for example, Rorty and von Frassen. Moreover, Maritain has standards for arguing that something is a being of reason in this particular case. And his statements about the relations between facts, law, and theory need only be verified by the relative position in science of particular propositions. So he has no need for universal criteria for identifying theoretical statements. He has a section in chapter 2 on distinguishing theoretical elements within factual statements. But that problem is different from analytic philosophy's problem about there being no universal criteria for distinguishing fact from theory.

(. . . . But perhaps most basically and most to the point is the fact that he distinguishes different meanings for the word "real" in philosophy, mathematics and science (pp. 165-167). In making this distinction, he is an effect is saying to Quine go ahead and quantify over any entities you want. For the scientist to assert the existence of, for example, a non-Euclidean space does not commit the philosopher to asserting its existence.)

5.

[Digression: Before going any further I'll try to give an even clearer example of an ontological analysis. Consider the statement that the human soul is immaterially subsistent. The word soul is defined as a substantial form. Substance is an ontological concept because it is defined as that which exist in itself or that which does not exist in another. The difficulty with defining ontological analysis is that it requires another analogical set. The common ground of the members of the set is the inclusion of a concept of being or of that which exists. But the concept of being is logically included in all concepts, in one of the senses of logical inclusion that I explain in causal realism. So to find a way of expressing what an ontological concept is we have to find a way for a concept to include being that we can affirm of ontological concepts and deny of all other concepts.

Being is included in all concepts as a common element. That means, for example that it is included in the concepts of red and green in the same way; the concept of red does not distinguish red from green by a way of relating to being that green does not share. Red is in fact a different way of existing than is green. But the way that being is included in the concepts of red and green does not objectify red as a different way of existing. The way being is included in the concept of red objectifies a way in which red is similar to the green, not different from green.

Likewise, being is included in the concepts of substance and accident as it is included in all concepts, namely, as a way in which substance and accident are similar. But in addition being is included in the concept of substance and accident as a way in which they differ. That is, the concept of substance distinguishes substance from accident by a way of being related to existence that accident does not share. Not only are substance and accident different ways of existing, as are red and green, but also the definitions of substance and accident objectify them as being different with respect to their relation to existence. Substance is that which does, and accident is that which does not, exist in itself or not exist in another.

So all concepts include existence, that is, a relation to existence, as something common. But ontological concepts also include a relation to existence as something that distinguishes concepts from one another, that is, distinguishes the objects of the concepts from one another.

So one part of the concept of soul is ontological, namely substance, what about the other part, form? Form is that which causes the result of the change to be what it is. What-it-is is, by hypothesis, an ontological concept; and so is change. Change is coming into existence out of what already exists. So the concept of soul is an ontological concept.

Now one of the things that the argument for the subsistence of the soul shows is that humans, as opposed to other material things, have abilities that must come from the substantial form, as opposed to coming from some efficient cause other than the efficient cause that brought the substantial form into matter. That is, the ability to think by means of universal concepts cannot be an accident added to us so that it would not derive from our substantial form. If it were added to us and did not derive from our substantial form, our substantial form need not differ from those of animals. The differences between humans and animals could be explained completely by accidents.

The only way it makes sense to speak of two things being different kinds of substance is to say that one has accidents that the other lacks and that these accidents can only be derived from the substantial form. The argument for the subsistence of the soul shows that in the case of human beings. For that argument shows that those things that can think by means of universal concepts must have a substantial form that is capable of its own activities, activities that do not belong directly to the whole but belong to the whole because the substantial form belongs to the whole. On the other hand, things in which the ability to think by means of universal concepts is lacking do not have a substantial form capable of its own activities. So ontological analysis reveals that between things that can and things that cannot think by means of universal concepts there is a difference of having subsistent and non-subsistent substantial forms, respectively, substantial forms that do or do not have activities of their own, and so can or cannot exist apart from matter.

This is an example of what Maritain would call dianoetic intellection as opposed to perinoetic. We don't stop at the surface but penetrate to the substantial essence. But here I want to focus on the fact that this dianoetic intellection takes place by way of ontological, as opposed to empiriological, analysis.

The ontological analysis/empiriological analysis distinction is more important for Maritain than the Dianoetic knowledge/perinoetic knowledge distinction, because he keeps coming back to the former again and again in "the philosophy of nature". Likewise, Simon refers to it much more often, whereas Sikora refers to the dianoetic/perinoetic distinction much more often. End of digression.]

6.

Now let us return to the comparison of science and philosophy. By way of another analogical set, Maritain can both speak of the essences of things being hidden from us and say that we always know what things are in some way. He says we can know essences quidditatively or non-quidditatively, which amounts to saying that we know quiddities quidditatively or non-quidditatively. And the fact that essences are hidden from us is one of the reasons why science uses fictions and beings of reason. But that raises one of the problems with Maritain account.

The fact that essences our hidden from us is not enough to justify or explain using BORs. For in the case of physical natures, why couldn't we at least guess the truth about essences. The fact that something is hidden from the does not prevent me from at least guessing the truth. Whether Napoleon wept at Waterloo may be forever hidden from my knowledge. But that the does not prevent me from having a 50-50 chance of guessing the truth.

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Why can't we guess at the hidden essence of physical things? Because to do so would require ontological concepts, and ontological concepts do not descend to that level of detail. The cannot get to the detail of phenomena because of the causal opacity of empirical concepts (see Causal Realism).

So one answer Maritain could give would be that the correct guess would be a guess at an ontological analysis, and ontological analysis simply can't descend to the level of details we are talking about. (Ontological analysis and dianoetic intellection are distinct concepts, but are they co-extensive? No, at least because math is dianoetic. But what about knowledge of real existents? From Maritain’s examples of dianoetic intellection — Jim is fallible because jim is the human being, man is political, man has free choice, human beings are mortal, human beings are risible — it would seem that they are not coextensive; these are not examples of explicit ontological analysis. But a philosophical grasp and justification of these common sense level dianoetic intellections would require ontological analysis.)

But why can't ontological analysis descend to the details of phenomena and thus allow us to know physical quiddities quidditatively? One reason is that ontological concepts are very general concepts like being, existence, essence, cause, effect, substance, accident, act, potency, necessity, contingency, change. The most we can get out of ontological analysis is what we can get out of concepts like that, what we can get working with concepts like that.

At the other end of the conceptual spectrum, concepts immediately derived from sensory experience do not reveal causal connections sufficiently to allow us to penetrate into the nature of causes ontologically. As the example of the argument for the subsistence of the soul illustrates, it is by way of causal relations that knowledge moves from what is known to what is not yet known. Thus the soul's subsistence is recognized by the soul's ability to produce effects of certain kinds. But empirical concepts are causally opaque, as I explain on pages 340 to 342 true of ‘causal realism.”

The "details of phenomena" that Maritain contrasts to the object of philosophy, being, are features of experience that we can distinguish from one another by the operation of the senses alone. For example, by the sense of sight alone we can know that of the liquid in one tube is higher than liquid in another tube, or that the liquid in one tube has reached a the mark next to a shape like "3", and the liquid in another tube has reached a mark next to a shape like "4". But by the senses alone we cannot understand the concept of heat as the energy of moving molecules.

Logical positivists were concerned about verification. Meaningfulness was only consequence of verifiability. But their opponents focused more on Verifiability than on meaningfulness. To be verifiable, a proposition had to imply some *difference* in our experience. For example, the unverifiable proposition "God exists" is compatible with every variation in our experience; therefore it is unverifiable by experience. No variation in experience could speak more for the truth of "God exists" and could any other variation. On the other hand, "water freezes at 32 degrees" makes a claim about one specific variation in our experience as opposed to all others, namely, that the thermometer will read 32, and not any other number, when water freezes.

This logical positivist point corresponds precisely to what Maritain means by philosophy not being able, while science is able, to explain the details of phenomena. Because philosophical principles express what is true of being or sensible being insofar as it is being, not insofar as it is this kind of being or this kind of sensible being as opposed to any other kind, ontological principles cannot give us knowledge of the details of phenomena because they cannot apply more to one particular variation in our experience more than to all other possible variations in our experience. They are true no matter what the variations in our experience. So the logical positivists show why Maritain is precisely correct in distinguishing these two modes of knowing and in stating that because philosophy is ontological it cannot give us an explanation of the details of experience as such. In philosophy, the "formal perspective" (Maritain uses this phrase somewhere, perhaps page

37 of his ACPA talk on the unity of the sciences) is being. Therefore the perspective of philosophy is what is true no matter what variations occur in experience.

So we cannot even guess at the kind of ontological analyses that would be relevant to the objects of our experience. In fact, we only seem to produce adequate ontological analyses at the specific level where we are aware of causal relations introspectively. I do not mean to imply, however, that the only true statements we can know using ontological concepts are statements about ourselves. But outside of the details of human nature, ontological analysis must remain at a very general level. For an example, we can go back to the chapter on the mathematical attenuation of time. Maritain demonstrates that there must be simultaneity between physical events occurring at a distance, but that demonstration is too general to give us any specific information about whether any two individual distant events are in fact simultaneous. And we can make broad ontological generalizations about vegetative life, but these are obviously too general to explain all the variations in vegetative phenomena.

7.

The fact that the natures of things are not revealed to us is a partial answer, but not a complete answer, to another problem that Maritain's philosophy of physics faces. In chapter 4 of the degrees of knowledge he tries to explain why it is proper for physics to make use of mathematics. The reason he gives is that quantity is the first accident of physical things. As a result, all other features of physical things, including active and passive causal qualities, are quantitatively conditioned. For they all presuppose the first accident, quantity.

But this justification for the role of mathematics in physics is in terms of real quantity. When Maritain talks about quantity being the first accident of physical things, he is talking about the real dimensions of real physical things. How to get from that to the appropriateness of the use of mathematical being of reason in physics? Why does real quantity make fictional quantity relevant? Part of the answer is that though our measurements are real, they still do not reveal the intrinsic nature of physical causes. So we must posit fictional causes to support our mathematical reasoning. But that is only part of the answer.

(Note added later: Real quantity is always relevant to the scientific law but not necessarily to the theory that explains the law. Maritain is emphatic that the connection between science and reality occurs at the level of measurements. So it occurs at the level of real quantity as expressed by measurements and expressed by the laws derived from the measurements.)

But note that the empiricist's problem of distinguishing fact from theory does not affect this position of Maritain. Maritain places a burden of proof on himself when he claims that science is using a being of reason in a particular case. He must satisfy that burden by offering an ontological argument that a particular theory of science postulates something incapable of existence. For example, on p. 167 of DOK he asks "How can we know if a mathematical being of reason — and especially that system of geometrical entities that is called a space — is or is not real in the philosophical sense of the word?" If his argument works, by that fact he has shown where a being of reason enters the scientific process, and the place where it enters will be at the level of theory, by hypothesis.

7.

Still, I have not explained in what sense the use of BORs can be said to be a genuine way of knowing physical reality. To explain that I must now return to the postponed question why science can use its fictional quantitative entities if the justification for using mathematics is the real quantity science knows by means of its measurements.

The most detailed example of a mathematical being a reason that Maritain gives us is the space-time continuum of relativity. He analyzes time in detail in the chapter on time, and the analyzes space in detail in chapter 4 of degrees of knowledge. In the chapter on time he demonstrates the existence of absolute simultaneity just as strongly as Einstein demonstrates the impossibility of measurable simultaneity, on the two assumptions that all motion is relative and the speed of light is constant in a vacuum, in his first relativity paper. But the fact that simultaneity could not be known to the physicist is itself something that can be known to the physicist. Einstein saw that Fizeau's experiment implies that motion must be relative to the observer as far as physical epistemology is concerned. By physical epistemology I mean that no measurable events can tell us that any motion is absolute. And Einstein showed that if motion is relative for the physicist, absolute simultaneity would have an existence that was not knowable to the physicist. In grasping this, relativity was grasping one of the *effects* of necessary causal laws. Namely, absolute time, motion, and distance are excluded from science because the events known to science are measurements, and the *measurement* of absolute motion is impossible to physical epistemology.

Although Maritain has not developed this point, the fact that ontological analysis reveals of the existence of simultaneity while empiriological analysis cannot provides one answer to the question why the physicist must use mathematical being a reason, in particular the space time continuum, in his explanation of real quantities, that is, the quantities really returned by physical measurements. For the universe the scientist will be attempting to explain is necessarily simpler than the universe that the philosopher knows to exist. The ontologically "real" universe has at least one characteristic that the physicist's "real" universe cannot have, simultaneity.

The upshot is that the physicist's explanation of nature must of necessity be simpler than the corresponding ontological explanation, if it were possible for us to come up with one, would be. I tried to show in "causal realism" that the principle of simplicity, the principle that we should not posit any more causes then are necessary for what we have to explain, does not just express a subjective preference for simplicity. Instead, it is based on objective and necessarily true causal relations, on the one hand, and the necessary final cause of reason, on the other hand. So it is the scientist's very responsibility as a rational seeker of causes to postulate theories that have no more explanatory factors then are absolutely necessary for the data available to him.

But the data available to the scientist includes fewer characteristics than are really there. So the scientist must of necessity posit a theory that is out of sync with ontological truth. His theory is not just something other than an ontological analysis. It is something that ontological analysis can show to be impossible. In order for there to be relative motion and relative acceleration there must be absolute motion and acceleration. An infinite number of ontologically conceivable motions can account for one body moving away from another body at one mile-per-hour. The first body may be at rest, the second in motion, or vice versa. Or the first may be moving in one direction that two miles per hour while the second is moving in that direction at one mile-per-hour. Etc.

And since motion is not ontologically relative, real quantity cannot explain the facts about motion that the physicist knows; the laws of real quantity cannot explain those facts. But a mathematically expressible explanation is needed since the facts to be explained are so expressed.

So, first, it turns out to be a physical fact that measurements of time and distance are relative to each other depending on the relative motions of the observers. But to represent this fact by making space and time part of one continuum requires the use of a being of reason, the square root of negative one. And the fact that gravitational motion is epistemologically just as relative as inertial motion means that there is nothing more for physics to know about physical events than what can be "explained" by changes in the geometry of space-time. Our explanation of gravitational fact is bound to consist of a change in the geometry of the space-time continuum, because those facts are nothing but collections of space-time coordinates, that is, nothing but events in space-time.

Einstein made up (deduced?) General Relativity "out of whole cloth" and only then found out that it predicted Mercury's orbit. But he started out from the insight that there could be nothing more to gravity, from the viewpoint of the methods of empirical physics, than what is expressed by the curvature of a mathematical world-line. He got that insight from the equivalence of gravity and inertia. Previously it was thought that accelerated motion was not relative, that laws of physics could tell the difference between acceleration and inertial motion. Yes, but it turns out that laws of physics cannot tell the difference between gravitational acceleration and any other kind. And if not, the world can offer no empirical evidence about gravitational behavior than could not be expressed by the curvature of a world line, and by the same kind of curvature of a world line that expresses any kind of acceleration.

In other words, if gravity and acceleration are equivalent, then a curving of Minkowski's space-time will give you gravity. And if gravity and acceleration are equivalent, then there can be nothing more to gravity, from the viewpoint of strictly empirical evidence, than what a curving of M's space-time will give you. Mathematically, there is nothing more to describe, there are no more questions to ask, than what can be described as a change in the geometry of a space-time continuum. That's all there is to say.

From the point of view of mathematics, imaginary numbers are as legitimate as integers, so from the beginning one way of looking at the space-time coordinates is as legitimate as the other mathematically. But one way of looking at them produces a theory that is more simple than the other. And since motion is epistemologically relative, there can be no physical reason for preferring a more complex explanation. Now four-dimensional geometric laws describe this continuum, and when the laws of the geometry describing relations between events in a continuum change, the necessary result is that these events are explained as far as their quantitative relations are concerned. The necessary result is that the behavior of bodies as explained as far as the quantitative properties of their behavior are concerned.

And the same facts exclude the ontological cause of gravity from physics because they make the ontological cause meaningless to physics. Motion must be represented as indifferent to its causes. The quantitative conditions under which physical causes act and under which we make observations are such that the effects physical causes produce, namely, motions, must be observed such that, and so must be mathematically representable such, they would be the same even if there were different physical causes acting on the bodies that are in motion than are really acting on them. Assume bodies A and B are in relative motion. Then, either A is being caused to move toward stationary B, B is being caused to move toward stationary A, or both A and B are being moved toward each other. But not all of these situations can be true at the same time. No more than one of them can exist at any one time to get that result. But at least one of them must exist. Some one thing must be happening. If the universe contains bodies A and B at rest relative to one another, change can occur if and only if either A is moved from potency to act relative to B, or B relative to A, or both relative to one another. One or the other of these things, and at most one of these things at any one time, must be happening. But a system that represents matters as if the cause could be acting on A, B, or both indifferently, is a system that cannot reveal the ontological nature of the cause but only, to the extent that it is indifferent to which thing is being caused to move, a being of reason substituting for the true ontological cause.

The fact that science uses beings of reason does not mean that there could be a theory contrary to the one using beings of reason that did not use beings of reason. Such a theory would not have physical significance. Nor can we necessarily proliferate opposing theories using beings of reason all of which succeed and explaining the same data. If the theories were equally simple, the differences between them would have no physical significance. Maybe this helps to understand what Maritain means by suggesting "If you want a certain kind of theory, a certain approach, then you will necessarily use BORs" (not an exact quote, but his words can sometimes be interpreted this way).

Maybe he's not implying by the "if" that you could have a different kind of mathematical science, or a different kind of scientific theory. He is saying, if you want to do mathematical physics, if you want to do physics quantitatively and deduce from mathematical assumptions, then if and when you think of viewing space/time data and space/time descriptions as if they were coordinates in one space/time continuum, you will know that you can't want anymore of a description than describing the "geometry" of that continuum can give you.

(Assume that [contrary to Harre and Madden in their book Causal Powers] there really are two distinct fields, gravitational and electromagnetic. That would not prevent us from finding some mathematical trick to represent them as one field. What kind of trick? A trick using a being of reason, for example, a trick similar to multiplying time coordinates by an imaginary number to represent space-time coordinates as aspects of one continuum. If we could find such a trick to unify the field, then we as scientists must treat the fields as one; our explanations must treat them as one. Similarly, before Minkowski and general relativity it was true that if we could find a way to represent space and time in one continuum, then we must treat them that way. Because events for the physicist are nothing but space-time measurements. There is nothing more to explain for the physicist than space-time measurements. Any explanation that did not treat them as coordinates in one continuum would be less simple, and unnecessarily so from the physicist's point of view. Nor would we have any access to the true, ontological explanation. We can only get the true explanation by applying our necessary truths to the data. But the data here are nothing more than measurements, quantitative variations.)

8.

This way of showing why real quantity can require explanations using mathematical BORs is not exactly the one used by Maritain. But it not only is consistent with his principles but follows from them, if we add the principle of simplicity. In doing so it shows not only why beings of reason are useful but also why a scientist can be expected to believe that his explanatory entities are not just BORs but really existing causes. As far as the scientist as scientist is concerned, the data that he has is all that exists. So when he knows that his data is all that can exist for him, as Einstein shows by showing that absolute simultaneity is unmeasurable, he will think that the explanation he knows to be the simplest possible has metaphysical weight.

Maritain's principles might explain even more, although he did not go this far. Because simplicity is a standard with an objective basis, it is conceivable that there be such a thing as the only possible being of reason that will explain the data, since any other explanation would be less simple. The insight that started Einstein on the path for the general theory of relativity was that concerning gravity there could not be any data available to physical epistemology other then the kind that could be explained by variations in the geometry of a space-time continuum. He knew that no other data concerning gravity were available. And we can assume he was astute enough to know that any explanation other than one by variations in a space-time geometry would automatically be more complex than necessary.

In this case there would be only one "correct" being of reason, to speak paradoxically, a "true" being of reason. For the scientist will have to accept as the true theory, true in Maritain's sense of scientific truth --- though in this case appearing to be even more than that to the physicist --- the theory that the scientist knows to be the simplest possible explanation of what he knows to be the only possible kind of data available to him.

But the real relativity of time would be contradictory. (Duration is continu de l'avant et de 'apres dans le devinir, Reflexions, p. 236.) P. 237: It is absurd to impute to real times and real simultaneity a relativity that is the property of the relations of reason which vary according to the observer (epistemological fallacy). (Quantity is that which is measured by relations of simultaneity and hence terminates relations of simultaneity; that which terminates these relations does not consist of these relations.) Cf. DOK, p. 157: our knowledge of absolute dimensions bears only on relations.

The empiriological way of looking at nature as composed of events in space-time and the ontological way lead to contradictory results about simultaneity. The space-time events way of looking apparently leads, inexorably, to the absence of simultaneity. The ontological way shows, necessarily, that there is simultaneity. So these are not only two ways of looking at things but to asymmetrical ways, ways whose dissymmetry is irrevocable. As a result, we cannot expect to be able to directly interpret elements of one theory in terms of the other; we cannot map one onto the other directly. Another example, science speculating about time travel. This demonstrates science's non-ontological viewpoint. Ontologically the present is defined as that phase of time that exists. The past in the future are that which do not exist. But the physicist's viewpoint is doubly not ontological. It is non-ontological in so far as it uses mathematics, since mathematics is in different to existence. And it is non-ontological insofar as it is empiriological and perinoetic.

Contrary to Maritain, there may be such a thing as a space-time continuum. But the space-time continuum conceived by Einstein must be a being of reason, since it allows physicists to talk about the possibility of moving backward in time. Ontologically considered, the past as a destination for travel has the disadvantage of not existing, since that is what is meant by "the past."

Mathematics uses causal relations to objectify the objects of mathematics, but those objects are not themselves causal relations. So mathematical physics is at two removes from real causality. (1) first there is the causal opacity of empirical word functions. (2) mathematics and quantitative measurements get at causality only indirectly. Quantity is only a condition associated with the active and passive properties of bodies. Extension is associated with them as their material cause.

Quantity is a real aspect of things; so why must it call for beings of reason? And granted that the nature of things, and especially the natures of the quantitatively measurable aspects of things, for example, weight, heat, are not directly available to us through observation, still why can't we guess at their true natures guided by the principles of empirical knowledge?

The answer is that the principles of empirical knowledge are useful only as applied to the world as we experience it. For the only evidence we have for existence is experience and what the principles of empirical knowledge allow us to conclude from experience. But certain cognition independent facts about cognition-Independent causal relations that determine the way we experience things and the limits of our ability to experience things make certain other facts, which ontological analysis reveals to us, completely unavailable to our experience.

Events that are simultaneous in the ontological sense cannot be known as simultaneous by experience and cannot be part of the data on which science is built. Likewise, deterministic causal relations make it impossible for events resulting from determine the causal relations to be known as such by science and therefore cannot enter into the data on which science is and must be built. Likewise, we cannot perceive continuous or accelerating motion in an enclosed environment. The existence of such motion turns out to be a fact outside the scope of experience, because nothing in the causal makeup of our organs or apparatus of experience would permit such an effect as the detection of this motion.

So scientific theories must be constructed as if these data were not there. So science is necessarily excluded from knowing the true nature of underlying causes whose measurable aspects, or of the measurable aspects of whose effects, it does know: that is, the true nature of the causes underlying the measurable aspects of things, for example, the effect we call weight and the cause we call gravity.

(In some cases, science can approximate these causes and differ from them only statistically; in other words in those cases science gives us probabilistic knowledge. In other cases, we deal with outright beings of reason rather than merely incomplete approximations which don't tell us the whole truth.)

So even if we could guess the true nature of that which we are measuring by its quantitative aspects that knowledge could not help us predict our future experience or organize our experience by quantitative laws. For our experience would necessarily go on as if the simplest mathematically expressed beings of reason by which it can be predicted were true. Knowledge of its true nature, for example, God's knowledge, would have no scientific relevance. We could not confirm or disconfirm it by experience. The knowledge would be scientifically useless.

Rather the theoretical entities by which science would explain the laws that it is able to establish would have quantitative characteristics necessary for deducing the quantitative law's. But the natures of the things which had these characteristics would necessarily be other than the natures of the real causes of physical things.

9.

Mathematical physics is not based on what must exist but on what *knowledge* of what exists can be gained experimentally. There is no absolute simultaneity experimentally considered; so science's theory must be constructed for world without absolute simultaneity. Any other theory, a theory with absolute simultaneity would not be a scientific theory; for it would have no experimental meaning. Likewise, quantum mechanics and Schrodingers cat. Any theory that postulated the existence of an absolute position and velocity prior to measurement would have no experimental meaning to that extent.

A theory with determinate position and velocity has no experimental meaning either, and so it would not be a scientific theory. And of theory in which something other than the geometry of space-time tells a body where to go has no experimental meaning either. Still, these theories all account for universal experimental laws that are based on necessary causal relations, laws that express the results, *effects*, of necessary causal relations.

We can apply Maritain's philosophy of science to quantum mechanics in the same way that we applied it to relativity. In the case of relativity I said that science required a theory that was simpler in terms of the number of causal factors than an ontological theory would be. The reason was that the data available to science necessarily left out things that ontological analysis knows are really there. We see something similar about absolute position and absolute speed in quantum mechanics.

Page 173: quantum theory also uses mathematical beings of reason and for the same reasons, for example, the mathematical structure of the atom and the wave theory of atoms and light.

In the mathematics of quantum mechanics, there is nothing to give the particle this actual position or that, this actual speed or that, until we intervene to measure it. But in reality it has either this position or that, either this speed or that.

November 14, 2004

Mathematical theories objectify physical natures in the way that mathematical theories are supposed to objectify physical natures. For example, consider the quantum theory cat that is nonexistent until a measurement takes place. The reason a cat is nonexistent is that the theory has no place for such an existent cat before a measurement says either where it is or how fast it is moving but not both. That is what is theory is supposed to do. Theory is supposed to have no place for either actual position or actual velocity before the results of a measurement are entered into the calculations.

To conclude that the cat does not exist in a metaphysical sense, one must impose a metaphysical interpretation on the mathematical theory. But in saying that the mathematical theory does not support a metaphysical interpretation I am not saying that the mathematical theory is false. The mathematical theory is true. It is true in the sense in which a mathematical theory is supposed to be true. That is, the theory succeeds in objectifying natures in the way that the theory is supposed to objectify natures.

Concerning the interpretation of quantum physics that says it is unthinkable that things not be this way. The person who holds that owes us an explanation of how his scientific theory would have to be different if there were real velocity and position, but merely could not be measured at the same time because of physical causal relations.

There are absolute dimensions. The spaceship does not at one and the same time (am I assuming absolute simultaneity?) Have both the length observed from frame of reference (1) and that observed from frame of reference (2). But absolutes, motion, dimension, simultaneity, etc., cannot make any difference to the physicist; and he constructs his theory accordingly. Really the universe is at rest relative to the spaceship, but the theory explains *everything* that happens so that it makes no difference which is at rest. For the effects of the genuine ontological causes would be the same in either case.

10.

If this explains why the scientist sometimes must use BORs in her explanations, how do we justify calling such explanations a way of knowing what physical reality is? Maritain would answer (see for example the paragraph at the bottom of page 163) that the theory of relativity tells us correctly, allows us to know correctly, that what nature is is something that behaves as if there were such a thing as a space-time continuum as described by Einstein. Whatever else nature is, we know that it is something that behaves as if Einstein's theory were true, true in a philosophical sense. It is something that behaves that way as far as the only kind of measurements available to us are concerned. And the fact that those are the only kind of measurements available to us is itself a fact (a "philosophical" fact stripped of all merely theoretical components) about the way nature behaves, and so a fact covered by Einstein's Theory.

When we know that, we know much more about what nature is than we knew before. We understand nature in a much better way than we would if we did not know that. At least we understand the details of nature in a much better way then we would otherwise. And it might be the best understanding of the details of nature that we could ever get, since an ontological analysis is not available to us.

DOK. p. 173, second paragraph; and page 43, note?: "mathematical physics knows the real "metaphorically". What does it mean to know the essence metaphorically? It's not just knowing how it behaves. We already know how it behaves before we construct our theory. But the symbolic theory gives us the knowledge that the essence behaves as if it had the structure of this being of reason. It behaves similarly to the way this being of reason would if it existed. (We use metaphorical knowledge of this kind in our ordinary life on a daily basis.)

If you're tempted to think that metaphorical knowledge like this is not a very good way of knowing physical reality, consider this. As Maritain knew, the acceptance of a physical theory depends on more than its just being able to explain measurements already obtained. It must be able to predict accurately the results of new experiments. If the theory did not accurately tell us that in the future nature will behave as if this BOR was its essence, that is, as if this metaphor were apt, we could not accurately predict future behavior that we have not yet observed.

So our reaction to Maritain should not be that he takes a roundabout route to get us to a place not very profound, a place pretty mundane, and one that it does not take much philosophical ingenuity to think up: the place, namely, of holding that science only lets us know that nature behaves as if a certain picture were true.

Other philosophers since Maritain have interpreted science as telling us that nature acts "as if" its theoretical entities existed. But Maritain gives a rigorous and realist justification of science. He explains the success of science in constructing theories that predict new and non-metaphorical laws of real physical behavior on the basis of objectively (and ontologically) true philosophical principles. He shows that there is objectively something cognition-independent to know, ontological natures and their necessary causal dispositions, and why the knowledge that those natures are metaphorically similar to mathematical BORs can allow us to make accurate predictions about the laws of real physical behavior that we couldn't make otherwise.

Just look at his theory of philosophical truth vs. scientific truth. A lot of philosophers today are willing to qualify the notion of truth to account for the way they perceive science to work. Think of Putnam's internal realism. But since scientific truth is the only truth they recognize, qualifying the notion of truth amounts to qualifying the human ability to know reality. Maritain can qualify the notion of truth in the case of science in the only sane way. For he has a standard against which to compare the results of science. Without such a standard, diminishing our ability to know the truth is self refuting.

A central feature of Maritain's theory of truth for science is that (anticipating Quine but in a more moderate way) scientific truth applies to a theory as a whole rather than to individual propositions. So the metaphorical aspects of the theory, that is, the aspects that rely on BORs, are not the whole of the theory, but can belong to the true theory because the theory as a whole conforms to the known data. The metaphorical aspects are seamlessly interwoven with the non-metaphorical aspects, since mathematical physics is indifferent to the use of real explanatory entities or BORS. And a theory that contains metaphorical elements can be true in an even stronger sense if its BORs happen to be the simplest possible ones for explaining the data.

xxx Maritain on science, August 19, 89

At the Boston University metaphysics society of America meeting, Richard Boyd contrasts the "empiricist" and "realist" conceptions of science. "Empiricist" currently means science only organizes phenomena. The realist says science gets knowledge of the essence. Maritain says science gets knowledge of the essence. But the way scientists knowledge of the essence makes empiricism and social constructionism (Boyd's other category) plausible. So Maritain can explain the realist character of science while at the same time explaining why the other explanations of science look plausible.

Boyd says that words, for example, "water", are defined a posteriori as opposed to stipulatively, as he claims of the "empiricist" does. How come science's a posteriori definitions are consistent with our pre-scientific usage? Causal interactions between the users of pre-scientific language and water explain why pre-scientific "water" refers to the same thing the scientist later defines as water.

11.

But what is Maritain's own justification for the use of mathematical BORs given that real quantity is what allows us to use mathematics in Physics?

On p. 141 of DOK: "a knowledge of the physical real which does not examine the essence and causes of it in themselves, in their properly physical or ontological reality, but which reconstructs it [1] from the pure point of view of relations of measurement involved in it and [2] according to the exigencies of a mathematical deduction as general as possible, will necessarily make use of many beings of reason as indispensable auxiliaries."

In other words, because a mathematical deduction as general as possible of relations of measurement will take the place of the (unavailable) "physical" or ontological knowledge, many beings of reason will be needed to support the mathematical deduction.

My first comment: "Many" is not all. Not all the theoretical entities of mathematical physics are beings of reason. And the necessity for sometimes using them follows from having a mathematical explanation as general as possible. That might be interpreted to say, as other quotations to be given below seem to say, that the basis for beings of reason is the *desire* for a mathematical explanation as general as possible, that is, the desire to explain mathematically and quantitatively what is physical and not quantity by essence, or what has a physical cause and is not simply caused by quantity.

But basing the use of beings of reason on desire may be appear to make the reason for their use subjective, the way many philosophers of science consider the use of the criterion of simplicity to be based on a subjective desire, "a taste for desert landscapes" (Quine). Also, that can sound as if adequate explanations that are not purely mathematical are available to us, but we don't use them because we prefer explanations as mathematical as possible. But where are those adequate nonmathematical explanations?

We have to remember that Maritain in fact denies that adequate nonmathematical explanations are available to us, because we cannot see the essences of natural things in themselves. So the only kind of explanatory, that is, deductive, science we can have of them is mathematical, and for that kind of science to explain as much as possible it must be as mathematical as possible. This may be a desire, but it is a desire to explain as much as possible in the only way possible, not just a desire to explain in this way rather than that way as a subjective preference.

Someone might say, "What do you mean 'If I want to do mathematical physics,' what other kind of physics is there? Well, Maritain does not mean that there is another kind that could do the same thing for you that mathematical physics does, something that will get you the same results about predicting events by space/time coordinates but will get them by starting from a different kind of theory. He means the opposite. Only mathematical physics will give you that. But he means there are other kinds of things to learn about nature. The kind of things biology, geology, etc. learn, and the kind of things the philosophy of nature learns.

But even more precisely, when Maritain talks about the tendency to as complete a mathematization or geometrization as possible, he is talking about a tendency belonging to an epistemological type as opposed to a tendency or 'desire" belonging to a person. He is saying that this tendency is inscribed in the epistemological nature of what Aristotelians call a mixed science, a science that is formally mathematical but materially physical. Such a mixed science is the only science we can have of the quantitatively measurable aspects of phenomena and the only deductive science we can have of any of the details of phenomena. Therefore that science must be a science that by nature tends to be as completely mathematical, as far as its explanatory theories are concerned, as possible.

Page 156, note one: the new physics manages to reconcile the *tendency* toward knowledge of the physical and its causes with the tendency toward universal mathematization. (From one point of view, the new physics differs from the old in being more physical; from another in being more perfectly mathematical. For example, an a priori for rational mechanics was the existence of absolute quantitative determinations, spatial extension and time. As more physical, the new physics gets rid of absolute dimensions; as more mathematical, it's explanations are more completely mathematical than those of the old physics.) "Tendency" is another word that can give the appearance that physics's use of mathematics and so mathematical beings of reason is based on a subjective desire; see comment above.

Page 156, section 13, first paragraph: a reason why science uses beings of reason is that it "*tends* to complete geometrization."

13.

There is still more, however, to Maritain's own explanation for the use of mathematical BORs given that real quantity is what allows us to use mathematics in physics. Again, on p. 141 of DOK: "a knowledge of the physical real which does not examine the essence and causes of it in themselves, in their properly physical or ontological reality, but which reconstructs it [1] from the pure point of view of relations of measurement involved in it and [2] according to the exigencies of a mathematical deduction as general as possible, will necessarily make use of many beings of reason as indispensable auxiliaries."

Why? M says that science can use math because quantity is the first accident of bodies; as a result, all their causal interactions are quantitatively conditioned. But that is an ontological fact about a real accident of bodies. How can a real accident give rise to the use of beings of reason? The first part of the answer comes from the distinction between law and theory. Real quantity is expressed at the level of law. In Reflexions and other places, M talks about scientific laws expressing how one quantity varies with another. In other words, scientific laws directly concern real quantity as opposed to real causal relations expressed directly as such (see Salmon, "Why Ask Why?", the law of gases example). No matter how real quantity is, quantitative variations are not causal explanations.

In more than one place, Maritain opposes knowledge of the nature of something, or of causal relations in nature, to knowledge of how one quantity varies with another quantity. What does he mean? As such, the occurrence of one quantity varying with another does not express an efficient causal relation. For example, as the sides of a triangle vary in length, the angles of the triangle vary in size. Yet there are no relations of efficient causality between them. But Maritain does not say that this prevents the scientist from knowing that the quantitative relations can reflect and indicate a causal relation and so are a means for knowing truths about causal relations.

The physicist, however, needs explanations, not just unexplained numerical data. Where does she get these explanations. On the one had, as non-causal, real quantity alone cannot provide them. Viewed purely quantitatively, there is nothing efficiently causal about the variation of one quantity in connection with the variation of another. On the other hand, the physicist needs an explanation that will yield numerical results, since the facts to be explained, that is, experimentally acquired laws, consist of the variation of one kind of quantity with another. Where will the physicist get explanations that yield numerical results? Only from some sort of quantitative explanation. But not an explanation in terms of real quantity, which is not causal per se; so it must be in terms of non-real quantity. So

BORs come in at the level of *theories* explaining why one real quantity varies with another. They come in because (1) we need an explanation with quantitative assumptions in order to deduce the quantitative laws from it and (2) the real natures, i.e., causal dispositions of things are unknown. Hence, we invent fictitious quantitative explanations. In other words, we do it because we need an explanation that is formally mathematical, because the material fact we are explaining is a quantitative fact.

Despite appearances to the contrary that some of Maritain's formulas may give, he knows that the facts theories are explaining are never purely quantitative facts but are facts about quantities of something, quantities of this rather than that. But at the theoretical level, we can't get at the nature of that something "directly," that is, in an ontological way (ontological analysis). So at the level of theory, the quantities postulated to get the wanted quantitative results at the level of experiment must be supported by theoretical entities that are BORs.

14.

Implicit in what I have called "the first part of the answer" (that the need for BORs derives from the distinction between fact and theory given that (1) the facts to be explained are quantitative laws requiring quantitative theoretical assumptions from which to deduce them and (2) the real causal natures of things are hidden from us) is a deeper metaphysical reason why you will inevitably get many BORs if you set out to deduce the measurable aspects of nature: the traditional Aristotelian distinction between quantity and quality. (See Simon, "Foresight and Knowledge," pp. 107 f.)

Page 162 of DOK, second paragraph: a reason why science uses beings of reason: "science becomes symbolic to the extent it's a mathematical regulation obliges it to attempt a complete explanation of the real wherein things, the form and formation of which belong to the world of qualities, will be formulated in a wholly quantitative fashion."

P. 256 of Reflexions: Take all the measures produced by bodies in qualitative interaction, express them in a system of equations verified in experience. Now consider those equations as algorithms of geometric properties, not of qualitative interaction, then the geometry must be non-Euclidean (and see good example at end of paragraph); and M considers non-Euclidean geometry a BOR.

DOK, p. 166, middle paragraph: Once science attributed to non-quantitative physical factors what could not be predicted by geometric properties alone. Now it abandons that division (by including the behavior of bodies in time among the geometric properties). Thus, the effects (e.g., an apple falling) of all real physical causes can be accounted for (by changes in the time line) geometrically while leaving the real physical causes untouched. (And they are accounted for as they must be, that is, they are accounted for by the "right," correct, theory.)

These passages explain what Maritain means by the distinction between the "physical" and mathematical relations of measurement in the quotation from p. 141 above. He means the Aristotelian distinction between quality and quantity, causal dispositions being qualities. In replacing explanations through an unavailable ontological analysis of the nature of qualities with an explanation from the point of view of the necessarily quantitatively conditioned state of those qualities, many BORs will be needed to support the quantitative mathematical deductions. But there are BORs and BORs:

DOK, p. 171: The 'forces' of classical physics were beings of reason less pure than the new beings of reason, because they were a compromise between ontological causes and the, needed-by-and-for-science, empiriometric entities.

The needed empirio*metric* entities are entities that (1) make the mathematical deduction as general as possible and (2) satisfy as far as possible the intrinsic tendency of the epistemological species to "universal mathematization" and "complete geometrization."

On p. 183 of reflections on intelligence, he states that science occupies itself with causal relations in order to establish mathematical functions to which science tends and which indicate simply how one quantity varies when another quantity varies. He goes on to speak as if this is the only thing that science deals with. But in this book and elsewhere he is clear that he knows that science does not deal with pure quantities the way mathematics does but always deals with a quantity of something.

Considering physical causes in themselves amounts to considering them "in their qualitative reality." And since science must fall short of complete geometrization, science must fall short of complete elimination of quality. In other words, science is always dealing with quantities of something, something whose intrinsic ontological nature is known, pre-scientifically, insofar as we know that it exists but is unknown as to what it is that exists.

But his point about mathematical law considered as such not being causal (in the sense of efficient causality) is important. The angles of a triangle vary with the lengths of its lines and vice versa. The relation between the lengths and the angles are not relations of efficient causality. So Maritain is obviously right about that point. But he does not imply, in fact he everywhere shows that he knows the opposite, that quantitative relations cannot reveal truths about causal relations that come from the active and passive dispositions of things, or that quantitative relations cannot be helpful in learning something about physical causal relations. He emphatically affirms that the reason why quantity and quantitative analysis is helpful in science is that physical causality is conditioned by the first accident of matter, quantity.

There are thousands of examples where a variation in the kind of quantity that conditions the efficient cause produces a determinate change, a change that is either an exactly equal change or at least a mathematically specifiable change, in the quantitative conditions of the effect. Changing the number of volts, of pounds, etc. produces a change in the number of amps, watts, speed, momentum, etc.; gravitational and magnetic forces are proportionate to the square of the distance, etc. But the reason why variations in quantity can be informative causally is that we are always dealing with quantities of something or other, not pure quantities. Still, knowledge of these quantitative variations alone does not necessarily get us any closer to knowing what the inner nature of these somethings are. We still don't know what electricity is or what gravity is.

But how can theories using BORs be so successful in giving deductive explanations and making predictions of new quantitative laws? Dissimilar causes, in this case the real causes or Einstein's beings of reason, can have the same effect. But Einstein's beings of reason are based on necessarily true (because of necessary causal relations) quantitative relations at the level of law; hence the power of his quantitative explanation.

In the degrees of knowledge p. 170, he says that the physical space of science depends on the measurable properties of bodies. But we can know those properties only insofar as we are capable of taking the physical measurements that reveal them. So the physical space of science depends on measurable properties of bodies, and the results of measurements depend on the physical causal conditions that determine what our measurements are able and are not able to tell us, because measurements are themselves physical events subject to physical causal laws. So if physical causal conditions prevent us from making measurements that are reconstructable in Euclidean fashion, then our physical theory needs to postulate a space whose geometry is non-Euclidean.

Such "non-Euclidean" limitations to our ability to measure would be, for example, the variations in measurements of distance and time due to the relative motion of the coordinate systems, non-simultaneity, etc. Here the causal conditions, however, need not be efficient causal conditions, at least not in a mechanical sense of efficient causality. But we certainly should not strict efficient causality to its mechanical meaning.

Relativity declines any absolute quantitative properties or determinations (of time or space) because it looks at dimensions, not in themselves and independently of any physical means of observation and measurement, but from the point of view of physical observation and measurement and the conditions for it. Thus, it is more physical than mathematical to that extent, and a more genuinely physical world than the old physics (DOK, p. 156, top). But then starting with conditions of measurement, it attempts a mathematical explanation of measurements--as they actually occur, a quantitative explanation of quantities as actually measured.

DOK. p. 170: The geometric properties of space-time are themselves modified by the matter that occupies it. What are expressed by geometric laws? Geometric properties.

Page 170: is physical space Euclidean or non-Euclidean? Philosophically it is Euclidean. But scientific physical space is not Euclidean, since "as filled with physical natures, space is not homogeneous or isotropic"; the physical characteristics of space depend on what fills it. And so (see note one) "only the ensemble of geometry and physics is empirically verifiable. So metrical structure, as physically measurable, is not given a priori" but depends on the causal properties of matter, and hence depends on the matter that fills (philosophically Euclidean) space.

Page 173: "Einstein's space-time is the geometric symbol which best translates into a mathematical language the reality of physical interactions quantitatively measured."

15.

However, it is possible that the preceding arguments prove too much, if they prove that mathematical science must always use beings of reason, rather than "many" BORs, since Maritain rightfully denies it must always use being of reason. The following remarks are an attempt to save M's argument from an interpretation that would require that the theories of mathematical physics rely totally on BORs.

Prior to the level of theory there is the level of law, which the level of theory must explain. At the level of law there are measured relations of, at least, one *kind* of quantity, a quantity of something, to something else. Perhaps the earliest law was the law of harmonics that tell us that changes in the sound produced by a plucked string correlate with changes in the length of the string. This law has a quantitative element, the length of the string, but what is non-physical about this law? Length may not be a quality, as sound is, but it is a physical fact if anything is. So far there is nothing in the science that we would have to call a being of reason or non-physical.

The level of theory begins when we conclude that different sounds correlate with the length of unobserved waves propagated in a medium surrounding the string when the string is plucked. Although the waves and medium may not be directly observed, there is no basis for considering them beings of reason as opposed to real beings. If they are not real beings, the theoretical explanation is false, and to find the truth, we need to postulate other explanatory entities that do actually exist.

Still, there could be, at a minimum, a possible kind of scientifically legitimate ideality (use of BORs) here even if the postulated entities do not exist. For they could still help us make mathematically correct predictions about sound or sound-related behavior. Isn't that what the wave theory of light did for well over a century until Einstein showed the particle nature of light on the basis of correct predictions that the wave theory could not make? And even the full integration of the particle theory with the rest of physics took a new type of mathematical theory, the statistical theory of the probabilities of the distributions of photons. And the mathematical characteristics of that type of theory had implications for the rest of physics with which the particle theory of light was integrated.

Later methods of observation, however, show the real existence of the medium and of waves whose length correlate with variations in the pitch of the sound. And the measurable aspects of the medium and the waves do not imply any non-physicality; they are physically real. But they are also now less theoretical, and theory is where you look for BORs for Maritain. The history of science is full of once theoretical entities that became, at a minimum, less theoretical as our ability to observe advanced. We cannot conclude, however, that an advance in ability to observe automatically correlates with reduction in ideality. A genuinely new observation will include some new reality revealed. But as Maritain emphasized in Chapter 2 of DOK, a scientific "fact" always has to be critically scrutinized to determine what is ontologically real and what is not about an observed fact. For advances in powers of observation themselves usually depend on background theories that may impose conceptual structures that are merely theoretical on the results of an experiment.

And even prior to knowledge of their existence, the postulation of sound waves and their medium was not the postulation of pure quantities. The waves were postulated as quantities of *something*, something that was not a pure quantity but would have to have qualitative characteristics to produce transmit sounds with various characteristics. But before we had investigated those qualitative characteristics of the medium, and therefore of the waves, we would know that the medium would have the accident of extensive quantity, of being physically extended, occupying measurable space, in order to transmit waves of different lengths. So certain quantitative characteristics of the medium would be known to be required by the theory. And we would have a similarly vague understanding that the causal qualities of the medium would be such as to allow it to be sufficiently malleable to be moved in wave fashion by the motion of the plucked string.

As so far developed, the theoretical explanation of the law of harmonics requires no elements that must be considered BORs, despite the fact that the explanation is formally mathematical. At no point in the explanation of sound have we yet introduced any "non-physical" elements. Perhaps here we should recall Maritain's statement about BORs entering mathematical physics at least at its *most* theoretical levels. At the level so far reached, the fact that the qualitative nature of sound is unknown to us does not make the hypothesized explanation any less physical, since all we have explained is the correlation of changes in pitch (still objectified as a sensory quality) with a change in physical quantity, the length of a string, and we have explained it by hypothesized truths of a physically quantitative nature, the existence of waves of various lengths in a medium.

As thus developed, the theory implies that the physical natures of the medium and of the string whose vibrations cause vibrations in the medium, will have whatever characteristics may be necessary for the quantitative law of harmonics to be caused. All further developments of the theory must be consistent with the natures of the medium and of the string having such characteristics. But so far, neither our lack of knowledge of the ontological nature of the string and the medium nor the formally mathematical nature of the explanation has not introduced any non-physical ideality into the theory.

As advances in science, including new means of observation, give us more understanding of the medium caused to move in waves by the plucked string, where would BORs enter in? At one time the medium was considered continuous, that is, not composed of divided atomic units. That conception was a BOR in the sense of a false theory. When we discovered the atomic composition of matter in general, not to mention the nature of air as a mixture of elements, we were not postulating BORs according to M; for he says that atoms are not BORs as to their existence, which is real, but only as to the then current theory of the natures corresponding to that which is known to really exist. (Recall the En-lil's roar analysis above.) So it would be consistent with M's assertions about BORs at the most theoretical level and about the example of the atomic theory of matter, that the theory behind the law of harmonics only begins to use BORs when we get deeply into the theory behind the fact (not itself a BOR) of the atomic structure of matter.

16.

So let me analyze atoms further. The following examples are taken from "understanding physics," volume three by Isaac Asimov. Page eight, Proust "found that the elements always present in certain fixed proportions: for every five parts of copper (by weight) there were four parts of oxygen and one part of carbon. This observation uses measurements of quantities. But so far, what is non-physical about this knowledge; nothing, but we are at the level of law, not theory.

(Page 10): Dalton concluded that "each element is made up of a number of units all with the same fixed mass; that different elements are distinguished by being made up of units of different mass; and compounds are formed by the union of small numbers of these units." From the universality in the fixed proportions of the weights of elements in chemical compounds, we can conclude that the elements always come in units whose weights are in fixed proportions to one another. In what sense do these conclusions not express knowledge of how the natures of the elements involved in chemical interactions really exist? These conclusions in fact express *new* knowledge of these natures without the use of BORs. Neither the postulated units nor the nature of their proportions are just symbolic mathematical entities. Nor need M. say that they are.

The new knowledge thus acquired concerns quantitative aspects of these natures. It tells us that elements of a given nature are composed of units of a smaller weight than larger examples of the elements. It tells us that different elements are composed of units of different weights. It tells us that all the units of an element have a weight that has the same numerical proportion to the weight of the units of other elements. For example, the weight of the oxygen that goes into water is always eight times the weight of the hydrogen. So we know that a unit of oxygen is at least eight times heavier than a unit of hydrogen.

Later it was found that the hydrogen it goes into water occupies twice the volume of the oxygen. So now we have another quantitative measurement; the measurement of differing volumes. So the units of hydrogen in water occupy twice the volume of the units of oxygen. But the volume of oxygen weighs eight times as much as the volume of hydrogen. So a unit volume of oxygen must weigh 16 times as much as the corresponding unit volume of hydrogen.

Now what is nonphysical about that knowledge of the relation of oxygen's nature to hydrogen's nature? We have acquired new knowledge about two quantitative properties of previously unknown units a number of which make up a sample of an element. But there is nothing non-physical about this knowledge. In neither case is it a question of complete knowledge of a nature. But it is true knowledge of the nature of oxygen and the nature of hydrogen that they are composed of units of smaller weight and smaller volume than larger samples of either element and that each unit volume of oxygen weighs a 16 times as much as a corresponding unit of hydrogen. The knowledge postulates the existence of new entities, but these are not beings of reason. They are entities reasonably believed to exist just as much as the larger samples of oxygen and hydrogen exist, and not only do they exist at least as much as the larger samples do, they may have an even more basic claim to existence. Again, M need not and would not disagree.

At the level so far reached, the fact that the qualitative nature of the elements and of weight (gravity) is unknown to us does not make the hypothesized explanation of the law that elements always combine in relative weights of the same proportion any less physical, since all we have explained is the constant correlation of differences in weight, weight being a quantitatively measurable, and we have explained it by hypothesized truths of a physically quantitative nature, the existence of units of constant relative weights. As thus developed, the theory implies that the physical natures of the elements will have whatever characteristics may be necessary for the known quantitative truths of the relative weights and volumes of the elements to be caused. All further developments of the theory must be consistent with the fact that the natures of the elements have those characteristics. But so far, neither our lack of knowledge of the ontological nature of the elements or of gravity nor the formally mathematical nature of the explanation has introduced any non-physical ideality into the theory.

(Page 63) Later, Mosley "found that (for each element) the wavelength of the X rays went down (and the frequency went up) as the atomic weight increased. By taking the square root of the frequency, he found that there was a constant increase as one went from one element to the next." Again, the knowledge expressed by this observation concerns quantitative, measurable, aspects of nature: the frequency and length of phenomena behaving like waves, on the one hand, and the atomic weight, on the other. But there is nothing non-physical about this knowledge. The facts referred to here rely on more theoretical background than do the previous facts about atomic weight, although those previous facts certainly do presuppose some theoretical background. But the quantitative aspects of this new knowledge do not in themselves make this new knowledge in a less physical. Still, we are here dealing with a new physical law that is not itself a new theory.

"Mosley decided that there was *something* about the atom which increased by regular steps as one went up the periodic table." This is a new theoretical conclusion. What this new conclusion adds to our knowledge is very vague: there is "something" that explains the constancy of the quantitative changes in wavelength and frequency as atomic weight increased by itself being a quantitative characteristic of elements that increases in regular steps as we go up the periodic table. No matter how vague our knowledge of this "something" is at this stage, still "something" does not express a being of reason but what must be real feature, a feature with quantitatively measurable characteristics, of the atoms making up elements. So there is nothing non-physical about this no matter that it involves the postulation of an otherwise unknown quantity-bearing (because quantitatively conditioned) qualitative causal factor in the nature of elements or that the explanation of the constancy of the numerical change wavelength/frequency as atomic weight increased is formally mathematical.

Later, we learned that this new factor was the positive electric charge on the nucleus of the atom of an element. The simplest atom had a charge of positive 1 and the charge on the nucleus of each succeeding element increased by one. This number became called the atomic number of an element. And (Page 65) "once the nuclear charge of an element was known, something was also known about the number of electrons in the atoms of that element. . . in the neutral atom, the number of electrons had to be precisely enough to neutralize the nuclear charge." Since each electron had an electric charge of negative one, a neutrally charged element whose atomic number was X had to have the same number of electrons.

Again, this new knowledge concerns a quantitative, measurable characteristic that must be true of the atoms of an element in order for a certain quantitative observation to be caused, namely, the observation that the electric charge on a particular atom is neutral. Here "neutral" means that no positive or negative integer can be associated with any electric charge on the atom. And there is nothing non-physical about this knowledge. And the entities postulated may begin by being hypothetical, but they were postulated because measurements returned quantitative physical facts the required the real existence of physical entities really bearing certain quantitative characteristics.

Now does any of the realism illustrated in these examples contradict anything Maritain says about scientific knowledge? Not at all. Each example gives us new knowledge of natures. But Maritain insists that we always know natures. He says that even primitive people have very precise knowledge of "what are" the things in their environments. He also tells us, however, that this is perinoetic knowledge, as opposed to dianoetic knowledge. For example, does anything here tell us that an atom of hydrogen is a substance in the philosophical sense? No. And does anything in these examples contradict what Maritain says about the role of quantity and quantitative explanations in empirical science? No.

The quantities in these examples are quantities conditioning the behavior of qualities whose ontological nature is unknown, weight and electricity. But the fact that we do not have direct ontological understanding of these qualities does not require atomic theory as so far developed to use beings of reason. For the ontological truth about the natures of gravity and electricity are not at stake in these theories beyond the very vague and general truths that the behavior these qualities cause is quantitatively conditioned. The natures of gravity and electricity must be such that their effects have measurable characteristics.

In Maritain, there are two places will we have to put the focus of the epistemological critique of scientific knowledge. The first is the level of philosophical facts. We have to sort out what belongs to theory and what belongs strictly to observation. I have not attempted that here. But there are clear cases of observational facts in these theories, and they are quantitative observational facts. Water, for example, divides into a volume of one kind of thing that is twice the size of the volume of another kind of thing. The presence of quantity here does not make the facts in question less physical, less real, or more reliant on beings of reason.

The second level where we have to focus the epistemological critique of scientific knowledge is the level of theory. In the examples we have just seen, previously unknown theoretical entities, entities we are unable to observe, are postulated to exist as part of the natures of things in order to causally explain quantitative aspects of the behaviors of things that are observable. But there is no reason to think of atoms as so far illustrated by these examples as beings of reason. And Maritain himself explicitly states in "degrees" that atoms are real entities as far as their existence is concerned.

In the case of atoms, where the question of beings of reason comes up is concerning the nature of that which exists. But even here, as far as we have investigated the nature of atoms in these examples, there is no reason to suspect that what they tell us about nature consists of beings of reason. Atoms are smaller units whose combination in numbers larger than one make up the larger samples of the elements that we observe. Those atoms each possess weights that explain the measurable relative weight of each element in compounds of the elements.

So far we know about the nature of those units that they occupy space, that they have volume, since larger volumes are made out of them. We know that those units have weight, since they explain the relative weights of larger samples of the elements. And so on.

In what sense is postulating weight of an atom or size of an atom something that is merely on the level of beings of reason? In no sense, and Maritain does not say that it does. In effect, he denies explicitly that it does.

17.

But if everything I have said so far as true, then why and where do beings of reason enter scientific theories for Maritain? Good question. Important question. The answer to this question will tell us where our epistemological restriction on the realistic value of scientific knowledge should be placed.

We have all ready mentioned the restriction that this is perinoetic knowledge. But from the point of view of scientific realism, that is not really a restriction. The vast majority of our pre-scientific knowledge of nature is perinoetic; but no scientific realist must consider that pre-scientific knowledge of less reality for being perinoetic.

The ontological/empiriological distinction also need not make a difference concerning the realistic or nonrealistic epistemological evaluation of science. The examples given are clearly empiriological rather than ontological, since they deal with characteristics that distinguish one kind of experience from another, that is, they deal with the details of experience rather than the ontological truths that are common to all experience. There is nothing unreal about the details of phenomena for Maritain. Phenomena are a subset of being. Beings of reason do not correspond exactly to empiriological analysis; mathematical beings of reason appear only in empiriometric analysis. But even there, as these examples show, an empiriometric theory does not have to use beings of reason just because it explains observed quantities by more fundamental quantities.

Why, then, does Maritain say that necessarily the mathematical theories of science will sometimes use beings of reason? Since the role of quantity in these postulated theories does not require that BORs have any role, can M. consistently say that "science becomes symbolic to the extent it's a mathematical regulation obliges it to attempt a complete explanation of the real wherein things, the form and formation of which belong to the world of qualities, will be formulated in a wholly quantitative fashion." Perhaps the key words here are "to the extent that" science attempts "a complete explanation of the real." Nothing in atomic theory as so far considered here obliges science to attempt a complete explanation of the real. And we are reminded of M's statement that science uses BORs at least in the most theoretical parts. That would refer to the explanation of gravitational behavior in relativity and of subatomic behavior in quantum mechanics, where M definitely believes science relies on BORs.

In the case of gravity, it turns out that the effects of ontologically qualitative causes need to be "completely" explained quantitatively because, once the time co-ordinate of the description spatial temporal events is included in the same continuum as the spatial co-ordinates, there is nothing more to be explained about what physics can know about events than can be explained by the laws of a 4-dimensional geometry. The phrase "nothing more to be explained" does not imply that this "complete geometrization" is the same kind of application of the principle of simplicity as is the fact that the time component of the 4-dimensional geometry must exclude simultaneity. There the unknowability of simultaneity meant that the number of factors to be explained is smaller than the number that ontologically exist, and so the mathematical explanation must posit a smaller number of explanatory factors than ontologically exist. Here the fact that the temporal coordinate of an event can be mathematically treated as belonging to the same continuum as the spatial coordinates means that some geometric "explanation" of events is a "complete" explanation as far as what science is able to know about events.

Still as M says, complete mathematization of explanations is impossible even in intermediary sciences. Relativity must posit, without explaining why, that the laws of 4-dimensional physical geometry change according the amount of mass present. So relativity implies that mass, or some other, perhaps unknown, part of nature, has whatever unknown qualitative property explains that fact.

Is this an adequate account of why, as an intermediary science, mathematical physics requires an explanation that is as mathematical, as opposed to physical, as possible? Perhaps. But if so, it is not exactly the kind of account M claims to give. The gravity example presupposes but is not just based on the nature of intermediary science. It is also based, first, on the physical fact that spatial and temporal coordinates vary proportionately between frames of reference in relative motion and rest. That fact is predicted by relativity theory, beginning with special relativity, but is itself at the level of law, not theory. Second, it is also based on the development of 4-dimensional, non-Euclidean geometry. If such a geometry had not been developed, the "complete" geometrization of the theory of gravity would not have been possible. An intermediary science still would have been needed, since the facts to be explained and predicted at the level of law are quantitative. But without the development of the needed kind of mathematics, an intermediary science giving a theory that explains gravity would not have been possible.

These two additional reasons for the would-be complete geometrization of physical theory are not in any way inconsistent with what M says, but their addition is needed to account for the geometrization of the theory of gravity. They allow intermediary science to become even more formally mathematical and so to realize its epistemological type more fully. But they do not result solely from the nature of that epistemological type. But perhaps it is only in appearance that M claims the geometrization of mathematical physics results from the nature of its epistemological type. Perhaps he did not mean to claim that but only that given quantitative character of the facts to be explained and the nature of intermediary science as formally mathematical, when the opportunity is there for a geometric theory of the physical, because of the specific facts of physical measurement and/or the state of mathematics' development, intermediary science will explain the physical mathematically or we will not have an explanation at all.

Reflexions, p. 258: The goal is to assimilate physics to geometry; when it is not assimilable, change the geometry. Comment: but this should not mean an alternative explanation is available and the goal of assimilating physics to geometry is only a choice, a preference. Unless Einstein had found a way to change the geometry, we would be stuck with the inadequate Newtonian theory of gravity or perhaps no theory of gravity. If an intermediary science is going to explain gravity “completely,” it must explain it geometrically. For what is not formally mathematical is an unknown to intermediary science at the level of theory.

But if this is an adequate account of why mathematical physics requires an explanation of the physical that is as mathematical as possible, is it an adequate account of why that mathematical explanation uses BORs? If so, it is, again, not exactly the kind of account M appears to claim to give. I have already mentioned the simplicity argument for using BORs in relativity and quantum mechanics: The unknowability to physics of simultaneity and co-existing determinate place and speed, mean that the factors to be explained by physics are less numerous than really exist, and so physics must posit an explanation with fewer explanatory factors than really exist. But this account the use of BORs, while consistent with what M says about science, adds the principle of simplicity to his principles. So it goes beyond the explanations of BORs that he appears to give, unless he intends to include this kind of unknowability in his statements about ontological and dianoetic knowledge being unavailable to the physicist. But those statements usually seem to concern knowledge of the natures of things known to exist, not the unavailability of knowledge of the existence of something itself. Although his argument for the existence of simultaneity is, and the existence of absolute place and speed would be, ontological, he does not combine those arguments with a simplicity justification for the use of BORs.

18.

He gives one more important analysis accounting for the use a specific BOR, non-Euclidean space, that is not exactly the kind of account he appears to want to give. When DOK analyzes a specific example of a being of reason in physical theory at some length, M does not explain the example merely in terms of the fact that the theory tries to become a pure example of a quantitative intermediary science. He explains the example in terms of observable facts of nature.

The example concerns "real" space and whether it is Euclidean or not. The first step in answering this question sets him apart from all contemporary scientific realists. He asks "what do you mean by "real"?" And he distinguishes between what the word "real" should mean to the philosopher, the mathematician, and the physicist. Scientific realists from the analytic tradition have at most one standard for what is meant by "real"; because scientific knowledge is of the whole of knowledge as far as they are concerned.

When Maritain asked the question, he was already equipped with another standard for judging the reality quotient of a theory, and can define other standards by reference to his primary standard. In comparing Maritain's position to realism and instrumentalism in the analytic tradition, you cannot emphasize too much that Maritain has standards for "reality" and "truth" that are independent of scientific reality and truth. That allows him to know such things as that there are nature's for the scientist to investigate, that those natures are the basis of the universality of science's laws, that quantity is the first accident of material substance and so the active and passive powers of material things are quantitatively conditioned, etc.

Before going any further, we should note that this has significance for the way Thomists should try to relate the questions that other contemporary philosophers deal with to Thomism. Unless you get down to the basic disagreements between Thomism and analytic philosophy, the disagreements at fundamental levels, discussing how they would approach the same question can only be extremely superficial, and probably unhelpful to either side.

Maritain can grant the physicist a particular meaning for real space, but it turns out to be one that calls for explanation in terms of a being of reason. Maritain grants that real space is not Euclidean from the point of view of the experimental scientist. He grants that Euclidean geometry's laws do not in fact express the relations between measurements that the physicist is able to derive from nature. As a result of what "real" space must be for the physicist, his theories must make use of a non-Euclidean geometry. And to the extent that they are making use of a space that is not Euclidean, not describable by Euclidean laws, those theories are making use of a being of reason. And they must do so. So this explanation of how beings of reason into science and an actual case does not just follow a priori from Maritain's views about intermediary science. It follows from actual facts, from "reality" at the level of experimental fact. The laws that theory must explain require a non-Euclidean geometry.

We have looked at in what sense the physicist's non-Euclidean space is real and unreal for Maritain. Maritain has arguments to the effect that only Euclidean space is real in the philosophical sense. We can wonder how strong those arguments are. Passing over them, what about the four-dimensional space-time continuum, as opposed to just its spatial component? It is likewise a being of reason for Maritain. In addition to whatever remarks on this question Maritain makes in "degrees", there is an argument showing the being-of-reason character of Einsteinian time in "Theonas" that Maritain does not refer to an "degrees." In Theonas he gives an argument demonstrating that simultaneity does indeed exist. That argument is clearly a case of ontological analysis. So that argument demonstrates that to the extent that Einsteinian time rules out the possibility of simultaneity, Einsteinian time is a being of reason.

But just as in the case of non-Euclidean space, the "true" scientific theory must postulate a space-time continuum from which simultaneity is absent. For Einstein demonstrates that absolute simultaneity at a distance is not physically observable. That demonstration follows from the physical facts about the observation of the speed of light and of the relative motion of things in the universe. Those are the same kind of facts that make the space that is "real" for the physicist non-Euclidean. So ontological analysis show that reality is actually more complex than the data available to physics. So physical theory must be more simple than would be ontologically necessary. So again, physical theory must make use of beings of reason. The same kind of ontological arguments can be made for the existence of absolute dimensions, absolute positions, absolute velocity, deterministic causal connections, etc. But each of these ontological realities is beyond the ken of physical observation, and deterministic, necessary causal connections make them so.

19.

Are there any other bases for the use of beings of reason in physics? Perhaps the fact that the in their natures of things are not knowable to us by ontological analysis or dianoetic knowledge provides a basis. We can ask why we can't make a good guess about the inner nature, but even that guess would be irrelevant science if it has to take an ontological form. My problem was how does the fact that quantity is the first real property of real physical beings justify the use of beings of reason in physics. An answer that I ignored appears immediately after Maritain that statement about real quantity. He immediately adds on p. 143 that quantity can be considered in a different way, namely, the mathematical way which abstracts from its conditions of real existence. The implication is that when we apply mathematics to the study of physical things and even physical quantity, we are by hypothesis viewing physical reality from a point of view that abstracts from the conditions under which quantity exists, conditions necessary for the possibility of quantity's existence.

For example, in this way an apparent problem in quantum mechanics could be handled directly by Maritain. When you have zero particles, you still have a probability range of energy. And when you have zero energy, you have a probability range of particles.

The reason is that when you have a whole number of one, you have a statistical probability of the other. And zero is a whole number. Maritain could reply that this paradox is an artifact of a tool used by physics, mathematics. Of course, this tool is an indispensable tool. You can hardly get any place in physics with out it. But while zero is certainly a whole number from the point of view of abstract mathematics, it is certainly not a number in the sense of a measure of real quantity. Zero indicates an absence of real quantity, not a species of it. If the use of zero does not indicate the absence of real quantity, what does? So from the point of view of real, physical quantity, using zero as an integer on a par with other integers is using a mathematical being of reason.

So another basis for the occurrence of at least one being of reason in the theories of mathematical physics is the fact that from a mathematical point of view zero is a genuine number, while from a physical point of view it is not. (This corresponds somewhat to the difference between "real" space for the physicist and "real" space for the mathematician.) So the paradox in quantum physics resulting from the relation between integer quantities of particles or energy and statistical quantities, respectively, is simply a bi-product of the tool, mathematics, that physics must use. The paradox is that to zero particles or energy there must correspond a non-zero probability of the other, since from a mathematical point of view, zero is a genuine integer. But from a physical point of view zero expresses, not a number, but the absence of number, the absence of quantity. If a zero does not express the absence of quantity from a physical point of view, there is no way to express that absence. And at the absence of number is not a number. So physically speaking a quantity of particles or energy that is truly zero does not and cannot correspond to a non-zero quantity of the other. Insofar as it is used as a "measure" of physical quantity, zero is a being of reason.

Another example of the use of a BOR resulting from the simple fact of mathematic's abstracting from the conditions necessary for quantity to really exist is Minkowski's multiplication by the square root of negative 1, a clear BOR, to make space and time part of the same continuum.

Mathematical physics does not and cannot view nature as a mode of being even though quantity is a mode of being, because mathematics considers quantity in abstraction from conditions without which it cannot exist extra objectively. Mathematics does not treat quantity by looking for conditions of the possibility of its existence. (Is this a superior way of saying it to Duhem's?)

"The Philosophy of Nature," page 52, my comment: phenomena and their connections are beings. But quantity is also a form of being, but mathematics does not consider it with reference to the conditions for the possibility of existence. Likewise, empirical science do not treat the phenomena from the point of view of conditions for the possibility of existence considered as such.

20.

So there are many levels to the ways Maritain would respond to philosophical claims made for, about, or on the basis of empirical science. And at that is as it should be. But we do not need are more over-simplified theories in philosophy. And as is almost always the case, Aristotelian-Thomistic philosophy provides alternatives unknown to other philosophies and that show the arguments of other philosophies to be based on false dichotomies. To provide those alternatives, a theory must have more subtleties than those offered by the other theories

One level, the very first, is the fact that science is not the only way to acquire knowledge of nature. And even here there are multiple levels. There is the fact that there exists another method of acquiring knowledge of nature; so that claims implying the opposite amount to methodological imperialism, the U-turn. There is also the fact that science could not exist, could not verify its assertions, without the help of necessary truths about change and causality provided by ontological analysis. And there is the fact that different meanings for "real" and "truth" available to the philosopher. As a result, the philosopher can grant to the physicist times and spaces that are real in his sense but not real in the philosophic sense and that, therefore, require the use of beings of reason to explain what is physically real for the scientist.

Another level, although perhaps just another sublevel of the first level, is that ontological analysis reveals a reality that is more complex than the reality available to physical observation. The theory that explains those observations, therefore, must make use of beings of reason in order to be more simple, from the point of view of postulated causal factors, then ontological necessity would call for.

A second level is just the fact that, as we have just seen, the very use of mathematics introduces at least one being of reason into scientific theories, namely, zero.

At another level, given the facts of physical epistemology, it follows by philosophical deduction that relativity's explanation of physical events must take the form of the change in geometric relation between the measurements, because that's all the physical facts are, relations between measurements, and because absolute simultaneity is not observable by us, and because the spatial measurements that are available to us do not conform to Euclidean laws.

At another level are the discernable degrees of ideality and reality in different explanatory theories of science.

At another level, the philosopher can base philosophical "myths" or plausible hypotheses on the current results of science. And some of these could help resolve paradoxes in science. For example, it comes to mind, although I have certainly not researched this, a philosophical hypothesis might help the problem of action at a distance in quantum mechanics. The events happening at a distance might be philosophically interpreted as manifestations of one underlying accident of one physical substance, the sub-living or sub-animal universe. If so, the supposed action at a distance might really be the effect of one ontological action unknowable to us as such. For this hypothesis to work, we would have to conceive the universe as starting off, at least, as one substance. And if there are now many substances in the universe the properties of that one original substance would have to continue to exist as virtually included in the substances that now populate the universe.

This may seem an odd hypothesis to a Thomist. But under any hypothesis, we have to account for the existence of the two fields, gravitational and electro-magnetic that exist every point in the universe. Since they exist every point, they cannot both be substances and yet remain distinct from each other. So the fields must be accidents of a substance or of substances.

And none of these levels have invoked the principle of simplicity, which is an addition to Maritain though perfectly consistent with his principles.

The problems I have pointed to in Maritain's account of the use of BORs in physics do not undermine his fundamental principles, which remain the basis for the only sane approach to the issues of realism and explanation in science. But Yves Simon seems to be sensitive to these problems, as the distinction2 he makes in the chapter on scientific realism in The Great Dialogue of Nature and Space (which I strongly recommend) indicate. But his main conclusion, perfectly consistent with mine and with Maritain's most fundamental principles, is that "the question of the real import (of the reality quotient or of degree of reality and ideality) of science can receive only a nuanced and not very glittering answer that is well suited to dissatisfy everyone, especially the popularizers."

21.

Another recently verified phenomenon of quantum mechanics seems to require a return to action at a distance. My solution to that would be one that will appear radical to most Thomists. Ever since the pope's science adviser invented the big bang theory, it has been possible to consider the universe to be one substance, one extended complex substance. If a human being, as an extended and complex as she is, can be one substance, why does the greater size of the universe prevent it from being one substance? If the universe were one substance, a change at point A could immediately produce an effect at distant point B, if the change you're a change in just one accident of the substance, an accident that happens to be spread out.

A one substance universe could also solve the problem that Harre and Madden raised in the last chapter of causal powers: a theory of natural necessity. They ask how to distinct fields, the gravitational field and the electromagnetic field, can exist in the same place. While, why can't a substance have to different accidents existing in the same place as long as the accidents are of different species, that is, as long as they are actuations of different potency of the substance?

We can even preserve the advantages of the one substance theory if we modify it to allow each human being to be a distinct substance, or each animal and plant. Assume that the universe is one substance untold the emergence of animal. If they're really were only one substance, the theory of prime matter and substantial form would not be needed. But it animals are a distinct kind of substance from the rest of the universe, the emergence of animals requires the emergence of a new kind of substantial for, and also the previous existence of another kind of substantial form making the universe the kind of substance it was prior to animals.

But the new substantial form would contain the old virtually. Every property that the old form could cause to exist in prime matter would be caused by the use form, but the use form would cause additional properties. By seamlessly containing the old form the new form would seamlessly produced the accidents that the old form produced.

Take the action at a distance example. Assume that an action at point B, someplace at a distance from an ovum, instantaneously produces an effect at point B inside the ovum.

Now consider the same action after a sperm has entered the ovum, causing a substantial change. Imagine a line from the same point A, outside of the zygote, to the same point B inside the zygote. The part of the line outside of the zygote belongs to one substance, the universe, the part inside the zygote belongs to another substance, the zygote. In each case the imaginary line represents an accident of its substance. And action at point A instantaneously causes a change in the whole of the line outside of the zygote. But if that line is contiguous with the line inside the zygote, there is no reason why the action at point B would not also instantaneously produce an effect at point B, inside the zygote. Remember, action and passion are simultaneous. So the action of any cause is simultaneous with the existence of its effect.

August 2, 1999

Some more advantages to the one substance theory. If the universe is one substance, the individuals making it up are really integral parts of the substance. So the spatial relations between those individual are really accidents of the substance. They are not accidents existing between distinct substances. So why is there a problem about the reality of relations? The problem was supposed to be the that in addition to being an ordinary accident that got its reality by inhering in a substance, a relation also has a sort of in-between state that is hard to accommodate to the substance accident metaphysics. But if there are no substances for relations to be between, but only one substance whose integral parts are related, why can't those relations be ordinary accident since they have nothing to be accounted for other than the reality they possess as inhering in the substance.

And we could still have animals as distinct substances with out having to postulate real relations between the animals and the rest of the universe. The reason you could want real relations despite their problems to begin with is this. Change must bring something new into existence. What does change of place bring into existence except a new relation between things? It seems that with our the reality of spatial relations there is nothing new for change of place to bring into existence. The one substance theory takes care of that problem, but it does the introduction of other substances reintroduce the problem?

Not necessarily. Instead of the troublesome relations somewhere in between substances, we can have the real causal influence of one substance on another. When I moved my finger from one place on the desk to another, the finger is now exerting its causal influence on undue part of the desk, and is being influenced causal he by a new part of the desk. These causal influences our transcendental relations, or material relations, not formal relations. And area of the desk is undergoing a change because my finger is touching it. Another area is no longer undergoing such a change. That change is something real in the desk, not in the finger. But that change has a transcendental relation of dependents on a cause, the finger. When I moved the first finger away and replace it by a second finger in exactly the same area, the area is not undergoing a numerically distinct change with a numerically distinct transcendental relation of dependents on a cause.

Another thought about getting multiple substances into the one substance universe. What about neutrinos and other phenomenon that seemed to pass right through the us with out ever been coming part of us. Should wait or should lead not a that while they are in us, they are held in existence by our substantial form, and their substantial form is only virtually present? That is certainly one possibility.

Another possibility that may appear attractive is to say that our substantial form only supports those integral parts that have some functional role in us. But while it may be true that neutrinos have no functional role relative to our substantial form, trying to say that could be tricky. They certainly have a functional role relative to the one substance universe. If our substantial form virtually includes the substantial form of the one substance universe, shouldn't what ever role neutrinos have for that universe the virtually present in us? This requires more thought.

22.

The following remarks concern mathematics itself:

Is Euclidean space the basic kind of space that all other kinds of space depend on? When I say that my straight line is shorter than your geodesic, you reply by asking what kind of space my straight line is embedded in. So the question is does three-dimensional space come before two-dimensional or one-dimensional .

But the Euclidean starts with a point. He need not start by saying that the point has one particular position rather than another. If he said that he would be assuming that the point is embedded in a space whose characteristics are already determined. Instead, he can generate by asserting that the point begins to move. (But when we say that point begins to move, are we making the implicit assumption that the point does have position relative to which the motion takes place? Or can we say that the motion creates relative positions by creating one-dimensional lines?)

I want to say that as point moves from A to B, a line is generated; a line comes into existence for the first time. So a dimension, a single dimension, comes into existence for the first time. Now there are an infinite number of ways for the point to move between A and B. I now want to say that the shortest of these ways of moving is what I will call a straight line. Can I say that without implicitly presupposing some background space, at least two-dimensional, to provide some sort of standard for measuring whether one distance is shorter than another? Perhaps not. Can I, for example, assume that in all of these different paths this point is moving at the same speed? Then the path that takes the point to B first is the shortest distance. But am I not assuming a concept of distance already given when I speak of speed?

Maritain wants to say that the dispute between intuitionism and formalism can be solved by just considering the fact that certain objects of mathematics are representable in the imagination; therefore, he claims, these objects must not contain any contradiction.

Perhaps that claim can be defended in the following way.

Possibility is best proved by actuality. The actuality where the objects mathematics first exists is in sensible things. But the quantities found in sensible things precede the qualities of sensible things. So quantity that exists in the sensible world is objectifiable in abstraction from the sensible qualities without which they cannot actually exist. Still, the possibility of these quantities existing is proving by their actual sensible existence. So if we can connect some construct incapable of sensible existence with the imaginable quantities abstracted from sensible existence, we can connect it with possible quantity, that is, some quantity whose internal lack of contradiction is already known. So if we can represent this unreal space by way of an imaginary space, we have shown that the unreal space does not contain any internal contradiction.

xxx mathematical intuitionism and the imagination, December 20 4, 90

Unlike formalism or intuitionism, Maritain grounds consistency for mathematical objects in constructibility in imagination. For example, page 131, note two. For natural things, the juxtaposition of two distinct objects in imagination could hide a contradiction. For example, centaurs and Phoenixes may combine features that are actually mutually exclusive, because of causal necessities in nature. But we cause the mathematical object by constructing it. So "ab esse ad posse", that is, consistency, applies to the mathematical objects that we construct in imagination. The imagination is their proper domain of existence in so far as they are considered by mathematics, namely, insofar as they are separated from natural sensible properties.

Maritain is talking about complete construction from the ground floor, which we can only do for mathematical objects. But when we can completely construct them from the ground floor, we know they are not self-contradictory, even though it may be contradictory for some of them to have an existence that is not cognition constituted, that is more than being-known. A contradiction is an opposition between two different features. But if all the features amount to, all they are, are objects constructed in the imagination, then their juxtaposition in imagination shows them to be non-contradictory. For example, a line every point of which is equidistant from a single point, a figure with three straight lines, a the shortest distance between two points, etc.. If they contain contradictions, they could not be constructed in the imagination; their notes would conflict.

xxx idealization in mathematics, January 22, 84

2 in the abstract does not exist. Only two dogs or two apples exist. To say, for example, "2 + 2 = 4", is to consider 2 not as a possible existent but merely as term of a relation. But what does *that* mean? There are two kinds of relation to be considered with reference to mathematical quantity: (1) relations of equality or inequality; this is a particularization, an instantiation, an embodiment of the identity relation. (2) causal relations, for example, adding and subtracting.

We might consider the relations of more-than or less-than as instances of the inequality relation. Yes, but they are more specific than the mere assertion of inequality because they add causal relations to it. More-than X means X plus something, with something added; less than X means X with something something subtracted.

2 is a possible existent, but once we have abstracted these relations of equality and causality, we can construct other mathematical objects by defining them as terms of such abstract relations: negative numbers, imaginary numbers, even rational and irrational numbers, etc.. Even transfinite numbers. As so defined they do just as well for mathematics as do integers, because math does not worry that the integers that are its original objects are capable of real existence. Their capacity for real existence is important for the psychological genesis of mathematics but not for its methods of verification. Once we have

acquired in needed relations by abstraction, then the object terminating such a relation is as valid for mathematics as are the original objects of mathematics.

But notice that, as Simon says in his article on mathematical abstraction, the square root of the negative one is a contradictory idea. Still, still mathematics successfully makes use of it.

On the incommensurability between "abstract" as said of metaphysics, on the one hand, and as said of mathematics in logic on the other. When referring to metaphysics, we are talking about the abstract as of the content, with reference to the content, not of the absence of content as in the case of systems for calculation. The content in our knowledge of how to calculate is extremely concrete, not abstract in the metaphysical sense. That is why calculational methods are so certain and so helpful, namely, because the content that we need to know about is so concrete.

In mathematical abstraction we view a quantity, for example, 2, not as the number of, for example, human eyes or human ears, but as the object of an algorithmic operation, the target, the result, of operations on symbols. Metaphysical abstraction is the opposite. Precisely because of the content that remains in metaphysical abstraction, calculational methods are irrelevant, indeed impertinent, to metaphysics.

23.

The following remarks are more random.

October 23, 86

First I will argue that Maritain is more realist in his philosophy of science than is usually granted. And I will offer improvements to his theory that (1) move more toward realism, (2) yet ground the use of beings of reason even more firmly than he does, and (3) remain attached to his fundamental principles and develop them more purely than he does.

The necessity of the use of beings of reason in mathematical physics is not de jure; it is not based on the *essence* of mathematical physics. The necessity is factual, based on the conditions in which mathematical physics actually exists. But this fourth point raises the issues where Maritain's theory needs correcting, both in the direction of realism and in the direction of establishing the need for beings of reason in science.

If the success of mathematical theories derives from the fact that quantity is both a reality and the first accident, why must *any* of the quantitative constructs that science uses be BORs? Some of the reasons we have seen so far: Because the data science has available can be simpler than the reality, because a dianoetic knowledge of natural events would be ontological, not empirical, and especially because the causal properties of things are qualities, while the explanations of mathematical physics must be as quantitative as possible.

We can glean some other reasons from Maritain. For one thing, the quantitative aspects of things though perfectly real need not derive from the things' substantial forms but from accidents of the disposition of matter resulting from the history of the universe. For example, man is a featherless biped. This is a way of knowing what man is. For "biped" and "featherless" are both ways of answering the question "What is it?" about something. We can say that "featherless biped" is a superficial understanding of what man is, but only if we are ready to define the goal or goals from the perspective of which some ways of knowing what man is are more or less superficial than others. And defining those different perspectives is precisely what Maritain is striving to do.

"Featherless biped" gives us only a perinoetic understanding of what man is because a common accident like being bipedal need not result from the interior nature of man's substantial form. It may result from an historical accident in the evolution of man's body.

And among such nonrevelatory, or nondianoetic, common accidents are quantitative features like the two-ness of our feet, hands, eyes, nostrils, etc. For example, man's substantial form may require man to be pedal, or multi-pedal, or multi-appendaged, but not to have this or that number of feet, or to have legs as well as arms, etc. So a combination of common accidents may not tell us anything revelatory of the nature of a specific kind of substantial form.

M says that there is such a thing as the epistemological species he calls" biology," in which mathematical method will always be subordinate. He does not say that in what is biology sociologically mathematics will always be subordinate. He says the opposite on p. 198 of DOK.

Scientists do not need an ontological/dianoetic understanding of causes to solve their problems and explain their facts. But where schematic sciences can explain their facts proximately without ever using beings of reason, metric sciences cannot. Why? The mere fact that the ontological natures hidden is not a sufficient answer, because it is hidden from the schematic sciences as well. Maybe it's that the explanations of the metric sciences are more remote, not relative to their own facts, but to the facts of the schematic sciences. More remote and hence deeper. And as deeper, closer to the unattainable area that would be needed to know the ontological explanation of schematic facts.

Xxx Perinoetic is more than just that which cannot be derived from the self-evident (as I imply in my article on M's views on the philosophy of nature). M is thinking of things having different substantial natures, i.e., natures determined by specifically distinct substantial forms. But usually our knowledge of the properties of things does not allow us to deduce the fact that the substantial forms are of distinct species, or deduce how the substantial forms must differ for the known properties to be what they are. Instead, we stop at the properties which function as natural signs (as smoke is a natural sign of fire) without being able to get to that of which the signs are signs, except as something standing behind the signs.

Xxx Science and Rity 5-7-92

In the Boston Globe's 4-4-92 article on the COBE-Smoot big bang ripple discovery, it describes the inflation theory as saying the inflation went faster than the speed of light. And it says that this does not contradict relativity because the speed of light limits things in space, while the expansion affected space itself.

But doesn't speed not only limit things in space but *measure* things in space, so that it wouldn't make any sense to apply the same standard of measurement to space itself? Speed measures change within space, so how can it measure change that does not take place internally to space but affects space as a whole?

Xxx Beings of Reason 4-23-91

For any being of reason (BOR), we must be able to state its truth conditions without using BORs, i.e., we must be able to relate the BOR to predicates that are not BORs. Examples of how to do this are "known by A" as related to "A knows" and the explanation of BORs in science in Causal Realism. Also, the explanation of evil as a privation.

September 8, 1997

A change occurs when A goes from relative rest to relative motion. Now A has kinetic energy that can cause effects not possible before. But is the locomotion itself a process of change? If so, change in what? Can we say that for relativity it can only be a change in A's world line, and so is a change in relative space-time? If so, can we say that when A changes to being in motion, A changes to being in a state of causing a change in the geometry of space-time? Perhaps the relativist will say that inertia, being in a state of relative rest or of continuous relative motion, is the limit case where there is no change in the geometry of space-time. But then, what is there a change in? If gravity is acceleration and is universal, perhaps it is a change in the relation A to the acceleration A would otherwise be undergoing.

yyy Causality in science and in philosophy, Apr 1, 1998

Science does not determine what to believe about causality. Causality determines what to believe in science — just as nonstandard logic requires us to use standard logic. That is, to verify the nonphilosophic uses of causality in science we have to rely on our philosophic understanding of causality.

Apr 27, 1998

We discover new ways of describing the world, e.g., chaos theory, mandlebrout sets, non-Euclidean geometries, statistics. Thus we discover new kinds of statements we could not have made before (and hence neither could we have contradicted them before).

DOK, p. 167: Which space is real in the philosophical sense? Sense verification and measuring instruments can tell us nothing (and cf. n. 2). Measurements must be interpreted. The senses and scientific instruments know phenomena, not the space that binds them together.

111679 And there are, necessarily, distances that correspond to Euclidean straight lines. I mean physical, real distances, i.e., between real bodies. Why necessarily? Because if we can measure a non-Euclidean line, we can determine from it what the Euclidean distance between the points is.

111379 Reflexions, p. 186: Aquinas (In Boeth. de Trin., q. 5, a. 3, ad 5): The science of music does not consider sounds as sounds but as numerically proportionate to one another.

Ad 7: The same thing can be demonstrated physically or mathematically. For example, the curvature of the earth can be demonstrated physically ex motu gravium, astrologically from considerations of lunar eclipses. Cf. Post. Ana., lib. II, c 13; Meta, lib. XII, cc. 2 and 3.

Reflexions, p. 187: The ancients has particular examples of intermediary science, but a universal mathematical interpretation of physical nature did not occur to them.

Reflexions, p. 238: If what we call 'speed' and 'movement' is not in things, speed and movement exist only as a number found (a relation of measure discovered), only as a measure effectuated by an observer (and that is the kind of physical event explained by Einstein). The same thing must be said for duration, time, and simultaneity. They are nothing more than measures effectuated by observers under certain conditions--then there is no contradiction in relativity. (Space and time would then not be intrinsic to objects in the world but are relations between objects and an observer.)

Reflexions, p. 250: In the sciences, measure plays the role of nature in philosophy (and measures are extrinsic denominations and as such do not reveal the nature of what is measured.)

Reflexions, p. 221-2: If two thinkers at A and B along a railroad track have the same thought, they are to admit a sound of the same pitch. The stationary observe verifies the same pitch. But by the Doppler effect, the moving observer does not get the same pitch. Do we conclude that the identity of these thoughts is relative to the frame of reference from which we observe (measure) it?

111279 Einstein defines space and time by the possibility of measuring them, that is, he defines them as the possibility of physical measurements or as the results of possible measurements. But a measurement and that which is measured are not the same. So what if Euclidean laws cannot express the results of our physical measurements?

Reflexions, p. 213, n.1.: An example of light actually moving less than C but still observed as C?

Why should the observer on the train assume the lights were not simultaneous unless he was making the prior assumption, and why should he, that the sources of light were not in motion relative to the train?

1116791 DOK, 155: Mathematics considers motion by taking a point as a pure term of a relation of distance. The relation changes but reciprocally, i.e., it makes no difference whether the point is moving vis-a-vis the axes or the coordinates vis-a-vis it. So the variation studied by mathematics posits no more reality in the point than in the axes, i.e., real motion is posited in neither one. What is studied is an effect of real motion. What is studied is a change in the relation of distance, not the term of the relation as more-than-the-term-of-such-a-relation, but the relation as relate to terms, as relating, as terminating in, terms considered as pure terms. Still, statements made from this point of view can be true statements, not yet involving beings of reason.

4279 The theory that is more complex than necessary will call for changes to occur that will not be observed. Since they are not observed, there is no reason to believe the more complex theory. Does relativity disprove this? Observation of change is relative; maybe it is the more complex change that is taking place so far as observation is concerned (for example the earth not turning on its axis, but the universe turning around it.) I want to say there is no reason to believe the earth does not turn on its axis, because this is by far the simpler explanation. The other explanation calls for billions of more motions and the causal relations necessary to explain them.

Maybe simplicity only works for *kinds* of causal relations. If the most simple theory, in terms of kinds of causal relations, permits either interpretation of the facts (few motions, many motions), simplicity can no longer help us decide, for observation can no longer help us decide. Simplicity presupposes that observation can help determine the number of changes occurring. Can't observation, however, tell us whether there is enough energy for the universe to be spinning around the earth? Energy = causal relations.

xxx another reason science uses beings of reason, May 25, 2005

Simplicity. Many things that exists ontologically simply do not fall and cannot fall, as it turns out due to physical causes, within the ken of science: for example, absolute motion, absolute dimensions, simultaneity, absolute position, absolute speed, deterministic causality.

xxx perinoetic knowledge, May 26, 2005

In so far as perinoetic knowledge does not conceptualize essences as differences of being, the knowledge achieved is circumfrential to the essences as capacities for existence without which the existence of their effects would not be possible.

Can we describe the dianoetic knowledge of this way? To grasp a property in the ontological sense is not only to see the essence as a necessary cause of the accident (necessary relation of effect to cause), but to see the accident as a necessary effect of the essence (necessary relation of caused to effect). For the essence is by its identity with itself a cause of such an accident. To know the accident as having the nature as a necessary cause would be to know the nature only circumfrentially. To know that and why the nature has the accident as a necessary effect would be to know the nature interiorly.

March 14, 86

If there is such a thing as essence, science is not interested in it whenever essence is not testable by the sensibly distinguishable differences that constitute the data of science. A difference in its substantial essence is only knowable when distinguishable effects are not traceable to accidents received from an outside agent. In that case, the effects must be traceable to the substantial form, and distinguishable effects demonstrate the existence of substantial forms with distinct natures. Most sensibly distinguishable differences are not of that kind.

Now what is nonphysical about that knowledge of the relation of oxygen's nature to hydrogen's nature in water? In neither case is it a question of complete knowledge of a nature. But it is true knowledge of the nature of oxygen and the nature of hydrogen that they are composed of units of smaller weight and smaller volume than larger samples of either element and that each unit volume of oxygen ways a 16 times as much as a corresponding unit of hydrogen.

So we have acquired new knowledge about two quantitative properties of previously unknown units a quantity of which makes up a sample of an element. But there is nothing non-physical about this knowledge. The knowledge postulates the existence of new entities, but these are not postulated beings of reason.

In the case of atoms, where the question of beings of reason comes up is concerning the nature of that which exists. But even here, as far as we have investigated the nature of atoms in these examples, there is no reason to suspect that what they tell us about nature consists of beings of reason. Atoms are smaller units whose combination in numbers larger than one make up the larger samples of the elements that we observe. Those atoms each possess measurable weights that explain the relative weight of each element in compounds of the elements.

so far we know about the nature of those units that they occupy space, that they have volume, since larger volumes are made out of them. We know that those units have weight, since they explain the relative weights of larger samples of the elements. And so on. In what sense is postulating weight of an atom or size of an atom something that is merely on the level of beings of reason? In no sense, and Maritain does not say that it does. In fact, he denies explicitly that it does.

Why, then, does Maritain say that necessarily the mathematical theories of science will sometimes use beings of reason? He gives one apparent explanation when he says that beings of reason will enter to the extent that the intermediary science tries to explain things purely in quantitative terms. That is, tries to give an explanation purely in terms of physical mathematics, physical geometry in particular.

August 3rd, 2002

Is there any evidence for Maritain's claim that we have an intellectual desire for a philosophy of nature, not just an empirical science of nature? Yes, that evidence is a constant tendency to make science into a philosophy of nature, for example, quantum mechanics's Cats Problem (I can't remember the guys name right Now. Schrodinger.); that proves Maritain's claim.

Maritain and Science

Toulmin, in the NY Review of Books review of Teilhard, accuses Maritain of "Anti-scientism." Ironically, Toulmin is correct, but for a reason opposite to his. (But notice how the empiricist wraps himself in the mantle of science. "If you are against me, you are against science. Shades of Paul Erlich. And he may do this sincerely; he may honestly think that to honor science, he must make it into a metaphysics.) Maritain is not anti-science; he is only anti-scientism. In his first article, Maritain criticizes the limitations of the scientific *mode of thinking* for not being appropriate for giving us knowledge of things like God.

Maybe the scientific mode of thinking contributes to the abortion mentality. Not science itself, i.e., not that which science informs us about babies; but the scientific mode of objectifying, mode of signifying, that which science knows about the real. Maybe that mode contributes to our ability to substitute circumlocutions like "product of conception," "genetic material," "mass of cells" for more appropriate descriptions of the baby.
These descriptions stop at the phenomena.

Maritain can explain the success of quantum mechanics without making either reality or the human intellect irrational. But to show this requires more work than Thomists have done and probably more than the there training has made them capable of doing. Somewhere in the degrees of knowledge Maritain asks whether or not workers will be wanting. It turns out that they have been wanting. The reason is that have just about the time of the degrees of knowledge Thomists graduate schools changed from teaching their students to do philosophy Thomistically to teaching them to do Thomism historically and textually.

In other words, they trained their students to engage in intramural Thomistic debates about what Aquinas said rather than training of them to deal with philosophical problems philosophically. Predictably, this resulted in a lot of not very perceptive interpretations of Aquinas. You can't understand any genuine philosopher unless you're able to read him with a philosophical frame of mind, the same frame of mind that produced his insights. And you won't have a philosophical frame of mind if you're not taught to do philosophy by dealing with philosophical problems. Solving problems is the only way philosophy advances. The discovery of philosophical truth almost always requires philosophical error to prompt the search for the true. There could not have been and Aristotle with out a Plato.

So we stopped doing the philosophy of nature in favor of talking about the philosophy of nature as an epistemological type. That is, we stopped doing the philosophy of nature, of which there had been previously a considerable amount, in favor of doing a form of epistemology about the philosophy of nature. And most of that epistemology was less than enlightened.

Also, we stopped doing philosophy of science other than to state how science allegedly fits into Aquinas his scheme of the sciences, or I should say, some philosophically unenlightened interpretations of Aquinas his scheme of the sciences. As a result we have not even begun to do the kind of work necessary to deal with quantum mechanics.

Perhaps one way to express the import of Maritain's into the role of mathematics in physics is this. Mathematics is our most powerfully precise discipline. But because of the fact that it cannot reveal causal relations as such, together with all the other natural limitations on our ability to know the natures of things that we can become aware of root sense experience, that is, all the nonmathematical limitations on these things, we can only get a fuzzy, blurry picture of the inner nature of things through our most precise discipline.

3-5-01

Mathematics is the most precise knowledge humanly possible. But relative to the intrinsic natures of things, the use of mathematical conceptualization can give us only a fuzzy, blurry, through a glass darkly, picture of thing's. So the most powerfully precise discipline gives us a blurry picture.

xxx Maritain and Quine, October 14 89,

In "the ways of paradox," Quine talks about eliminating "because" from scientific language. In effect, Maritain predicted that 40 years earlier, but not because "because" was in valid. Rather it is an ontological term in the background of science, since other ontological concepts are logically included in scientific concepts, at least in the epistemologically primary scientific concepts, and since ontological truths, for example, causality, our regulatory of science without entering into science.

Page 55: he introduces the dianoetic/perinoetic distinction in the context of a discussion of verification being relative or not relative to experienced fact, to the constancy of an experimental relation. This is opposed to the philosophy of nature where experimental fact does not constitute "the medium of demonstration". (This is perfectly consistent with my presentation in my article on (Maritain's views on the philosophy of nature.)

Page 177: Dianoetic knowledge discloses the substantial form.

"We know that the immanent action by which the living organism constructs itself, the activities of sensation and intellection, all disclose quidditative principles, one purely potential and determinable, the other specifying and determining, which we call "prime matter" and "substantial form." (And prime matter and substantial form are ontological concepts."

xxx is space-time continuum a being of reason? June 9, 2005

Why should time not be just a natural extension of spatial continuum? But even if it is, it does not follow that the space-time continuum as postulated by Einstein is not a being of reason. If that continuum is postulated so as to explain the non-simultaneity of events at a distance, then to that extent it is a being of reason, since from an ontological point of view, distant events can be simultaneous.

xxx scientific knowledge as causal, January 18, 79

Arno Penzias on Dick Cavett says that science does not know causes, does not explain; it only describes. But is it describing causal connections or not; does it know causal connections or not? The answer to the last question is yes and no. It knows causal connections but not as such since it does not use the concept of cause or its cognates.

And science is directed by necessary to about causal connections. So *philosophers* can look at science and evaluate scientific knowledge as being about causes and causal connections. This is the sense in which Maritain says that the scientist knows causal connections "blindly." That which the scientist knows are causes and their effects, and their relations to one another. But the scientist does not know them as such. (In fact, Maritain says that science knows *essence* blindly; for "essence" read: necessary causal connections or a locus of necessary causal connections.)

The scientists uses mathematical relations that are not causal but concern the equality of quantities. But the quantities in question describe things which are causes and effects, and the relations between quantities are determined by causal properties of causes and effects. And it is the fact that causal connection determine these quantities, or that causal

dispositions are quantitatively conditioned and so are quantitatively describable, that is, are measurable, that is at the basis of our scientific knowledge. For it is this fact (the fact that what we measure are causal dispositions and causal connections) that allows us to apply the principles of empirical knowledge, which are causal principles, to our quantitative measurements.

xxx empiriological knowledge of essence and beings of reason, October 23, 86

We don't know "what" electricity is. But can we give a model showing what this non-existent knowledge of "what" would be like? Yes, philosophical, ontological models. (Definitions of man, animal, vegetable, mineral, human properties and virtues, etc.) But does the mere fact that we don't know what something is imply that science uses beings of reason?

No, in the case of gravity, whose essence we also don't know, we use beings of reason. But the mere absence of knowing what electricity is does not by itself imply that our knowledge uses beings of reason. If we use beings of reason in describing subatomic particles, it is because absolute position and velocity are unknown to us. So our theory *must* be simpler than is required ontologically.

But knowing what electricity is ontologically, like knowing what gravity is, could make no difference whatsoever to the quantitative relations expressed by our laws (so it could not be verified by differences in our experience). Though it need not use beings of reason, scientific knowledge is totally indifferent to the ontological understanding of what electricity is.

October 16, 86

Perhaps the opposition between formally mathematical and materially physical means that the fact of physics's looking at things quantitatively implies that it cannot acquire knowledge of natures in themselves. (We do not know what either electricity or gravitation are, and guessing what they are would be scientifically irrelevant.) But if so, the quantitative point of view would add something to the fact that perinoetic knowledge in general cannot know natures in themselves. What would it add? I am not here talking about the effects of simplicity on empirical knowledge. But it does add the possibility of a being of reason explanation being more simple. That possibility would not be true if the quantitative approach reveals the nature in itself; and it seems to add to perinoetic knowledge in general, which does not imply the use of beings of reason.

March 14, 86

See Asimov's three volume summary of physics, volume two, pages 60 and 61. As long as light was undifferentiated, light could be represented by a geometric line and geometric optics would do. So there was no question of the nature of light; leave that to philosophy. But analysis of colors showed light to be differentiated; the question of the nature of light arises. Why? Because an explanation of sensibly distinguishable differences is needed.

So you got "physical optics" not "geometric." But with relativity, physical optics becomes geometric because geometry now includes time and beings of reason imposed by the

underlying hidden nature of light. The old geometric optics explained certain behavior about light without explaining what it was that behaved in this way, for example, waves or particles. Modern "physical" optics is geometrical in another sense. It accounts for the nature of light in geometric terms. And it is unreasonable to believe there could be simpler explanation than relativity gives.

September 8, 85

Why do some beings of reason make good (that is, true) science while others do not? Maritain says scientific theories are true as a whole. Some beings of reason produce more simplicity, more powerful predictictiveness, more practical applications.

May 13, 83

Geometrical laws govern relations among the measurements of quantities. For example, in Euclidean geometry the laws express relations between the measurements of lines and angles. The laws express how one measured quantity relates to another and how changes in one of the measurable quantities would require changes in another.

And physical events are nothing but complexes of four-dimensional space-time coordinates, space-time measurements. The Apple is at these spatial coordinates at this time and at these other spatial coordinates at this other time. So space-time geometry explains gravitational events. And nothing could explain them more simply.

October 10, 82

Physical events of measurement are subject to quantitative conditions. Those quantitative conditions must be representable by rotating the axes. As a result in physical epistemology, the primacy of the interval, the absoluteness of the interval, follows from the physical quantitative conditions of measurement.

July 30, 82

Gravity causes relative acceleration; relative acceleration causes the relations between physical measurements to be non-Euclidean. Does Einstein have it the other way around? The change in the geometry of space-time, that is, mathematical relations between results of physical measurements, cause gravitational motion, that is, cause the world line to curve.

But for physics, the change in geometry is all that counts because its method of necessity makes the motion into a world line governed by geometric laws. The foundation in reality for the being of reason, the explanation by change in geometry, is the fact that geometric relations between physical space-time measurements are in fact of non-Euclidean. And epistemologically there is no absolute space and time; they are relative to frames of
reference.

But ontologically there is an absolute time and space (spatial dimensions lengthen and shorten but they are always one thing or another and not both). But the facts of physical epistemology exclude absolute and ontological spaces and times from science. And it's

theory must conform to the facts as it knows them. Given the epistemological facts, it follows by philosophical deduction that relativity's explanation of physical events must take a certain form, the form of the change in geometric relations between measurements.

Because that's all physical facts are, quantitative relations between measurements, and because geometry now includes time coordinates, as it must for relativity, change in geometry explains motion. Relativity must include the time coordinates in geometry because measurement of spatial coordinates varies with relative motion, and the time parameter, unlike in Newton, varies with relative motion.

24.

The following are comments on various lines of "the degrees of knowledge". Almost all of them concern the philosophy of science. But I was interested in a variety of questions about the philosophy of science. Perhaps most importantly, I was interested in stressing the realist aspects of Maritain. Under that heading, I was interested in comparing and contrasting his position to that of Duhem, Ashley, Sikora, Wallace, etc.

Page 21: a reference to the laziness of the defenders of Thomism.

Pages 24 and 25: "scientific law never does anything more than express the property or requirements of . . . what philosophers call essence."

Page 25: "it is exactly within (essences) that there resides the reason for the necessity of those stable relations which are formulated by science." (Essence is a locus of necessary causal relations).

Page 25: "the law means that solid ... has within the secrets of its nature something which ... necessarily and unfailingly determines it to expand ... under the action of heat." (The object of science is causal necessity.)

Page 29, last paragraph: "every cause in nature is necessarily determined or ordered by its essence to an effect ... and such necessary determinations are the objects of the sciences of nature, or rather their foundation." That is, empiriological science knows effects of necessities inscribed in essences, those effects being regularities which result from causal necessity.

Pages 30, last paragraph, 31: good and clear on dianoetic knowledge versus perinoetic knowledge. Perinoetic knowledge refers to the inductive sciences (apparently as contrasted with mathematical explanation).

Page 33: "inductive sciences are unable to uncover the intelligible necessities hidden in their object. But physics and the experimental sciences of moderns do not remain purely inductive." (Against Duhem?)

Inductive law is "more than a simple general fact; it unfolds in essence without revealing it." (Check "unfolds.")

Page 140, top: mathematics, and so mathematical sciences, are indifferent to real beings or beings of reason. And see page 164. (But the point of interest to the philosophy of science is that they can use beings of reason. I want to say that they are able sometimes to use beings of reason.)

(In empiriological analysis, the constructed concept does not reveal the object as a possibility of being but as a possibility of being experienced; the object is defined by the possibility of observing it by certain operations. So the objective concept cannot be self-evidently linked to other objective concepts such that the impossibility of the opposite is seen. It takes ontological objective concepts to do that.)

Page 141: "Einstein's times are beings of reason substituting for certain realities whose ontological value is of no interest to science." Even more, their ontological value has no meaning, significance, for science, for example, absolute motion or deterministic causality. Because the existence of such things cannot be verified by sense experience due to necessary causal connections in nature.

Page 146, top: indifference to beings of reason again; and "may even be led" to use beings of reason. So scientific theories are not only mathematically symbolic by essence.

Page 148: although the ontological is never disengaged for its own sake in empiriological science, it is always present there "indirectly and obliquely." The ontological exists there only as a foundation for empirical representations and definition." (But it is there; is this against Duhem?)

Page 150: "relativity transforms laws of nature into identity laws or truisms which explain behavior by behavior, changed mathematically into a property of the structure of the world mathematically fabricated on purpose."

Page 153: "the ideal of de-ontologizing" is in asymptotic limit. That is, ontology is always there at the foundation of science and to some degree in the structure of science's concepts, though less and less in the second case.

Page 154: two reasons why science is "bound to ontology" in an implicit, obscure, ungracious and unavowed fashion: 1) by way of presuppositions (foundations); and 2) elaborated science refers on obliquely to the being of things as the foundation for the explicative representations it fabricate. So references to ontology intervene in the very structure of the science. So science can never be completely de-ontologizied in itself. (The first "foundations" must be the foundations that precede the construction of theories. That is, the foundations that guide us in the discovery and formation of scientific laws, the laws which the series will explain. The second "foundations" refers specifically to the construction of theoretical "explicative representations". To "refer obliquely" to the being of things is to refer obliquely to essences, substance, accident, causal properties, dispositions, tendencies, etc. Even existence is only obliquely referred to when they contemplate travel to the future or past, which have the big disadvantage of not existing.)

Page 156, paragraph at the top: realism in Maritain's theory.

Page 156, top: relativity declines any absolute quantitative properties or determinations (lengths of time or space) because it looks at dimensions not in themselves and independently of any physical means of observation and measurement, rather it looks at dimensions from the point of view of physical observation and measurement and the conditions of it. From this point of view, science is more physical than mathematical; you get to this extent a more genuinely physical world than that of the old physics.

But then starting with conditions of measurement, the new physics attempts a mathematical explanation of measurements -- as they actually occur, a quantitative explanation of quantities as actually measured.

Page 156, section 13, first paragraph: a reason why science uses beings of reason is that it "*tends* to complete geometrization."

Page 157: on relativity theory. Physics reaches absolutes, that is, laws whose form is absolute, "outside of things." That is, it ignores the reality of absolute motion, simultaneity, etc.

Page 157, note one: we don't know what the real dimensions are in themselves (quid), but we know that they exist (quia).

Page 158, paragraph at the bottom and following: what it means to say science does not look for essence.

Page 161: science knows causes and natures but not in themselves. Section 16.

Page 160, second paragraph (and following paragraph): against Eddington. Phenomena are not opposed to being but are "points of emergence through which an aspect of things existing in themselves appears to us."

Page 161, section 16: mathematical physics knows the physical causes and natures, but not in themselves; it knows then in some other way.

Page 162: the observable and the measurable are "substitutes for essence" in mathematical physics. The scientist then mathematically symbolizes the real thus determined by measurement.

Mathematical physics is "not knowledge of the (given) real by a deeper real." But all his examples show that he is not denying that science explains by a "deeper real" when, for example, it postulates the existence of atoms and of subatomic particles. So here he must mean something like a "deeper real" in the sense that dianoetic knowledge grasps the real more deeply than perinoetic knowledge.

Page 162, second paragraph: a reason why science uses beings of reason: "science becomes symbolic to the extent it's a mathematical regulation obliges it to attempt a complete explanation of the real wherein things, the form and formation of which along to the world of qualities, will be formulated in a wholly quantitative fashion."

But why not explain by quantitative characteristics of the causes if we are only explaining quantitative characteristics of the effects? Maritain would probably say that's exactly what he means.

Page 163, top paragraph: he admits that although Aristotle invented the kind of analysis known as intermediary sciences, Aristotle did not draw instrumentalistic conclusions.

Page 163, section 17: empirical science does not know the nature ontologically or in itself. This seems to identify ontological analysis and dianoetic knowledge.

Page 163, 11th and 12th lines from the bottom: the scientist *does* know the nature. And see page 162 note two.

Page 164, second paragraph: "more realist . . . than Eddington."

Page 164: "science is indifferent to the use of beings of reason or a real entities *disclosed*in the measurable behavior of things. So the measurable behavior of things can disclose real entities that can be used in explanation instead of beings of reason.

Page 167: which space is real in the philosophical sense? Since verification and measuring instruments tell us nothing. (And see note two.) Measurements must be interpreted. The senses and scientific instruments know phenomena, not the space that binds phenomena together.

Page 173, second paragraph; and page 43, note?: "mathematical physics knows the real "metaphorically"." Note that "metaphorically" is in quotes. Likewise, in the essay on human equality, Maritain expresses his welcome liberalism by saying that we should get as much "for nothing" as possible. So I wouldn't base too much on a strict meaning of "metaphorically." To understand what Maritain means by it here, we have to keep in mind the whole of his philosophy of science.

Quoting Langevin: "perhaps a new geometry could have the result of synthesizing electromagnetism and gravitation." That is, a new non-Euclidean geometry could be a being of reason unifying the fields and so producing a simpler theory.

Once Einstein made the move of making time geometric, "the way was open to explain motion geometrically." And "we can vary our geometry indefinitely since Riemannian curves need not be homogeneous at every point."

Pages 177-178: Dianoetic knowledge, that is, knowledge of essential and specific definitions, knowledge of an essence in its specificity, knows differences of "being." Does this mean it always uses ontological analysis?

Page 180, note two: take away the mathematics from physical theory and you still don't have knowledge of essence as such; you have only perinoetic knowledge.

Page 191, top: the ontological point of view "thinks the world sub ratione entis."

Page 191: to render a property intelligible is to view it sub ratione entis. (So dianoetic knowledge must use ontological analysis? That is, philosophy is defined by ontological analysis; so dianoetic knowledge does not occur outside of philosophy at all?)

Page 203: Dianoetic knowledge is not like that of God, Angels, or Descartes's knowledge of essences in themselves, going to the inside non-discursively. Dianoetic knowledge goes from the outside in. How? It must be by means of ontological necessary truths.

Page 203, example of dianoetic knowledge: 1) we experience reason. 2) we recognize it as the most principal property of man. 3) we express a definition of man containing dianoetic knowledge. 4) we draw out the implications of the definition. (If this list is adequate, where do ontologically necessary truths come in?)

Page 204, line five: good description of dianoetic knowledge: essence perceived from the outside as by accidents emanating from it as an operation emanates from an active potency and from a substance.

Page 204: the mind never stops short at accidents. That would be contradictory.

Page 205: Dianoetic knowledge grasps an essence is in its "formal constitutive," as reason is the formal constitutive of man's nature. What is the formal constitutive of water? Two atoms of hydrogen and one of oxygen? But is that truth known by causal relations whose opposites are seen to be impossible; is the essence of water known as the locus of causal relations whose opposites are knowingly impossible?

Page 205: perinoetic knowledge "bears on essence," "grasps it from the outside." But does not grasp properties in the "ontological sense of the word." Knowing properties in the "ontological sense of the word" may be the same as knowledge by ontological analysis, but here "ontological" modifies "property" not "knowledge."

Page 206: again "ontological" modifies "property".

Page 206: Example of perinoetic knowledge by common accidents: density, atomic weight, melting point, boiling point, etc.

Page 206: Dianoetic knowledge reveals differences of "being." For example, human nature's difference is rationality. Animal nature's difference from other forms of life is sensibility. The differences between rationality and sensibility can be expressed through ontological concepts, for example, through differences in the formal objects of reason and sense. Chemical differences, on the other hand, cannot be articulated as differences of "being."

Page 2O7: perinoetic knowledge knows substance and properties but "by and in" signs.

Page 207: my comment: it follows from the fact that our substantial form causes rationality that everything with this kind of form must be rational; that is, rationality is a property.

Otherwise some beings which have it would have it because it is caused in them by an exterior agent. (Notes explaining properties, page 30)

Page 208: even the knowledge of primitive man is knowledge "very precise and very exact of "what are" the beings of nature with which they have to deal". (A fortiori, perinoetic knowledge is knowledge of what things are.)

Page 209: the (most lowly human knowledge ... grasps quiddities."

Pages 212-213: all (sensible) substances are known by dianoetic knowledge to "some degree"; "it's intelligibility" has "some determination of being." (Against Ashley?)

25.

The following are texts from Maritain's "the philosophy of nature."

Pages 15 and 16: he contrasts abstraction from the singular with abstraction from the "contingent" and material. That is, the goal of science is the grasp of necessary causal relations. That requires abstraction from what is accidental to such relations, accidental to the specific essence (page 17), where "accidental" means not causally necessary, rather than "accidental" in the sense of the categories.

So "formal abstraction" in Cajetan's sense (and I am only attributing it to Cajetan, not necessarily to Aquinas; that is a different question) is very much like the way we use the word "abstraction" when we say things like "in this discussion, let us abstract from such and such an issue, such and such a problem, such and such a question, in order to focus on" whatever it may be that we want to focus on. We are implying that we can say some significant things about our topic without getting into those other issues; so we are implying that the issues we are abstracting from are accidental to our topic, not necessarily in every respect and from every point of view, but with respect to the specific significant points about our topic that we want to make.

In other words, we are abstracting from things that may enter into causal relations, even necessary causal relations, associated with our topic, but those relations are not essential causal relations bearing on the specific significant points we want to make.

Page 19: a good example of perinoetic versus Dianoetic knowledge (both know essence, and essence is a "locus of intelligible necessities." That is, necessary causal relations.

A comment of mine coming between references to statements on page 31 and page 40: explaining by the fact that, or postulating the fact that, one quantity varies with another is not, as such, a causal explanation, that is, an explanation in terms of causal relations rather than relations of measurement and of equality and inequality.

Page 40: mathematical physics is a mathematical "projection" of the physical.

Page 48, my comment: in "the degrees of knowledge," chapter four, Maritain says that perinoetic knowledge "explains" by schema found in the phenomena.

We must never forget that when Maritain says that all kinds of knowledge know essence, but in different ways, and then puts forward dianoetic knowledge as the ultimate human way of knowing essence, he has a model of dianoetic knowledge in mind. Perinoetic knowledge is whatever fall short of that model in any extent. What is that model? Philosophy's way of knowing essence.

What is a philosophy's way of knowing essence? What properties characterize it? Well what does Maritain hold about philosophy as opposed to empirical science? Things like resolution to first principles as opposed to known by reference to experience. Self-evident truths. Necessary causal relations known as such, etc..

Page 48 and 49: he seems to say that empirioschematic knowledge, not just empiriometrical knowledge, uses beings of reason.

Page 58, bottom: he calls change a "substance" for Bergson.

Page 61: Duhem. "Once science takes measurements it cuts every tie with reality and moves to pure mathematical analysis governed only by laws of beauty." (Against Duhem?)

Page 63: Maritain seems to approvingly cite Meyerson is holding that it is impossible for a scientific vocabulary to be made up only of events and relations and not notions of substance, cause, raison d'etre, tendency, quality, force, energy or power (as we would say) potential state actual state. "Actually science is constantly using such notions."

Page 64: "science presupposes philosophical concepts, more or less altered or recast in transit.

Page 65: he works out the two ways, from "the degrees of knowledge," science uses philosophical concepts.

Page 73: ontological and empiriological analysis are two ways of "constructing concepts."

Emphasize against Wallace the *existential* character of ontological concepts.

Page 89: Thomist "logicians" distinguish the sciences by the mode of defining. So in chapter two of "the degrees of knowledge" he is doing logic, material logic.

Page 95: the philosophy of nature is a "deductive" knowledge. So it is a deductive science in the sense of chapter two of "the degrees of knowledge."

Pages 96 and seven: he identifies empiriological analysis with a knowledge of essence by signs. So he seems to identify empiriological analysis and perinoetic knowledge.

Page 103: subalternant sciences do, but subalternated science do not, resolve their conclusions into first principles.

Page 107: empirio schematic analysis includes concepts defined in terms of both external and *internal* observation. So he would include psychology and other human sciences, especially the moral and aesthetic ones, under empiriological analysis.

Page 129: according to my note (I'm not checking the text here) he says that since sciences are characterized by properties of their objects as objects, metaphysics is better defined as a science whose objects do not include matter than defined as the science of being as being, because the former bears on the object of metaphysics as object, on its mode of intelligibility as an intelligible object.

OK, but that gives "being as being" its proper status as singling out the extra objective value in things that metaphysics is interested in. This is important for dialogue in with Ashley, because even if there were no science of objects that can exist without matter, and so there was only the philosophy of nature as so defined, still within the philosophy of nature that would be the study of being as mobile, on the one hand, and being as being, on the other. Thus, some demonstrations would apply only to being as mobile, while some others, for example, that every being is one, would apply to being as being.

26.

xxx after reading "philosophy and the unity of the sciences," June 8, 2005

Maritain says the symbols of science are "explanatory symbols" (page 35). The symbols of the logical positivists are not explanatory; nor are those of Duhem.

(And notice that at this late date, Maritain is still referring to "eidetic" abstraction; page 35.)

Some other comments on this paper:

Page 37: the attempts of ancient philosophy to explain phenomena consisted of "interpretations which were less certain, more dependent on simple probability and closer to simple opinion, the nearer they came to the detail of phenomena." In other words, the ontological approach to phenomena cannot give us a *science* of phenomena, because it cannot produce *certitude* about them.

With Descartes "the royal power, as to the explanation of nature, shifted from metaphysics to mathematics." So in addition to metaphysical explanation as opposed to empirical explanations, there is metaphysical explanation as opposed to mathematical explanation.

Page 38: we must "free Thomists philosophy from its accidental association with an imagery provided by a pseudophilosophical explanation of phenomena which has been ruined." But belonging to that imagery is the idea that a zygote is too small and too undeveloped to be the home of a human soul.

Page 43: "the ways in which the proper tools or instruments of knowing, the concepts and definition are formed and constructed are essentially different in both cases." Here and elsewhere he explicitly reminds his opponents that the distinction between ontological and empiriological is a distinction in the way concepts are formed and constructed. On page 35, he quotes "the range of reason" as referring to "two essentially distinct ways of analyzing the world of sense perceivable reality and of building the concepts required for this." Then he quotes it as referring to how each "resolves its concepts and its definitions."

And on page 43: after referring to the way in which concepts and definitions are constructed be refers the "light in which the judgments are elicited is different in one case and in the other." Perhaps this is a reference to that "verification" problem of chapter two of "degrees."

Page 44: "a truth is expressed in the judgment which links together two objects of concept." An explicit affirmation that affirmation bears on the objects of concepts not on the concepts themselves directly.

Page 52: "the matter and energy of physics are physico-mathematical entities which are worked out by the mind in order to express reality and which correspond symbolically to what the philosophers call the proper accidents or structural properties of material substance (quantity and qualities). What we can say from the point of view of philosophy or ontological knowledge is therefore that material substance, considered in such or such an element of the periodical table (then it is disclosed to us only symbolically under the aspect of the "atom" of physics) possesses by virtue of its proper accidents or structural properties a certain organization in space (which is symbolically disclosed to us under the features of the system of electrons, protons, neutrons, etc. of physics) and a specific activity which derives from its very essence (and which is symbolically disclosed was as the "energy" invested in a system in question). . ."

But we know from chapter four of "degrees" that atoms are not merely beings of reason. But to say that does not give us ontological knowledge of the kind of being that the atom is. Relative to the ontological essence, the atom of science reveals it only symbolically.

On page 53: it refers to Kantian "regulative principles" in a way different from the way I have used them. He says they "orient thought and research, and play their part principally in that pre-rationalized, pre-systematized, pre-scientific backstage where the most decisive initial steps are taken." I say they also play a crucial part in the all-important *final* stage, that is, the verification of scientific hypotheses. Is this more than Kant says?

It seems to be more than Maritain says. But Maritain only mentions the principle of induction in passing and does not mention the objective role of simplicity in verification at all.