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3986 Title: Relativity: (at) the Interface between Ontological and Empirical Analysis

10485 Title: Was Maritain an Instrumentalist?

530831 Quote Toulmin on anti-scientism (see the New York Review of Books review of the Phenomenon of Man). Then write for the Journal of the History of Philosophy or the Cahiers.

We see the power of Einstein's reasoning and say Maritain <u>can't</u> be right about beings of reason. If fact, he is. And where I depart from him, it is to make the case for beings of reason stronger than he did, not weaker.

4179 The attempt to defend realism, as opposed to instrumentalism, in science on a purely empirical basis leads to a denial of realism regarding knowledge in general, that is, it leads to linguistically relativistic accounts of truth. The diacritical defense of the realism of knowledge in general leads to an instrumentalistic account of scientific truth, but this account is a diacritical instrumentalism (a more 'moderate' instrumentalism.)

Kripke, C9 Kripke is right. We know that X is something with a certain internal structure. That does not by itself substantiate the fixing of reference versus connoting view, however; that internal structure is the causal structure that explains why X appears in this way in these circumstances, e.g., it is able to reflect light.

But we can discover properties that are more revealing of the internal structure than others. The ability to reflect light tells us little about the internal structures of the things we call tigers, gold, and fool's gold. The fact that they have this in common is enough to show that it tells us little about what is specific to the internal causal structure that is what each one is. For dissimilar causes can have similar effects. What reveals the internal structure (or substitutes for it, Maritain on dianoetic knowledge) is a combination of common accidents (that is not shared with others and) that we find together frequently enough to designate the occurrence the occurrence of a natural kind, e.g., gold.

1485 Roger Bacon says experiment. That is not enough. We need to view nature quantitatively. Why? That quantity is the first accident is only part of the answer. That answer tells us only that quantities are one of the things we should study, not that they are essential things to study.

The first reason is that quantity is necessary for objectivity in sense experience. Without it, I can only say water freezes when it feels cold. (And someone else feels warm at the same time; objectifying by sensible quantities eliminates the subjectivity of the proper sensibles.) Also, natural causes act quantitatively, i.e., atmospheric pressue is a quantity of something; and changes in its quantity produce changes in other quantities.

Why do natural causes act quantitatively? Because they produce motion and are put in act by motions. And motions are continua.

Going back to experimental results: once we express them quantitatively, the explanations must also be quantitative.

Back to causes: change in temperature creates a change in the height of a liquid in a tube, a quantitative change. Natural causes act by changes in their quantity, or by changes in various quantities.

Quantity needed beyond experiment at three levels (for three reasons): (1) objectivity in sense experience; (2) natural causes act by changes in quantity; (3) quantitative theories are more powerful for explaining. Are (1) and (2) sufficient reasons for (3)?

81824 What is the difference between the statements that laws are the same no matter what system of reference and that there is no way to determine whether it is A or B that is in motion? Maybe it is the claim that the laws, which are the same for all systems, do not give us a means of determining absolute motion in a particular case. Then the second statement is falsified by the Big Bang and the laws tell us so. Hence the two statements are not equivalent. The laws say that all systems of reference are moving away from the place of the Big Bang, i.e., no matter what system of refernce you are in, your direction is away from the Big Bang. But do you curve back?

no date A formula represents a physical quantity not known in advance, e.g., J = K - 6. J represents the result of a mathematical operation performed on a quantity, K, not known in advance. The result will be a physical quantity. But to get that quantity must go through gyrations determined, not be nature, but by matematical requirements for the algorithmn to be used in deriving the physical quantity. That is, we must rig the formula to get the <u>desired</u> results.

111279 Why cannot the quantitative characteristics postulated for the explanatory entities of a theory correspond exactly to the quantitative characteristics of the actual physical causes in question? And don't forget, the effects to be explained are themselves quantitative, described quantitatively, described by their quantitative characteristics. Why should not those characteristics of the effect be correlated with certain definite quantitative characteristics of the cause, e.g., the length of the string with the pitch of the sound.

This does not imply that quantity is all there is to either the effect or the cause. It simply impies that just as the effect is necessarily quantitatively conditioned, so the causality that brings it into existence has quantitative conditions that explain the quantitative characteristics of the effect (assuming that non-quantitative, but quantitatively conditioned, action is taking place?). The characteristics of the cause explain those of the effect only because they are the quantitative characteristics under which the cause acts and which condition its action and, therefore, its results.

81486   But somewhere in these notes I put it more strongly and correctly. Physical causes act by changes in quantity. That is, they produce changes in quantity and are therefore brought into act by changes in quantity.

11879   Arno Penzias on Dick Cavett says science does not know causes, does not explain, it only describes. But is it describing causal relations or not? Yes and no. It knows causal relations but not as such (the sense know lawyers but not as such), since it does not use the concept of cause or its cognates. And science is directed by necessary truths about causality.

This explains Maritain's statement that the scientist knows causal relations blindly. That which he knows are causes and their effects, and their relations to one another. But he does not know them as such. (Maritain says science knows essence blindly.

For 'essence', read: necessary causal relations or the locus of them.) The scientist uses mathematical relations which are not causal but concerning equalities of quantities. But these quantitities describe things which, as a matter of fact, are causes and effects. And the relations between quantities that science knows are determined by the causal properties of causes and effects. And it is the fact that causal relations determine these quantities, or that causal dispositions are quantitatively describable, measurable, that is at the basis of our scientific knowledge. For it is that fact which allows us to apply the principles of empirical knowledge to our quantitative measurements (the fact that what we measure are causal dispositions).

330791 There is a reason why science must use mathematical fictions, bbut it goes beyond, while presupposing, the reasons given by Maritain. It is presupposed that science deals with the quantitative, measurable aspects of things and that science demonstrates through quantitative aspects of its explanatory elements. These are necessary conditions for using mathematical beings of reason, but not sufficient conditions.

For quantity is a real aspect of things; why must it call for fictions? And granted that the natures of things, and especially of the quantitatively measurable aspects of things, e.g., weight, heat, are not directly available to us through observation, still why can't we gues at their true natures guided by the principles of empirical knowledge?

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

Events that are simultaneous in the ontological sense cannot be known as such by experience and cannot be part of the data on which science is built. Likewise determined causal relations make it impossible for events resulting from determined causal relations to be known as such by science. Hence they cannot enter the data on which science is and must be built. So scientific theories must be constructed as if these data were not there. Hence science is exxcluded from knowing the true nature of the causes underlying the measurable aspects of things. In some cases, we approximate these causes and differ from them only statistically, e.g., uncertainty phsyics. In other cases, we deal with outright fictions rather hant merely incomplete approximations which don't tell the whole truth.

So even if we could guess the true nature of that which we are measuring by its quantitative aspects (e.g., IQ is that which is measured by IQ tests) that knowledge could not help us predict our future experience or organize our experience by quantitative laws. Our experience would necessarily go on as if the simplest mathematically expressed fictions by which it can be predicted were true. Knowledge of the true nature, e.g., God's knowledge or angelic knowledge, would have no scientific relevance. We could not confirm or disconfirm it by experience; the knowledge would be scientifically useless. (And the explanatory entities we used would not be definable by reference to sensibly distinguishable features of experience; hence they would be <u>meaningless</u> to science. If they could be so defined, our explanation could be verified by science.)

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

32379 Science grasps necessary causal relations at the level of law but not necessarily at the level of theory (or does it graps effects of necessary causal relations, necessary effects?). Thus, Einstein's theory saves Newton's laws of gravitation, the inclination (disposition) of bodies to move toward one another varies inversely with the square of the distance. But the theory does not necessarily give us causal relations. For it is not based on what must exist, but on what knowledge of what exists can be gained experimentally.

Not only are his mathematical fictions simpler, but data must be subjected to a rule of simplicity, i.e., our theories only explain what can be learend experimentally (as in uncertainty physics). For example, there is no simultaneity experimentally considered, so theory must be constructed for a world with no absolute simultaneity. And no other scientific theory is even possible. A theory with absolute simultaneity would not be a scientific theory, for it would have no experimental meaning. A theory with determinate position and velocity has no experimental meaning either. Still, scientific theories account for all laws based on necessary causal relations, laws expressing results of necessary causal relations (but these results are themselves material causal relations).

4779 The real cause of gravitation, even if we knew it, could not enter a scientific theory in a useful way. It would be scientifically pointless. For if we knew it, we would know absolute motion: is A accelerating toward B, B toward A, or both toward each other? But if we don't know real causes, how do we successfully predict? We know laws resulting from real causes, especially laws about the behavior of particles in space. They behave according to laws of Riemannian geometry. Why they do it is impossible to say. But we can postulate that certain geometric laws will apply in certain circumstances, e.g., near or far from masses. In our theory, we say that a certain geometry applies in certain cases, i.., particles behave as if there were somethng called space in which they moved. Matter behaves as if there were a container called space with a certain shape. That is a fiction that allows perfectly correct predictions. And no other fiction would do: our explanatory entities must be either causal or mathematical; causal are ruled out, so we are left with mathematical.

42791 When they say space is curved, they really mean that the behavior of moving objects in the space is described by the laws of 'curved' genmetry. It isn't the space that is curved but the motions of objects in space. So why say space is curved. Because in answer to the question why objects behave this way, it is said that they behave this way solely because the presence of matter in space brings it about those geometric laws and not others govern the motions of objects nearby. The presence of matter in space causes those laws to be operative.

But why does matter do this? Is it simply that physical principles tell us that those geometric laws operate in the presence of matter? That is, in the presence of matter use this geometry, and the <u>result</u> of using this geometry will be curved paths for motions? If so, curved paths are deduced but not explained. The effect to be explained is built into the assumptions and them deduced from them. That is, if these geometric laws apply, motions will be curved. But why do these laws apply? Be-<u>cause</u> motions will be curved? And why the are curved is not explained. Geometric laws really apply as <u>effect</u> (not cause) of the fact that motions are as they are.

1111792 The quantitative conditions under which physical causes act and under which we make observations are such that the effects physical causes produce, motions, <u>must</u> be representable as, and must be observed such that, they would be the same no matter if it were different physical causes acting on bodies, which the obides really acted on and really moving were relative to.

111279 The quantitaive laws expressing the space-time relations (quantitative relations) between objects in motion relative to one another remain the same for all observes. The laws that remain the same, because of the quantitative conditions under which causes act, bodies move, and measurements are taken, express what? They express quantitative changes between bodies in motion relative to one another. That is, these quantitative conditions under which..., make it impossible to judge by observation which system of reference is in absolute motion or rest.

111279 The quantitative conditions under which physical causes act and pysical observations are made are such that the quantitative laws describing the changes caused and observed are true which ever term of the relation in-motion-with-respect-to is actually in motion and hence actually undergoing the causal influence.

1222791 Due to the quantitative nature of bodies, it is necessarily the case that when an ontological efficient cause produces motion in a body, the quantitative description of the motion could be the same as if another efficient cause had caused another body to move. The description of the effect must be the same on either causal hypothesis. For the effect amounts to a change in spatial relations at different times. Hence ontological causality is irrelevant to scientific laws and, hence, to explanations.

Still, the spatial continuum is constant, and so we can't explain change just by geometry until time is included in the continuum. The time line of the apply extends even while spatial coordinates remain the same. Now since the effect is described quantitatively, a quantitative description of the cause such that as one quantity varies (cause) another varies (effect). So as mass varies, spatial-temporal relations of events (geometric laws) vary.

119795 Why could there not be some contrary theory that does not use beings of reason, or why can we not proliferate theories with contrary beings of reason? Relativity explains the universe exactly as it would be if there were no such thing as absolute motion, i.e., as if there were not ontological causality moving A toward B rather than B toward A, i.e., if all there is to motion is motion as we are able to observe it given the conditions of observation imposed by the underlying natures of things. So a theory without beings of reason would have no physical significance.

111679 DOK, p. 171: The 'forces' of classical physics (intertial or just gravitational?) 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, empirio-metric entities.

DOK, p. 166, middle paragraph: Once science attributed to non-qunatitative 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.

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: Aguinas (_In Boeth. de Trin_., q. 5, a. 3, ad 5): The science of music does not consider sounds as sounds but a 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 enterpretation of physical nature did not occur to them.

1011821 The motion of light is absolute. If light does not move, its source moves away from it at the speed of light and is therefore infinite in mass. And two objects moving toward the light would both move a C relative to the light but not necessarily relative to one another. And what about the observer moving away from allegedly motionless light?

1010822 Einstein not only assumes the constancy of the speed of light but also the absolute motion of light. It cannot be that the photon is still and the observer moves toward it if the speed of light is constant. Why? Because the observer would have infinite mass and his clocks would stop. So either (a) uniform motion is <u>not</u> possible relative to light, so that the constancy of the observation is just as ideal state like an ideal gas; or (b) uniform motion relative to light is possible and the constancy of the measurement is explainable either by the physical conditions of observation (Geroch), by the mathematics of the geodesics of the world lines of light and the observer (Born and Gamow), or by both (a) and (b).

The propogation of light is the basis of all measurement. If the observed measurement changed without our knowledge that acceleration was taking place, all measurement would be invalid. So evernying must be observed <u>as if</u> the speed of light was constant to an observer in uniform motion relative to light (or to another observer?).

Rity card Funny things happen to things at the speed of light, but not to light at the speed of light. Why not?

See Calder, Einstein's Universe, p. 43.

41791 In order for there to be relative motion, there must be absolute motion and acceleration. An infinite number of motions can account for one body accelerating away from another at 1 mile per hour: the first may be at rest and the second in motion or vice versa; or the first may moving at 2 miles per hour and the second at 1; or the first at 3 and the second at 2, etc. But not all of these can be true at the same time. Nor can more than one of them be trueat the same time to get that effect. But at least one of them must be true. Some one thing is happening.

The relativist replies that the one thing that is happening is relative change in motion. But that cannot be happening without of of these infinite possibilities happening. The relativist replies that it can. From one point of view it looks as if one of those possibilities is happening. But from another point of view, it looks as if another of those possibilities is happening. But this is an epistemological fact that does not change the ontological fact that relative change in motion is caused by some one of these things happening.

The relativist says that some one of these things happening is an effect of our point of view. But the difference of our point of view no more shows that no one of these things is happening than relative non-simultaneity shows there is no simultaneity. Either event A is happening and some other event is happening or event A is happening and the universe is at rest. Either the first body is in motion (moved from potency to act by a cause), or the second body, or both are moving but one more slowly than the other. If the universe contains only 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 re B, B re A, or both re one another. One or the other of these things must happen.

And sometimes there is an objective means of determining which happens. Simplicity is not just a subjective criterion. Of two theories with equally simple sets of laws, the theory with fewer events occurring must be deemed the true theory. If motion is not absolute, then it is valid to consider the object being sucked into the black hold as at rest while the black hold and the rest of the universe are in motion relative to it.

In a universe of 2 objects, A and B, God could cause a relative change in position only by reducing one or the other or both from potency to act. So there is absolute motion. If you do not believe in God, notice that your rejection is based on considerations extraneous to relativity itself. As far as relativity is concerned, there might be a God and, hence, absolute motion. And if there were no God, still there must be a reduction from potency to act performed by a cause, even if a thing is cause of its own motion.

81586 Either the ship shortens somewhat, the universe lengthens somewhat, or both. And what about mass? If I take myself to be at rest, I have one measured mass, and the moving body that was once equal to me has gained mass. But if I am the one considered in motion, my _measured_ mass must increase. Can this be strictly relative? And mass is Lorenz's Achilles' heel. What if that heel turns out to be absolute? Can Lorezz be saved?

119791 Speed is a property of motion. Motion is an ontological determination in things, a passage from potency to act with respect to occupying, or a being at a distance from, physical places. Speed is a property of motion relating motion to real measures in nature (not to the measures of science); speed is a numerable number, although we only objectify it by relating it to our measurements of _distance_, measured by such and such units, and _time_, measured by such and such units.

(Since duration and distance in themselves, not relative to us, are absolute, the speed of light must vary absolutely. But the nature of things measured, including their _real_ quantitative aspects, imply that measurements of time and space, measurements that are physical events governed by laws expressible quantitatively, e.g., rotating axes, will be relative. Thus, the absolute character of nature implies that the relativity of measurements is mathematically deducible.)

Speed presupposes time and depends on it (time can't go more or less fast). So the speed of light is constant only if duration and simultaneity in thhemselves are relative so that the Lorenz transformations apply to them in themselves.

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 aand 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 simltaneity 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.

Absolute facts about phsyical quantities, space and time, make it necessary that, if viewed from the point of view of the space-time continuum, it is the space-time distance that is absolute as measured, not the measured space or the measured time. (Does the distance between points shrink for a moving observer or only the space ship observed to move from point to point?)

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 philosopy (and measures are extrinsic denominations and as such do not reveal the nature of what is measured.)

Reflexions, p. 258: The goal is to assimilate physics to geometry; when it is not assimilable, change the geometry. P. 256: Take all the measures produced by bodies in qualitative interaction, express them is a system of equations everified in experience. No 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).

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 definse 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 assumer the lights were not simultaneious unless he was making the _prior_ assumption, and why should he, that the sources of light were not in motion relative to the train?

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_.

1116791 DOK, 155: Matehmatics 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.

Relativity declines any absolute quantitative properties or determinations (of time or space) because it looks at dimensions, not in themselvers and independentally 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, a more genuinely physical word than the old physics (DOK, p. 156, top). But then starting with conditions of measurement, it attempts a meathematical explanation of measurements--as they actually occur, a quantitative explanation of quantities as actually measured.

11886 Does the baloon double in size or does the rest of the universe shrink a little bit? One or the other happens. But causally, my exhaling acts only on the baloon, not on distant parts of the universe. The effects of my exhaling lessen, for example, the further away from me my breath goes.

3836 What does it mean to say science does not look for essence or gives up looking for essences? Relativity provides a good example. Lorenz posited a reason why the speed of light is constant. When the source of light is moving relative to the ether (or the universe?), the light slows down proportionally. When the clock mesuring the speed of light is also in motion relative to the universe, the clock slows down. Why does it do this? What is it about the essence of ether or mortion or the universe that causes this? By hypothesis, there is no way for science to know, because it follows from Lorenz's hypothesis that motion is epistemologically relative (not quite, he didn't predict increases in mass correctly; from my point of view, the testability of his thesis with reference to mass is a defect). Therefore, the essence, the underlying cause, is meaningless for the scientist.

Given the contingent fact that motion is epistemologically relative, it follows that the more scrupulously the scientist adheres to the demands of his own method, the less he is interested in essence, the less meaningful essence is to him. Because whatever the essence is, it has no measurable, sensibly detectable, effects that would make a <u>difference</u> to scientific theory. The sensible facts the scientist adheres to are part of essence and result from essence. But the essence itself, which explains why motion is epistemologically relative, does not do so in a way that has any effect on scientific theory other than to <u>underly</u> the theory or the facts on which the theory is based.

There was (almost) no scientific way to test Lorenz's assertion that motion is absolute, and light and clocks slow down. This truth is not judgable by scientific fact (test) any more than is the principle of causality. That principle covers all possible sets of opposite scientific facts; hence it cannot be tested by the occurence of this one as opposed to that one. It is in this sense that philosophy is more general than science even if science makes universal assertions. Those assertions do not cover all possible states of affairs--at least not knowably (they are not knowably necessary truths in the way the principle of causality is). Since they are not knowably necessary, they need sensibly distinguishable facts to confirm them.

That is why Maritain can say that as science becomes more methodologically pure, it is not concerned with essence, but essence underlies the data of science. There is something about motion and about matter that makes light and clocks slow down and mass increase. Whatever that something is, it does not reveal itself in a way that allows us to know it the way intellectual acts reveal through reasoning the existence of a substantial form of a different kind from animals, and a substantial form capable of existing apart from matter, or the way that immanent action reveals a difference of substance.

What, for instance, does it mean to say the presence of ether slows down light? Pressure here is a metaphor (but see Asimov), a metaphor that cannot give pressure the same sense it has in science. We know the effect of this unknown essence (these unknown essences), but do not possess the necessary truths to work from effects back to the nature of the cause. Another example, mass changing the geometry of space-time. Why? We can't know. (Because mass is resistance to inertial changes and gravity is inertia?)

Since motion is epistemologically relative, a cause explaining absolute motion is meaningless to scientific method and theory. Yet philosophically, we know motion is absolute and, hence, that light slows down. We know motion is absolute because either A is caused to move, or B, or both. But no scientific experience can tell which of these is true, so that fact is meaningless to scientific theory. Likewise, the relativity of length. Either one space ship shortened, or the other, or both. But which one really did is outside of the sphere of scientific fact, and hence of theory.

Again, philosophy is more general than science; philosophy covers all the possibilities--or at least a wider range of possibilities, not all possible worlds as such, but possibilities that are wider epistemologically since they are based on necessary truths known as such. There are other necessary truths unknown, e.g., the essence of ether, which are more general in the sense that they would be true no matter what specific test results occurred.

25862 Maybe an article on Maritain's philosophy of science is best done by showing how he corrects his predecessors, especially, Duhem and Meyerson.

81286 Tambasco didn't just say explanations stop somewhere; he said the constancy of the speed of light cannot be explained. And epistemologically that is true. But that just means the essence, e.g., of ether, is hidden from us.

3586 A way of showing how science uses true beings of reason. Assume there is something like Lorenz's ether that makes space-time coordinates come out as they are predicted to by Einstein'stheory. One prediction from the assumption of this ether, one deducible conclusion, is that the ether itself will be totally undetectable, hence non-existent as far as science is concerned. What exists for science, the totality of its reality, are measurements of the coordinates of events, i.e., events objectified as bearing mathematical, quantitative, values. A maximally simple mathematical theory predicting those values must be true for the physicist.

The being of reason will not be internally contradictory and its existence will be contradictory only for reasons not accessible to the scientist himself. But by this theory we, in a sense, know the ether, i.e., we know how it works. And if the ether only works for special relativity, general relativity tells us how fields work without telling us the nature of the cause, i.e., how mass causes a change in the geometric relations of space-time coordinates. The scientist, however, doesn't even know the existence of the ether, know it as such, but he seems to know the existence of fields. Maritain would reply that there are all levels of beings of reason in science.

31286 The Lorenz solution is motivated by a desire to explain, a desire promted by an awareness of ontological realities, the ontological background of the sensible realities. The Einsteinian solution is motivated by a desire to explain, a desire prompted by an awareness of the epistemological nature of science's data and a deep-seated commitment to respect the epistemological nature of that data.

But why does light slow down when the source is in motion. Doesn't explanation stop there? Why is it more satisfying to stop here than to stop with Einstein? Because we at least know, by Lorenz's theory itself, that there can be no further explanation that is scientifically testable. That is worthwhile knowledge to have.

Where does explanation stop? At something, an entity, an ontologist would call a cause, i.e., something whose postulated nature would make it a cause, e.g., an electron bearing a negative charge even if we don't know what electricity is. Stopping at such a cause is ontologically different from stopping at an epistemological fact like the measured constancy of the speed of light.

4186 I say science's explanation stops short of essence because it won't explain why light travels at the same speed for all observers, i.e., gives no ontological basis for the epistemological fact (but here epistemology refers to the results of physical experiments). But the reply is that explanation must stop somewhere. Even explanations concerning essence stop somewhere, namely, with the fact that an essence of that kind exists.

4386 Concerning the problem that explanation must stop somewhere, why not before essence? Yes, but we have ontological grounds for believing in absolute motion, simultaneity, spatial dimensions. Hence we know there are essences that science must refrain from seeking.

51486 Science forsakes looking for essences, but what are essences? I used the example of Lorenz's explanation of the absoluteness of light relative to all observers. On Einstein's theory, that absolutenss is completely unexplained. The objector replies that explanations must stop somewhere. But explanation stops not with a brute fact about an external relation between two distinct things (e.g., light and observes) but at postulations about the natures of things, postulations which explain, in terms of their inner structure and the relationships between their inner parts, their relations to external things.

Einstein deduces the constancy of light relative to observes from the postulation of the relativity of motion. But from the ontological point of view, the (epistemological) relativity of motion is an effect of the constancy of light. So the relativity of motion is not a postulate explaining the constancy of light. The fact of the constancy of light explains the relativity of motion.

The relativity of motion is an epistemological fact. It says the laws of nature remain unchnaged. Laws govern relations between external things. The relativity of motion may be an unexplained fact, but it is not an unexplained explanatory fact (nor an ontological fact?)

8286 Explanations come to an end somewhere. Yes, but they can come to an end somewhere that is not capable of any further natural explanation, i.e., explanation other than the fact that God made things that way. Or at least they come to an end at a place which, as far as the evidence available to us shows, does not need any further natural explanation. E.g., at Dalton's time, there was no need to consider atoms divisible, i.e., no need to explain anything by going further than undivided atoms.

On the contrary, the unexplained fact of the observed constancy of light leaves us wondering how (in the make up of the natural order) God made things that way. Because the observed constancy of light = constancy in results of measurements = a contant effect, since observations are effects to be explained.

So the reasons why explanation comes to an end are causal, i.e., the explanation we arrive at describes the causes of observed events in a way that cannot have or does not causally need any further natural explanation.

31486 When Maritain talks about science using beings of reason when it tries to explain this (things?) geometrically, he is not talking about a preference for this method of explaining as if an alternative method were available in science. Within science, there is not alternative method of explanation to one that constructs hypotheses that are testable by differences in quantitative, measurable results. (Lorenz's method of explaining was - almost - not of this kind.)

The alternative method of explaining is no longer scientific but philosophical. What Maritain talks about there is the same thing he talks about when he talks about science giving up philosophical pretentions and not looking for essence. That is, he is talking about science become conscious of the necessary consequences of its epistemological nature and the epistemological facts about its data (i.e., motion is epistemologically relative). (2 sides to consider: (a) science's own nature as a mathematical discipline with quantitative data to explain; (b) the contingent fact that motion turns out to be epistemologically relative.) He is talking about scientists (science) being rigorous in conforming to the limits of its nature and its data. The use of beings of reason is just another aspect parallel to the aspect of purifying itself from philosophy in conforming to its nature and the nature of its data.

When the scientist says, 'I exclude essence, am not interested in essence', this amounts to saying, 'I am not interested in what will not be verifiable by differences in measurements'. 'So I need the matehmatically simplets explanation, one which will explain my measurements without postulating unmeasurable (indirectly measurable) entities'. Maritain says, 'You need beings of reason for that'.

If there is such a thing as essence, science is not interested in it whenever it is not testable by the sensibly distinguishable differences that constitute the data of science. Substantial essence (but what about accidental) is only knowable when distinguishable effects are not tracable to accidents recieved from an outside agent. Most sensibly distinguishable differences are not of that kind. Accidental essences are distinguishable by their necessary objects, their final causality, but what makes an essential difference in objects? E.g., between memory and imagination, hearing and sight, desire and knowledge, the common sense and the external senses, etc.?

314863 See Asimov, vol. II, pp. 60-61. As long as light is undifferentiated, light could be represented by a geometric line and geometric optics would do. Hence there would be 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 get 'physical optics', not 'geometric optics'.

But with relativity 'physical optics' becomes geometric because geometry includes time through the use of beings of reason imposed by the underlying, hidden nature of light. The beings of reason are imposed by the fact that light _appears_ to be of constant speed relative to all observes, the fact that the data available requires us to treat time and space as a continuum, and the fact that this requirement makes the geometric explanation (not just description) of light the simplest and even the only possible one.

The old geometric optics xplained certain behavior about light without explaining what it was that behaved in this way (e.g., waves or particles). The new '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 a simpler explanation than relativity, and we can know it is unreasonable to believe there could be a simpler explanation.

9885 Why aren't caloric fluid and phlogiston, etc., examples of beings of reason founded on the real? They are certainly beings of reason. Why do some beings of reason make good (i.e., true) science and others do not? Maritain's answer is that scientific theories are true as a whole; some beings of reason produce greater simplicity, more powerful predictiveness, more practical applications.

91385 One big difference between a 'caloric fluid' type of being of reason and a _mathematical_ being of reason like the space-time continuum is that the mathematical being of reason can make a theory paragenerically 'true' in the sense of being more simple yet still explaining all the mathematical facts.

71821 Dormitive power objection is one that has little to respond to. It reflects the bare beginning of a long development, each step of which is causal. But at some point of development, we recognize that causality is subject to quantitative conditions. Then we describe things as events in space and time. Then we recognize we can include time in our quantitative description as a quantity along side of space. Then changes in geometric laws governing this continuum 'explain' causal relations. We are far from ontological causal relations here.

530831 Perhaps the relativist does not postulate the existence of the space-time continuum the way he postulates atoms or Newton postulated absolute space. But in explaining variations in space-time measurements by changes in geometric laws governing relations between quantities, he treates space and time as if they were part of a continuum. He explains the variations as if they were variations in a continuum. To leave explanation there is to explain them as if the continuum were as real as are the measured relations themselves.

524831 In all mathematical science, not just relativity, the effects to be explained are described quantitatively, i.e., are variations in quantities that describe events. But quantitative variations are not explained quantitatively unless the variations are part of a single continuum so that the variations can be conceived as changes in the laws governing relations between measurements of different dimensions of the continuum.

57831 The being-of-reason aspect of relativity comes in as early as Minkowski's multiplying the time coordinate by the square root of negative 1 (so special relativity does not use beings of reason??). The time component is real, but making it part of a continuum with the space components is a being of reason. It is a physical fact that the time coordinates and the sapce coordinates vary proportionally. But to represent this fact by making them part of one space-time continuum requires the use of beings of reason. Once we do this, however, our explanation of physical fact is bound to consist of changes in the geometry of the space-time continuum, because physical facts are nothing but collections of space-time coodinates, i.e., nothing but events in space-time.

It is the being-of-reason trick that brings motion into mathematics. And we need mathematically expressible explanations that conform to the physical facts of the space and time coordinates varying. Sincer there is no real space-time continuum, the physical facts cannot be explained by real quantity. Laws about real quantity cannot explain the facts. But a mathematically expressible explanation is needed since the facts to be explained are so expressed.

58831 Assume there really are two fields. That would not prevent us from finding some mathematical trick to represent them as one field. And on the basis of simplicity, we would confidently announce to the world that it had been shown that there is only one field.

What kind of trick? A trick (being of reason) like multiplying the time by an imaginery number to represent space and time coordinates as aspects of one continuum. If we can find such a trick to unify the field, then we as scientists must treat the field as one, and our explanations must treat the field 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. Why? Because events are nothing but space-time measurements for physics. There is nothing more to explain that space-time measurements.

But what about an explanation that would treat space and time as separate continua? Could they be so treated and still be explained? The physical fact is that their measurements vary in fixed ratios with one aother. Thus, any explanation that did not treat them as one continuum would be less simple than the relativity view.

The proof that one continuum is a being of reason is the fact that Einstein made them separate because time is not bi-directional as space is and the fact that, since MInkowski united them, people can talk about the possibility of moving backward in time.

Back to fields. If we represent them as one, we represent different measurements, of gravity and electro-magnetism, as variations in one continuous quantity. And these measurements are space-time events just as are the explananda of relativity. We are explaining things mathematically expressed. And a being of reason gives us a simpler way of explaining that which is to be explained, a simpler way of viewing it. And there is nothing more to explain than the measurements that we can see as variations of one kind of quantity. An explanation that treats them differenctly would only be an unncessary complication. Nor would we have any access to the true explanation.

We can get the true explanation only by applying our necessary truths to the data. But the data are measurements, quantitative variations. These are more simply represented as one field, and in relativity the space-time measurements do vary in fixed ratios as the Minkowski mathematics represents it.

Also, necessary truths cover all possible states of affairs, not just the actual ones that must verify sciences laws. Ontological necessary truths, functions of being, cover all possible states of affairs. Necessary truths that express the causal relations entered into by a particular essence are true only in those universes where the essence exists.

81386 But what if I can unify the fields by postulating the previous existence of more dimensions. Why does simplicity at the level of fields justify multiplicity at the level of dimensions? It doesn't. The postulation of previous dimensions implies that at that time there would have been a variety of measurements corresponding to the dimensions. It would be the existence of the multiplicity of measurable aspects that would justify the postulation of more dimensions, not the mere fact that it unifies the fields. Without a justification in terms of measurements to be included in theory, unifying the fields by multiplying dimensions would not reflect a valid use of simplicity. The validity of simplicity follows from the fact that known existence is the basis and goal of all explanation. That is something objective. Without that, unifying the fields by multiplying dimensions would reflect just a subjective, aesthetic desire for unity.

513831 If space and time form a continuum, or if the the time coordinate is included in the same continuum with the space coordinates, then a change in the 'geometry' of the continuum is all that is needed to explain events, and necessarily changes must be explained by changes in laws governing relations between abstracted quantities. Those laws govern relations among measurements of these quantities, how one measurement relates to others, and how one changes as other change.

And space-time events are nothing but complexes of space-time coordinates for bodies, i.e., 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 unified field events if the fields can be unified.

But do space and time form a continuum? If a mathematical being of reason can unite them into a continuum, they must be considered a continuum by mathematical physics. It is not a choice between that way of looking at them and some other. Why not? (Seeing them as a continuum simplifies the matehmatical rules concerning them.) First, the physicist deals with measurements, quantities, and from the point of view of mathematics, imaginary numbers are just as legitimate as real numbers. So one way of looking at things is at least as legitimate as the other.

But seeing them as a continuum simplifies the mathematical laws, e.g., the pythagorean theorem now applies to space-time coordinates, not just to spatial relations. And the mathematical physicist has no physical reason for preferring a more complex explanation. For his data are quantities. And from the point of view of the mathematical representation of quantities, imaginary numbers are just a valid as real numbers. So simplicity must rul, must decide the issue.

Further, viewing them as a continuum simplifies physical explanation. And the physicist qua physicist (as opposed to the philosopher) has no justification for a more complex explanation. It simplifies physical explanation because with time included in the continuum change is included. And now change is explained just by change in the abstract geometric laws of the continuum, as if the continuum were an entity for the physicist since it explains. And there cannot (necessarily cannot) be any evidence for a more complex explanation since evidence consists of mathematically expressed quantities which, by hypothesis, can be united in one continuum. So if the fields can be matehmatically united, physical explanation must treat them as one.

514831 Maritain says science uses beings of reason when it tries to explain things geometrically? Why does it try to explain things geometrically? Once it makes time part of the geometric continuum, science has no choice but to explain geometrically since that which is to be explained = variations in the four-dimensional continuum; that's all. So trying to explain geometrically = making time coordinates part of the continuum, i.e., describing the facts to be explained in a way that calls for a geometric explanation.

What other examples of beings of reason are there? The particle/wave theory described in vol. 3 of Asimov; cf. Asimov in vol. 2 on the magnetic field, also. See Maritain's discussion of different models for the atom. See Hesse in the Encyclopedia of Philosophy of Fields, i.e., discontinuous fields. Indeterminacy and probability physics may involve beings of reason.

Proof that including time in the continuum makes the continuum a being of reason: the simultaneity problem (but this occurred before Minkowski), unidirectionality of time as opposed to the physicist speculating on time travel.

411821 The author of 'General Relativity from A to B' says somewhere that he knowns no other way to look at nature other than in terms of events in space-time. There is another way, the ontological way. It is different from the space-time way. Why? How show they are really, not just apparently, different? They lead to contradictory results about simultaneity. The space-time way of looking apparently leads, inexorably, to a denial of simultaneity. The ontological way shows that necessarily there is simultaneity. So not only two ways of looking, but 2 assymetrical ways; the assymetry is necessary, irrevocable.

Get the same result starting from causality. So cannot expect to interpret the elements of one theory in terms of another. Cannot map one on to the other. Another example, science speculating about time travel = a non-ontological viewpoint. The present is defined as that phase of time which exists. But the mathematical viewpoint is indifferent to existence.

82382 Einstein's explanation of gravity by changes in the metric of space-time leaves nothing to be desired from the point of view of the description of physical events by quantitative values, quantitative word-functions, the point of view of the mathematical description of physical events, of quantitative relations between physical events, the point of view of permitting the mathematical deduction of quantitative relations between physical events.

But understanding the curvature of the space-time continuum as the physical cause of these events makes the space-time continuum into an entity, a fictitious entity.

57831 Mathematics objectifies quantitative relations, not causal relations. So causality is at two removes in science: (1) causally opaque empirical word-functions; (2) mathematics getting at causality only indirectly. Quantity is only a condition associated with the active and passive properties of bodies. And mathematics studies quantity.

Correction, Chap 9 It is not that einsteinian space-times are beings of reason, but explaining gravity by the curved geometry of space-time uses a being of reason (a being of reason as measured by the standard of ontological analysis)--but a being of reason that is in no sense arbitrary.

122841   An example of the use of mathematical beings of reason in science: fields extending to infinity because the algorithm describing the strength of the field has a result that can never reach zero.

3828   The quantity expressed mathematically is an accident of the force; hence the fact that the quantity seems to go on forever does not mean the force goes on forever (if the substance was finite to begin with.)

Why does mathematics use beings of reason? 2 in the abstract does not exist, only 2 X's or Y's. When talking about 2 + 2 =, mathematics does not consider two as a possible existent but merely as the term of a relation of causality, equality, or order. Two things can exist. But once we have abstracted these relations of causality, equality and order, we can construct other non-existent objects by defining them as terms of such abstract relations: negative numbers, even rational and irrational numbers. As so defined, they function just as well in mathematical formulas as do integers, because mathematics does not worry that its <u>original</u> 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 the needed relations by abstraction, any object terminating the relation is as valid for math as is its original objects.

111283   Note that Minkowski's move is purely mathematical, i.e., the result of one formula subtracting the time coordinate is the same as that of a formula multiplying the time coordinate by negative 1 and then adding it. This equality of quantities has nothing to do with postulating entities, for it is not yet physics. So this is a different kind of being of reason from postulating causal entities (maybe it becomes the latter in general relativity).

And the fact that the interval is absolute through rotation of axes does not itself show that time can be represented as part of the same continuum with space, because of the uni-directionality of time. But Minkowski's move does show this. Hence change is space-time coordinates is the same as, identical with, a change in the laws of the continuum, the geometric laws of a continuum as represented by Minkowski's formula. Maybe explaining gravity this way does not postulate an entity as much as it refrains from asserting the existence of the true causal relations. It postulates the effect, changes of laws, not the cause.

Rity What does Maritain mean by saying beings of reason are <u>necessary</u>. One thing that <u>is</u> necessary is that science cannot know causes ontologically and dianoetically. So science necessarily falls short of that. Also, science will necessarily be more simple than the true picture if science is excluded from data that is there, e.g., in indeterminacy. And where mathematics <u>can</u> simplify further, it <u>must</u> appear true to science.

101382 'What is intrinsic to space-time?' (Geroch). (1) Space-time descriptions are extrinsic denominations. (2) The interval is only <u>epistemologically</u> intrinsic; is is that wich all <u>observers</u> agree on due to the physical and quantitative conditions governing all observation. (3) The measurement of the interval, the actual numbers you get, are an effect of those physical conditions.

How do we get from knowledge of those effects to their causes? Motion must be represented as indifferent to its causes. Still, that does not contradict ontological causality. But what about indifference of whether the cause is gravity, i.e., granted inertia <u>and</u> gravity, whatever they are, are the same. Still a system that insists on representing matters (the cause) as if the cause could be acting on A, B, or on both indifferently, that system cannot reveal the ontological nature of the cause but only, to the extent that the system is indifferent, a being of reason substituting for the true ontological cause.

1010821 Einstein seems to be using the same kind of matehmatical abstraction Aquinas talks about in his commentary of the Physics' discussion of the continuum. (Cf. the two books by Vincent Smith; and Phillips Modern Thomistic Philosophy). Einstein sees that measurements are events subject to quantitative conditions; quantity = extension and time. The quantitative conditions, as material causes, make it necessary that measurements of the same events differ if the events of measuring take place in motion relative to one another. (But events are not in motion relative to one another; bodies are. Here something new enters, not an event but a body.)

Does the change in length, etc., relative to the entire universe follow just from material causality? No, efficient causality is implicit since motion <u>is</u> present. Events of measurement are subject to quantitative conditions. Those quantitative condtions must be representable by rotating the axes. Hence... = Physical epistemology = primacy of the interval in physical measurement follows from physical quantitative conditions of measurement.

72811 Relations between the quantities resulting from physical measurements do change (rotating clock example). But to go from there to the theory that the geometry of space-time changes and hence the motions of bodies change is to postulate space-time as a causal entity?

Why isn't it an entity. Not just a mathematical entity but a field. Not the 'unified field' but the gravitational field. But then what are those things that occupy the field?

730821 Gravity causes relative acceleration; relative acceleration causes the relations between physical measurements to be non-Euclidean. (Rotating clock example). Einstein seems to have it the other way around. The change in the geometry of space-time, i.e, mathematical relations between the results of physical measurements, cause gravitational motion; that is, the world line curves. But for physics, the change in geometry is all that counts because, of necessity, its method makes motion into a world line governed by abstract mathematical laws.

Ontologically, there is an absolute time (and hence absolute dimensions in space; the size of a body increases or decreases, but it is always something). Insofar as relative spaces and times are asserted to exist, relativity uses beings of reason. But all it asserts to exist are the events of measurements which are relative (though characterized by the interval which is not). But insofar as it excludes absolute times and spaces, relativity uses beings of reason.

Why must it? Because its theory must conform to the facts as it is epistemologically capable of knowing them. And epistemologically, there are no absolute times and spaces for physics. Given the epistemological facts, it follows that science's explanation must take a certain form, the form of explaining by a change in mathematical laws governing relations between the results of measurements. And since geometry now includes time, as it must for relativity, geometry now explains motion.

Time must be included because the measurement of spatial dimensions varies with relative motion and the time parameter, unlike Newton, varies with relative motion.

The same epistemological facts that impose beings of reason on relativity also exclude the ontological cause of gravity, make the ontological cause of gravity meaningless to physics. In a sense relativity must even deny the real cause, contradict it, if it denies absolute space and time and if it must necessarily treate events as if part of a space-time continuum.

Minkowski's imaginary number makes general relativity possible, so a being of reason makes general relativity possible.

Physics incorporates the conditions necessary to measure an event (objectify it) into the description of the event, i.e., an event is just a numbered space-time coincidence.

The space-time continuum is what is real for physics (even without Minkowski?) in the sense that only the space-time interval is an absolute quantity. But to go from this absolute result of measurement to there is a space-time continuum is a non-sequitur philosophically, although necessary for physical theory if that is all that is real (absolute) for science.

Einstein defines time by how it is known (objectified). He doesn't define time but defines the results of our attempts to objectify time, i.e., defines time by our means of objectifying time, defines by means, not end. (Likewise, Wittgentsein says a meter stick has no length. Length is what the meter stick measures. But length doesn't come into existence when we use the meter stick, only a particular way of objectifying length comes into existence. Wittgenstein confuses a method of objectifying with that which is objectified.)

Epistemologically, gravity and inertial acceleration are the same. Therefore, scientific theory must treat them as the same. There must be one explanation covering their epistemologically common aspects. And the explanation will work because, by epistemological necessity, no observation can contradict it. Again, a necessary being of reason.

413821 In practive, we are not indifferent to what us the cause and what the effect. The heart pumps blood, not vice versa. But the mathematical concepts we bring to our scientific understanding of these causal relations are, of necessity, causally neutral. The distance between A and B decreases. Is a cause acting on A, on B, on both, or on the matter between them? The anwer to this causal question makes no difference to the mathematical relations.

So the concepts used to construct scientific theories of what are really ontological causal relations are beings of reason from the very beginning. Yes, a unified entity corresponding to the name 'atom' exists; but what it is is a being of reason. Does a univfied entity corresponding to the name 'space-time continuum' exist? No, because of the ontological dissymetry between space and time, i.e., the past and the future do not exist.

726821 Geroch (General Relativity from A to B) gives the being-of-reason aspect of relativity away when he asks what is intrinsic to space-time. This makes space-time a thing. And he especially gives it away in making that question the central question for physics to answer. Instead, ask what is intrinsic to events in space-time, to events related spatially and temporally, or what is intrinsic to the spactial and temporal relations between events. Answer: what is intrinsic to events are the things that enter into them, things with absolute dimensions and motions.

81821 In a gravitational field or an accelerating field, the geometric relations between the results of measurements change. Of necessity, the physicist must take this as explaining gravitational motion. Why? Because (1) all he deals with are the measurements of space-time relations between events. That's all that exists for him, not just events, but events characterized by the four space-time coordinates. So (2) he must consider space-time to be one continuum because only the space-time interval between events is absolute, i.e., independent of coordinate systems.

(2) = we must include time in the quantity to which we apply our metric. (1) all we have are quantitative relations; (2) these change with acceleration; (3) time one of the quantitative measurements; (4) relations of time measurements change with acceleration also; (5) there are no other changes for the physicist than those described by the changes in the metric for these 4 quantities. Gravitational motion is nothing more than a change in relations between measurements.

12080 The explanation of gravity and field phenomena by change in geometric laws is <u>imposed</u> by the fact that science describes the effects to be explained mathematically. For special relativity shows something not hitherto seen but necessary. The results of measuring spatial dimensions is dependent on relative motion, but relative motion is measured by time coordinates. Likewise, the results of measuring time coordinates is dependent on relative motion, so time coordinates cannot be assumed as absolute and left our of further consideration.

So descriptions of events must take time as a dimension along with spatial dimensions in a four-dimensional continuum. But geometric laws can describe this continuum. And when geometric laws describe how relations between events in this continnum change, these events are explained as far as their quantitative relations are concerned; thus, the behavior of bodies is explained as far as the quantitative properties of that behavior are concerned.

4679 The events explained by sceince are the occurence of certain measurements. And physical causal laws make absolute measurements of time and distance impossible. Einstein grasped <u>necessary</u> causal laws making such events impossible in science. "Measurement is essentially relational."

119796 Minkowski's rotating axes show that some shortening must take place; is this change in length a change in measurement only? Asimov says so. The shortening of the space ship relative to the universe and the slowing of its clocks are not beings of reason. What is a being of reason is an explanation of the space ship's motion that makes it a matter of indifference whether the space ship or the universe is in motion.

From quantitative relations, physical facts follow: circles rotate more easily than squares; triangles offer more resistance to change of shape, _ceteris paribus_ than do rectangles, times and lengths change for systems of reference in uniform motion. The last example brings in time as a quantity. If they _appear_ to change, that appearance is itself a physical fact, i.e., the measurements producing different results are physical events, the kind of event physics deals with, measurements. The question of whether the thing measured _really_ changes dimensions only comes up in general relativity, where more than a shifting frame of reference is involved.

1111791 General relativity--the ship turning around and returning. Assume the lengthening of time follows a priori in Minkowski fashion and that the general relativity theory of gravity just translates this a priori fact. Still the theory is a being of reason. For the a priori drawing of conclusions that can be verified in experience only means that genuine physical causes operate is space-time according to certain quantitative conditions such that certain quantitative descriptions must be true of their effects.

Thus a certain force acting on a sphere or cylinder must make it roll; the same force on a cube must make it slide. A force can change the shape of a trinagle only by lengthening the sides or breaking their contact. Times over different distances, etc.

Still, by constructing a theory without absolute motion, the theory leaves out to that extent the specific causes which act according to these quantitative conditions. Hence the theory is a being of reason.

42792 If relativity isn't 'true' or uses 'fictions', why does it work? It works not only for the already-known but also predicts the unknown. It works because in a sense it is true; objects in space time do behave that way; there is nothing fictional or false about that. The fiction comes in when we built the effect into our theory as the cause by making geometric laws the cause (but does it really do that?).

After all, space is still Euclidean in the sense that for something that could pass through physical surfaces, did not have to obey the physical (not mathematical) law of not passing through surfaces, the shortest distance it would have to travel between two points would still be a Euclidean straight line. A Euclidean straight line is not the shortest distance on a surface. Rather, a plane surface is defined by the intersection of two such straight lines.

To build non-Euclidean geometry into explanatory principles is simply to arrange it so that an effect that could be described on the Euclidean model can be arrived at by deduction from geometric principles, an effect which could not be so deduced if the geometry were Euclidean.

33179 The proof of Einstein reading ontological implications into epistemological facts was his inability to accept indeterminacy just as an epistemological necessity.

31279 Does Einstein's theory result from a geometrizing of physical reality? (And does Maritain say or imply that it does? Maybe he only says geometrizing results from being more faithful to epistemological constraints.) Maybe. But Einstein had the idea of space-time before he had a metric with which to measure it. Four-dimensional geometry provided a method of measuring. But is it not an epistemological fallacy (not to mention a U-turn) to attribute to that which is measured, physical reality, properties of the method of measuring, the metric by which it is measured, whether three- or four-dimensional reality?

123079 Why must time be included as a geometric dimension? Because spatial measurements turn out not to be independent of time and because time measurements are not independent of the motions of bodies.

111679 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.

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 unvierse to be spinning around the earth? Energy = causal relations.

41798 Simplicity could reject relativity only if there were an equally simple theory giving more simple experimental results. But Einstein shows absolute motion cannot have any experimental significance. So a theory postulating absolute motion (e.g., Lorenz) adds something to relativity that has no experimental significance. It is a uselessly more complex theory.

121797 All that science has to explain are relations of quantitative variations such that one quantity varies with another. When time is included, that amounts to explaining how one spatial-temporal quantity varies with another in a four-dimensional continuum. That is all the effects science explains are. So a theory explaining any more is superfluous. And to explain this is to explain laws relating variations in quantities, continuous quantities. Such laws are laws of <u>physical</u> geometry, experimental geometry, laws of how physically measurable dimensions really relate. So the reason the theory explains geometrically is that this is all the effect is for science. The change of geometric laws, changes in laws governing physically measurable amounts, is in the effect and is to be explained there.

Effect = variation is spatial coordinates from one time coordinate to another. And since absolute motion is left out, laws are quantitative to the <u>exclusion</u> of ontological causality.

81886 The important point about including time is that time is now included as a <u>variable</u> whose variation depends on the frame of reference, i.e., the amount of time between the same two events varies with the frame of reference just as the distance between two things varies when they move relative to one another.

121794 The Euclidean or non-Euclidean character of <u>experimental</u> space depends on physical causal factors governing experiments. Those factors imply that the laws expressing teh spatial-temporal relations between events change in the presence of mass. So <u>geometrization</u> of physics, explanation by change in geometric laws. is absolutely and <u>physically</u> necessary. And the ontologist must recognize this as a being of reason insofar as causality is abstracted from.