Bergson Was Right about Relativity (well, partly)!

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SUMMARY

In the spring of 1922 a remarkable encounter occurred between the world's most prominent scientist and the world's leading philosopher of time. Einstein delivered a lecture on Relativity Theory to the Société Française de Philosophie in Paris, and Henri Bergson, in attendance, was among the French scholars invited to give some response. The exchange was subsequently published in the Society's Bulletin. In this exchange Bergson declines to enter into a discussion of his own peculiar (mis)understanding of the special theory but instead concentrates on a defense of absolute simultaneity and the unity of time. His arguments are novel and repay careful scrutiny.

BERGSON WAS RIGHT ABOUT RELATIVITY (WELL, PARTLY)!

Introduction

The meteoric fall of Henri Bergson from the philosophical pantheon of the twentieth century was doubtless due in part to his misguided critique, or rather misunderstanding, of Albert Einstein's Special Theory of Relativity.[1] Convinced of the unity of time and the existence of relations of absolute simultaneity, Bergson mistakenly portrayed Einstein's theory as postulating length contraction and time dilation in appearance only, analogous to the reciprocal appearance of shrinkage in size experienced by two mutually receding observers, in contrast to Lorentz's theory, according which the retardation of clocks and the contraction of measuring rods are real, physical effects. Bergson did not appreciate that it was in fact Lorentz, not Einstein, who preserved the classical notions of time and simultaneity and whose physical interpretation of STR's mathematical formalism was therefore better suited to Bergson's metaphysical views than Einstein's interpretation. Bergson's grasp of Einstein's theory was simply embarrassingly wrong and tended to bring disrepute upon Bergson's views on time.

This is unfortunate because, while Bergson's own interpretation of Relativity Theory remains unsalvageable, his defense of the unity of time and of absolute simultaneity is quite independent of that interpretation and continues to merit thoughtful consideration.

In the spring of 1922 Einstein delivered a lecture on Relativity Theory to the Société Française de Philosophie in Paris, and Bergson, in attendance, was among the French scholars invited to give some response. The exchange was subsequently published in the Society's *Bulletin*.[2] In this exchange Bergson declines to enter into a discussion of his own peculiar understanding of STR but instead concentrates on a defense of absolute simultaneity and the unity of time. His arguments are novel and

repay careful scrutiny.

Consciousness and the Unity of Time

Bergson begins with an argument for the unity of time based upon consciousness:

> Common sense believes in a single time, the same for all beings and all things. What does such a belief stem from? Each of us feels himself endure: this duration is the flowing, continuous and indivisible, of our inner life. But our inner life includes perceptions, and these perceptions seem to us to involve at the same time ourselves and things. We thus extend our duration to our immediate material surroundings. Since, moreover, these surroundings are themselves surrounded, there is no reason, we think, why our duration is not just as well the duration of all things. This is the reasoning that each of us sketches vaguely, I would almost say, unconsciously. When we reach a higher degree of clarity and precision, we represent to ourselves, beyond what can be called the horizon of our external perception, a consciousness whose perceptual field impinges on our own, then, beyond that another consciousness situated analogously with respect to it, and so on again indefinitely. All these consciousnesses, being human, seem to live the same duration. All their outer experiences unfold thus in the same time. And since all these experiences, impinging on each other, having, by pairings, a common part, we end by representing a single experience, occupying a single time. From then on we can, if we wish, eliminate the human consciousnesses we have disposed at long intervals like so many resting places for the movement of our thought: there is now only the impersonal time in which all things elapse.[3]

Bergson's strategy is to begin with the inner life of the mind and thence move to the external world. The strategy is brilliant because it immediately brings to the fore Bergson's distinction between "real duration and measurable time."[4] STR, as a physical theory based on operational definitions of simultaneity and length, deals with measurable time and is singularly ill-equipped to deal with time as immediately experienced in consciousness.[5] Time as experienced in consciousness involves, in Bergson's words, a continuous and indivisible (that is, ametrical) flowing of one's inner life. The mention of time's flow and the nomenclature of duration link Bergson's conception to the classical concept of absolute time, which, according to Newton, "flows equably without relation to anything external, and by another name is called duration."[6] We thereby see as well that durational time is what Anglo-American philosophers since McTaggart have called A-series time or tensed time.[7] Real duration is, as Bergson was wont to put it, "heterogeneous" in that its moments are constantly re-ordered as past, present, and future, not merely tenselessly related as *earlier than, simultaneous with,* and *later than.* The tensed nature of duration is also evident in Bergson's remark that "each of us feels himself endure," for contemporary philosophers working on problems of diachronic identity have delineated two quite different conceptions

of persistence through time: *endurance*, according to which an object exists wholly at any time at which it exists, and *perdurance,* according to which persisting objects have (spatio-)temporal parts, the whole object being as really extended through time as it is through space.[8] Endurance entails, on pain of incoherence, a tensed theory of time, while perdurance is inherently a tenseless notion.[9] Real duration is thus tensed time, through which I endure as a self-conscious continuant.

Bergson next observes that our inner life includes perceptions and that these are of two sorts: perceptions of ourselves and perceptions of things. These perceptions are experienced as simultaneous; to use our own example, we may perceive as simultaneous both the sound of a gunshot and our being startled at the noise. Since real duration is a tensed time, we shall experience these perceptions as occurring at the same A-series moment, which is, of course, the present, the moment which we denominate as "now."

The partisan of a tenseless or B-Theory of time must regard our tense perceptions as delusional. Since the objective world is tenseless, there really is no objectively present moment and therefore my perception of events as present or occurring now cannot be veridical. The presentness of events is an illusion of human consciousness, a subjective feature of experience. It is interesting that in his dialogue with Bergson this is precisely the line taken by Einstein, who under the influence of Minkowski and his reformulation of STR in terms of a 4-dimensional, geometrical structure, had embraced both a tenseless theory of time and perdurantism.[10] Einstein dismisses Bergson's real duration as merely "psychological time" and declares summarily, "there is no philosopher's time; there is only a psychological time different from the time of the physicist."[11]

Einstein does not argue for his position; but D. H. Mellor, who is perhaps the premier champion of the B-Theory today, defends at length the non-veridicality of my experience of the presentness (or as Mellor puts it, the presence) of events. In assessing the cogency of Bergson's argument, we should therefore do well to consider Mellor's rebuttal. In the first place, Mellor denies that we do perceive the tense of events in the external world. He grants that we perceive our inner experiences as present, but he maintains that we do not perceive external events as present. Now such a claim seems outrageous on the face of it; how can Mellor make such a contention plausible?

He argues, in effect, that Bergson's phenomenology of temporal consciousness is mistaken. We do not observe events to be present but only observe our experience of observing them to be present. To prove this, Mellor appeals to our observations of celestial events through a telescope.

> I observe a number of events, and I observe the temporal order in which they occur: which is earlier, which later. I do not observe their tense. What I see through the telescope does not tell me how long ago those events occurred. That is a question for whatever theory tells me how

> far off the events are and how long it takes light to travel that distance . . . . So, depending on our theory, we might place the events we see anywhere in the A series from a few minutes ago to millions of years ago. Yet they would look exactly the same. What we see tells us nothing about the A series positions of these events.[12]

This argument seems to me to be ineffectual against Bergson's position. In the first place, I clearly do not form my belief that, say, "The train is presently pulling into the Gare St. Lazarre" by inference from my belief that "I am presently experiencing observations of the train pulling into the Gare St. Lazarre," since I typically have no such belief as the latter at all! Beliefs about the tense of events are typically what epistemologists call "basic beliefs," that is, beliefs which we hold which are not inferred from more foundational beliefs that serve as evidence for them.[13] Mellor's analysis of the phenomenology of our temporal consciousness is plainly unrealistic and contrived. What then of his telescope illustration? All this proves is that our basic perceptual belief that certain events are presently occurring is defeasible and sometimes defeated. One might as well argue that the deliverances of our senses are not perceptions of the properties of things because when we look through a microscope things appear to be larger than they are. Nor does anything in these illustrations depend on the use of instruments: just as to the unaided eye a star which has in fact ceased to exist appears to be present, so the proverbial stick in the water appears to be bent. In both of these cases, physical theory serves to defeat and correct erroneous perceptual beliefs. But just as Mellor is not therefore prepared to abandon the general veracity and proper basicality of the deliverances of our senses, neither should he abandon the general veracity and proper basicality of our observations of things and events' being present. Of course, as a result of physics and neurology, we realize that nothing we sense is instantaneously simultaneous with our experience of it as present. But in most cases, the things and events we observe are contained within a brief temporal interval which is present, for example, the so-called "specious present," and our belief that "E is presently occurring" makes no reference to instants, so that such a belief remains veridical even for scientifically educated persons. The fact that under extraordinary circumstances our basic belief in the presentness of some event/thing should turn out to be false is no proof at all either that we have no basic beliefs concerning the presentness of events/things in the external world or that such beliefs are not generally veridical. Mellor therefore has given no good reason to think that we do not observe (defeasibly) the tense of events.

The difficulty facing the B-theorist becomes even more severe when we consider our basic belief in the presentness of our inner experiences, to which Bergson appeals. Mellor acknowledges that "the experienced presence of experience, is the crux of the tensed view of time and the tenseless camp must somehow explain it away."[14] Mellor admits that we do observe our experiences to be present. For example, even if the observed super-nova is not occurring presently, nonetheless my seeing the super-nova is, if I reflect on it, observed by me as present. In response to the question

whether we do not surely observe our own seeings and hearings as present, Mellor gives "the paradoxical reply that, although we observe our experience to be present, it really isn't."[15] Mellor notes that there is a difference between our experiences of presentness and our conscious judgements about those experiences. This is a valid and important distinction, as we saw above, and typically we have experiences of presentness without self-reflectively judging that our experiences are themselves present.[16] But sometimes we do reflect on our experiences themselves and perceive them to be present. In fact, the judgement that our experience is present is, Mellor recognizes, one in which we cannot be mistaken. He concludes:

> So my judging my experience to be present is much like my judging it to be painless. On the one hand, the judgment is not one I have to make: I can perfectly well have experience without being conscious of its temporal aspects. But on the other hand, if I do make it, I am bound to be right, just as when I judge my experience to be painless. The presence of experience, like some at least of its other attributes, is something of which one's awareness is infallible.
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> . . . No matter who I am or whenever I judge my experience to be present, that judgement will be true. That is the inescapable, experientially given presence of experience . . . .[17]

This analysis only serves to heighten the curiosity of Mellor's paradoxical reply. For through the comparison of our observation of the presentness of our experience with pain-reports, not only is the proper basicality of our belief in the presentness of our experiences underlined, but such experience turns out to be incorrigible. But if I am bound to be right in judging that my experience is present, if my awareness of the presentness of my experience is infallible, if my judgement that my experience is present will every time be true, then how can it be the case that, as Mellor says, "it really isn't?" If, unlike my belief that some external event is present, my belief that at least my experiencing of the event is present is an indefeasible belief, then how can the experience not be present, even if the event is not? By allowing that our belief in the presentness of our experiences is not only basic but incorrigible, Mellor seems to have painted himself into a corner.

Mellor's strategy, as he describes it,[18] is to contend that the belief that one's experience is present is a tautologous truth, and since tautologies are trivial, so is this belief. He notes that not all one's experiences are judged to be present, but only the experiences which one is having now. But, he says, while the belief

1. The experiences which I am now having possess the property of being present may not be a tautology on an A-Theory of time, it is on Mellor's B-Theory. For the tenseless, token-reflexive truth conditions of (1) are given by

2. The experiences which S has at the time of the tokening of (1) possess the property of existing at

the time of the tokening of (1).

Therefore, (1) is true, but trivial.

But this strategy is multiply ineffectual. First, the belief in question is not a belief like (1), but like

1'. My experience of seeing the supernova is present, which is not tautologous. Mellor creates his tautology by stipulating that it is present experiences which are experienced as present. But there is no need to identify experiences in this way; definite descriptions or proper names of experiences will do. Second, even (1) is not tautologous, if taken as a de re description, rather than de dicto. If "the experiences which I am now having" picks out certain experiences de re, then the ascription of presentness to those experiences out of all one's experiences across time is not trivial. Third, even if (1) is tautologous, it does not follow that the presentness of experience is trivial. Consider by way of analogy a misguided philosopher who denies that anyone has any experiences at all. We might point out to him that we have a basic belief that we have experiences, and perhaps he will admit that this belief is incorrigible. What value, then, would his reply have that

3. My experiences are my experiences is tautologous and therefore the belief that one has experiences is trivial? None at all, for the fact that one has experiences is not denied by (3). Similarly, it may be tautologous to assert that

4. My present experiences are present,

but (4) does nothing to deny or explain away the presentness of my experience. The fact that one can state a tautology like (1) or even

5. My present experiences are experiences, does nothing to undercut the belief in the presentness of experience. Fourth, the stating of tenseless truth conditions for a belief in the presentness of one's experiences does not constitute even a prima facie defeater of that belief. Even if we suppose that Mellor's tenseless, token-reflexive account of the truth-conditions of tensed sentence tokens or beliefs were correct, the mere statement of such conditions for the belief that one's experiences are present is just irrelevant to the proper basicality and veridicality of that belief. One does not believe, after all, what the tenseless truth conditions state; rather one believes that one's experience has the present tense. Supplying tenseless truth conditions for that belief does nothing to show that the belief is false or even prima facie defeated. Neither is one's belief shown to be trivially true by the provision of tenseless truth conditions: in order for that to be the case, (1) would have to be shown to mean the same as (2), a conclusion which Mellor wishes assiduously to avoid. If (1) and (2) are not synonymous, the triviality of (2) in no way undermines the significance of (1). No incompatibility has been alleged or demonstrated between the beliefs' having tenseless truth conditions and one's

experiences' having the property of being present. Mellor, in fact, more or less admits this, since he affirms that merely supplying tenseless truth conditions for tensed sentences does not show that the tensed view is wrong.[19] Finally, fifth, Mellor's token-reflexive account of the tenseless truth conditions of tensed sentences is in any case inadequate and incoherent, as I have elsewhere tried to show.[20] Thus, Mellor has not even succeeded in supplying an alternative account to the belief in the presentness of our experiences.[21]

It seems to me, therefore, that Mellor's account of our observation of events as present, whether in the external world or in one's inner, mental life, completely fails to defeat our properly basic belief in the present tense. Bergson is thus vindicated in his claim that we perceive events, both in the external world and in the inner life of the mind, as present. Moreover, our perception of the presentness of our own experiences is infallibly veridical.

Now Bergson is obviously aware that our judgements of the presentness of external events are defeasible and merely approximate. When Henri Piéron interjects in the dialogue with Einstein that it is physically impossible to establish relations of simultaneity between one's inner experiences and events in the external world due to the finite velocity of signal transmission and neural impulses, Bergson remarks, "I am entirely in agreement . . .: the psychological establishing of a simultaneity is necessarily imprecise."[22] Nonetheless, given the reality of the external world, there is no reason to doubt that we can within certain limits veridically, if defeasibly, perceive events around us to be presently occurring--indeed, our very survival is predicated upon such a belief. Moreover, unless we are solipsists, then we also believe, as Bergson proceeds to note, that other human minds, other consciousnesses like ours also exist. They, too, will enjoy an incorrigible perception of the presentness of their own experiences and will perceive external events in their neighborhoods to be present to them. This community of minds, each indefeasibly perceiving the presentness of its respective experiences, can be distributed throughout the universe in arbitrarily close proximity to one another, much the same way in which Relativity theorists sometimes postulate a hypothetical lattice of clocks throughout the universe.

But then, Bergson concludes, "All these consciousnesses . . . seem to live the same duration." For these consciousnesses can be placed so closely that they impinge upon one another and thus share a common experience. Thus they will all share to an arbitrary degree of approximation the same present events. The key to Bergson's argument is the realization that presentness, unlike simultaneity in STR, is not relative to a reference frame, but is possessed absolutely. When one perceives the presentness of his own experiences, he does not perceive those experiences as present relative to some inertial frame, but simply as present. Moreover the judgement that one's experiences are present is a judgement in which one cannot be mistaken. Thus, any two hypothetical consciousnesses, no matter how distantly separated spatially, necessarily exist in the same present. The proliferation of intermediate consciousnesses only serves to bring the external events locally perceived as present by

each mind into the same approximate present. The presentness of experience simply has nothing to do with inertial frames, relative motion, light signals, clock synchronization, and the like. Two spatially distant consciousness thus live in the same present even if they determine, using the conventions laid down in STR for defining simultaneity relations, that they are not simultaneous relative to certain frames of reference. What they will discover is that relative to no frame of reference does one lie in the absolute future or absolute past of the other, that is to say, on or within the forward or backward lightcone structure at their respective spacetime locations, since if two events can be connected by a finite velocity signal, they cannot be simultaneous and, hence, both present. There will thus be a unique, frame-independent class of present observers throughout the universe, and it is only due to our want of arbitrarily fast signals that we cannot identify more precisely than STR allows the members of that class.

Now these consciousnesses are merely hypothetical--though on the Apollo lunar missions such consciousnesses existed at a distance of some 240,000 miles from Earth-bound consciousnesses--and may therefore, as Bergson observes, be eliminated from our picture of the universe. Like the hypothetical observers employed in many textbook expositions of STR, they serve a heuristic purpose. If a consciousness could experience an event as present, then that event must be present, even if in fact no person happens to exist at that point to experience it. Once these hypothetical observers are eliminated, what remains is "the impersonal time in which all things elapse." There is thus a unity to time based upon the absolute present.

It is said that one man's *modus ponens* is another man's *modus tollens.* The validity of the Bergsonian argument laid out above is confirmed in a back-handed way by the many thinkers who argue that STR is incompatible with an objective present and temporal becoming.[23] These partisans of a tenseless theory of time publish articles with clever titles like "There's No Time like the Present (in Minkowski Spacetime)."[24] They typically argue that STR does not enable us on a tensed theory of time to formulate any plausible co-existence relation among spatially separated entities. For example, enduring entities E_1 and E_2 cannot be said to co-exist iff they are simultaneous in E_1's reference frame because co-existence is a symmetric relation, whereas in STR E_2 may be simultaneous for E_1, but E_1 will not be simultaneous for E_2. If we say that E_1 and E_2 co-exist iff they are simultaneous in both their respective reference frames, then it follows that only objects which are mutually at rest co-exist, which is outrageous. Other attempts to explicate co-existence for enduring entities prove no more successful. Therefore, if we believe that there are things in the world which co-exist, we must abandon a tensed view of time. Significant also in this connection is the fact that theorists who have attempted to marry objective temporal becoming to STR[25] wind up reducing present reality to a space-time point, thus bringing upon themselves the charge that they advocate solipsism.[26] This is noteworthy because, as we have seen, Bergson's argument is based upon an overt rejection of

solipsism. Advocates of STR, both B-theorists and A-theorists, thus recognize that STR in combination with a tensed theory of time has solipsistic implications. B-theorists are surely justified in rejecting solipsism. Therefore, either the objective present or Einsteinian relativity must go. B-theorists consider the empirical adequacy of STR to be sufficient proof that relativity should not be abandoned and that therefore the objective present must be regarded as illusory. But, as we have seen, our apprehension of the presentness of our own experiences is *infallible.* Therefore, our experiences, at least, must be really and objectively present. There must therefore be something wrong with relativity.

The Interpretation of Relativity

It is at this point that Bergson's reasoning, vindicated thus far, begins to go awry. He opines that his hypothesis of "a universal time, common to minds and to things," contains "nothing incompatible with the theory of relativity."[27] If by "the theory of relativity" he meant Einstein's theory, then he was simply mistaken, since that theory implies a multiplicity of times each associated with a particular inertial frame. The unity of time is therefore incompatible with Einstein's theory.

But it must be kept in mind that a physical theory like STR comprises two components: a mathematical core and a physical interpretation of the mathematical formalism. Two theories may share the same mathematical core but differ in virtue of divergent physical interpretations of the formalism. If these physical interpretations are empirically equivalent, then it will be impossible to adjudicate between the competing theories on the basis of scientific experimentation and prediction. Now there is nothing in the mathematical formalism of STR which is incompatible with the hypothesis of a unique, universal time.[28] Therefore, the incompatibility between STR and Bergson's hypothesis must lie in Einstein's physical interpretation of the equations. Given the soundness of Bergson's argument for the unity of time, there must be something wrong with Einstein's physical interpretation.

At one level Bergson understood this, for he does not challenge the mathematics of STR, but rather "certain currently accepted interpretations of relativity theory" which he thought to be "paradoxical."[29] His prescription was correct that we must "take the terms which enter into Lorentz' equations one by one and search for their concrete significance."[30] He believed that if we were to do so, we should "find that the multiple times of relativity theory were all far from being able to pretend to the same degree of reality."[31] Bergson doubtlessly meant to allude to his own physical interpretation of the Lorentz transformation according to which relativistic phenomena like time dilation and length contraction are merely perspectival and thus objectively unreal. He in effect agreed with the early Lorentz, who took so-called "local time" to be a mere mathematical artifice having no physical significance.[32] The problem with this "pure relativity," as it has come to be called, is not merely that it is not empirically equivalent to Einstein's interpretation and therefore lacking in empirical fit, but, more fundamentally, that it is incompatible with the mathematical formalism itself. If we interpret "*t*" in the

equations as clock times, then the formalism predicts that moving clocks run slowly relative to a clock taken to be at rest and that therefore, as illustrated by Langevin's parable of the twins,[33] absolute effects can arise as a result of relative motion. Bergson's claim that the twins would not experience differential aging but would appear to be similar upon their reunion was simply mistaken. His physical interpretation of the formalism was therefore untenable.

Bergson's mistake was probably due to his assumption that if there is an objective present apprehended by every consciousness, then the stay-at-home twin and the traveling twin must experience the same rate of flow of consciousness. This assumption is, however, a *non sequitur.* Since human consciousness is associated with a biological substratum which is subject to natural law, a person in motion relative to another will endure a slowing down of brain activity in comparison with the person taken to be at rest, with the result that his stream of consciousness will also be slower relative to the stationary person. Since consciousness does not "float free" of the brain, the slowing down of biological along with mechanical clocks implies that the contents of consciousness of the traveling twin pass slowly relative to the Earth-bound twin. This differential rate of their flow of consciousness no more implies the non-objectivity of the present than the differential rate involved in a slow-motion film shown at the same time as the film in normal motion implies that there is not an objective fact of what now appears on the respective screens. What is implied is that when we stop the normal-motion film and compare it to what has transpired on the slow-motion film, fewer events will have elapsed on the latter in comparison with the former; in the same way, fewer clock-events will have elapsed for the traveling twin than for his brother upon their reunion. Given the existence of a unique, universal time, it follows that even though the brothers have experienced the same lapse of universal time, the same real duration, and are therefore the same age, nevertheless the traveling twin has all the appearances of being younger due to the retardation of his "clocks," including his own body. In a sense, then, Bergson was right to say that the multiple times of relativity theory do not have the same reality; for there is really only one time, the universal duration of all things, and relativistic phenomena are physical effects in clocks and rods due to motion.

The reader will probably recognize that this is the physical interpretation of relativity championed by H. A. Lorentz and Henri Poincaré. A Lorentz-Poincaré theory of relativity postulates a privileged reference frame, and relativistic effects like clock retardation and rod contraction are the results of motion relative to this frame. Empirically equivalent to Einstein's interpretation, this is the physical interpretation of relativity which Bergson should have adopted.[34]

The Definition of Simultaneity

In the next section of his remarks Bergson turns to a critique of the concept of simultaneity underlying STR. He observes that intuitively simultaneity is a sort of diversity in unity. We perceive a multiplicity of

events to occur coincidentally, that is, at once. He states, "This is simultaneity, in the current meaning of the word. It is given intuitively. And it is absolute in that it depends on no mathematical conventions, on no physical operation like the regulation of clocks."[35] There is no gainsaying Bergson at this point. The intuitive definition of "simultaneity" involves occurrence or existence at the same time. The definition, as opposed to the determination, of simultaneity simply has nothing to do with physical operations, as is evident from the fact that natural language speakers know how to use the word even when utterly ignorant of Einstein's clock synchronization procedure. Of course, Bergson realizes that we cannot establish the absolute simultaneity of spatially distant events. Nevertheless, "common sense does not hesitate to extend it also to events as distant from each other as possible."[36] Bergson thus makes it clear that he rejects the verificationist epistemology which underlay Einstein's re-definitions of time and simultaneity. Einstein's positivism led him to regard the simultaneity of spatially separated events independent of some physical procedure for establishing that simultaneity as non-existent or even meaningless.[37] Bergson, like Lorentz, rejected the positivistic epistemological underpinnings of Einstein's theory and therefore saw no reason for denying the existence of relations of absolute simultaneity even if these cannot be empirically determined. Indeed, in his argument from consciousness, Bergson, by establishing the existence of a class of absolutely present events, has brought in absolute simultaneity through the back door, since events which are absolutely present must also be absolutely simultaneous—otherwise by being earlier or later than one another relative to certain frames, they would be past or future, not present.

Now Bergson supplements his argument from human consciousness by introducing the thought experiment of a supra-human consciousness:

> A superman with a giant's vision will perceive the simultaneity of two 'extremely distant' instantaneous events as we perceive that of two 'neighboring' events. When we speak of absolute simultaneities, when we represent to ourselves instantaneous sections of the universe which pluck out, so to speak, definitive simultaneities between events as distant as could be wished from each other, it is of this superhuman consciousness, coextensive with the totality of things, that we think.[38]

These words are reminiscent of a remarkable passage in Poincaré's *"La mesure de temps,"* in which he asks how it is that the concept of absolute simultaneity arises. He wrote,

> We should first ask ourselves how one could have had the idea of putting into the same frame so many worlds impenetrable to one another. We should like to represent to ourselves the external universe, and only by so doing could we feel that we understood it. We know we can never attain this representation: our weakness is too great. But at least we desire the ability to conceive an infinite intelligence for which this representation could be possible, a sort of great

> consciousness which should see all, and which should classify all in its time, as we classify, in our time, the little we see.
>
> This hypothesis is indeed crude and incomplete. . . . And yet when we speak of time, for all which happens outside of us, do we not unconsciously adopt this hypothesis; do we not put ourselves in the place of this imperfect god; and do not even the atheists put themselves in the place where God would be if he existed?[39]

What is intriguing about Poincaré's hypothesis of an infinite intelligence who discerns all relations of absolute simultaneity among events is that at the metaphysical foundations of the classical concept of absolute time as explicated by Newton lay precisely Newton's temporal theism, according to which infinite, absolute time is a concomitant of God's existence.[40] Poincaré, still in the thrall of positivism, tended to dismiss the theistic hypothesis; but Bergson saw more clearly that it is verificationism which must yield at this point, a verdict which has been overwhelmingly confirmed by subsequent developments in the philosophy of science.[41] The theistic hypothesis shows that the intuitive concept of absolute simultaneity is meaningful even in the absence of empirical verification.

Bergson proceeds to remark that "it is undeniable that the simultaneity defined by relativity theory is of an entirely different order."[42] For it is defined in terms of clock synchronization by electromagnetic signals, and the simultaneity relation which emerges from the prescribed procedure is relative, not absolute. What Bergson will argue is that this relativistic definition of simultaneity actually implies the intuitive concept of absolute simultaneity. For the establishment of relations of distant simultaneity via clock synchronization presupposes already the establishment of local simultaneity between one's clock and the event occurring at one's location. Bergson rightly reflects, "If this simultaneity did not exist, the clocks would count for nothing. Clocks would not be made, or at least no one would buy them."[43] But this simultaneity must be then the intuitive notion of absolute simultaneity. Bergson recognizes that the relativist will respond that his operational definition deals with distant simultaneity only and that he has no objection to taking local simultaneity as absolute. But the problem with this response, observes Bergson, is that terms like "proximate" and "distant" are relative terms. Scientific microbes will find the distance between the local event and the local clock to be enormous and so will be obliged to construct microbe clocks, which must be synchronized by an exchange of light signals. Just as the relativist cannot countenance the perspective *géante* of a supra-human observer who discerns the simultaneity of events which for us lie at a great remove from one another, so these scientific microbes, as good Einsteinians, will disallow our judgements of local simultaneity. Since this change of perspective could continue indefinitely, the implication of Bergson's argument is that simultaneity as defined in STR does not supplant, but presupposes the intuitive definition of simultaneity.

What shall we make of Bergson's argument? Einsteinians will agree that the so-called "elsewhen"

region of space-like separated events shrinks down locally to a single, extensionless space-time point which constitutes the intersection of the forward and backward light cones of that point-event and that the local simultaneity of one's clock reading and the event being recorded is simply assumed for the sake of convenience. Strictly speaking, all simultaneity is distant simultaneity, for the space-time point at which space-like separation vanishes just is one event. Thus, there actually exist only relations of distant simultaneity among events.

Such a response, however, fails to appreciate that Bergson's argument concerns, not the ontology of simultaneity relations, but their definition. Thus, he says, "I raise . . . no objection to your definition of simultaneity . . . . What I want to establish is simply this: once relativity theory is accepted as a theory in physics, everything is not finished. It remains to establish the philosophical signification of the concepts it introduces."[44] It will be recalled that Einstein's prescription for determining distant simultaneity comes in the section of the 1905 paper entitled "Definition of Simultaneity" and that he claims in that section to have successfully defined with the help of certain (imaginary) physical experiments both "time" and "simultaneity." He asserts, "The 'time' of an event is the reading simultaneous with the event of a clock at rest and located at the position of the events, this clock being synchronous, and indeed synchronous for all time determinations, with a specified clock at rest."[45] The idea here seems to be that a distant event and a local event are simultaneous just in case they are each simultaneous with similar readings of local clocks which are synchronized by Einstein's procedure. The problem with this definition is that it seems to be viciously circular: simultaneity is defined in terms of a distant synchronized clock's having the same reading as a local clock which is simultaneous with a local event. Since the same term appears in the *definiens* as in the *definiendum,* the so-called definition elucidates nothing. Einstein seemed to have some inkling of the problem here, for in a footnote he begs off discussing "the inexactitude which lurks in the concept of simultaneity of two events at [approximately] the same place."[46] The problem is not so much inexactitude as vicious circularity. Bergson would thus seem to be justified in saying that the intuitive concept of simultaneity lies at the root of Einstein's operational definition of distant simultaneity.

The significance of this fact is that it explodes the positivistic epistemology which underlay Einstein's demand for operational definitions in the first place. At the heart of his operational definitions likes a concept which is not operationally defined. Therefore, if his definitions are meaningful, it is not meaningless to speak of simultaneity relations even in the absence of a physical procedure for determining them. That opens the door to the existence of absolute simultaneity relations even if we are ignorant of them.

Einstein's Response

Einstein's very brief response to Bergson in the Parisian dialogue is baffling. He says,

> The question is therefore posed as follows: is the time of the philosopher the same as that of the physicist? The time of the philosopher is both physical and psychological at once; now, physical time can be derived from the time of consciousness. Originally individuals have the notion of the simultaneity of perception; they can hence understand each other and agree about certain things they perceive; this is a first step toward objective reality. But there are objective events independent of individuals, and, from the simultaneity of perceptions one passes to that of events themselves. In fact, that simultaneity led for a long time to no contradiction due to the high propagational velocity of light. The concept of simultaneity therefore passed from perceptions to objects. To deduce a temporal order in events from this is but a short step, and instinct accomplished it. But nothing in our minds permits us to conclude to the simultaneity of events, for the latter are only mental constructions, logical beings. Hence there is no philosopher's time; there is only a psychological time different from the time of the physicist.[47]

Up until the penultimate sentence, Einstein merely summarizes Bergson's argument from consciousness for the unity of time. His entire reply comes in the single statement that nothing in our minds [*conscience*] permits us to conclude to the simultaneity of events because these are but mental constructions or logical beings. By "events" Einstein seems to mean events in the external world, for he has just distinguished events in this sense from perceptions in consciousness. Is he serious, then, in asserting that events in the external world are mere constructs of our minds? I can only understand this to be a reversion to the phenomenalism of Ernst Mach, whose epistemology Einstein acknowledged to lie at the foundations of his STR.[48] It would be astonishing to find Einstein as late as 1922 taking this apparently Machist line, since it is conventional wisdom that Einstein's work on his STR freed him of Mach's anti-realism. If Einstein is indeed, advocating phenomenalism, then he has escaped Bergson's argument only at the cost of embracing solipsism. Not only so, but if there really are no external events, then there just is no problem of distant simultaneity among external events. If we restrict our inquiry to the world of appearances, then Bergson's argument applies in the world of appearances, too, and so is not escaped. Thus, Einstein's response to Bergson seems to be utterly desperate.

At this point in the dialogue, Émile Meyerson asks for clarification about two points, the second of which concerns the relation between Relativity Theory and Mach's program. Meyerson explains that Mach renounced any knowledge of things themselves as "metaphysical," which rejection is sometimes linked to an "extreme idealism" which holds things to be non-existent outside of consciousness.[49] Meyerson maintains that "no science is possible unless one presupposes the enduring object outside of consciousness" and expresses his confidence that Monsieur Einstein rejects "a purely phenomenalist attitude."[50] Nonetheless, he asks in view of the scientific and philosophical importance of the question for a clarification from Einstein's own mouth.

Einstein's response to both of Meyerson's concerns is ambiguous.[51] With respect to Mach, Einstein

denies any great relation between Relativity Theory and Mach from a logical point of view. He explains,

> Mach's system studies the relations which exist among the givens of experience; the collection of these relations is, for Mach, science. That is a bad viewpoint; in sum, what Mach made was a catalogue and not a system. Although Mach was a good technician, he was a deplorable philosopher. This short-sighted view of science led him to reject the existence of atoms. It is probable that if Mach were still alive today, he would change his mind.[52]

Change his mid about what? What Einstein seems to reject here is not Mach's anti-realism, but his restricted vision of scientific theorizing. Mach just catalogued sensations and their relations, but good science will not shrink from postulating theoretical entities like atoms. But what Meyerson wanted to know was, in effect, whether atoms really exist in the external world. Do the theoretical entities postulated by science exist outside of human consciousness? Einstein had just told Bergson that external events are only mental constructions, logical beings. His clarification to Meyerson remains frustratingly obscure.

Piéron's Objection

After the exchange between Meyerson and Einstein, Piéron introduces a criticism of Bergson's argument from consciousness. He argues that due to the finite velocities of physical signals and neural transmissions we cannot establish the simultaneity of external events with the presentness of our inner experiences. It is amusing to see how Piéron anticipated Mellor's argument against our perceiving the tense of external events, even down to the appeal to the illustration of viewing a star through a telescope![53] Bergson not only dismisses the admitted imprecision in our judgements of external simultaneity, as we have seen, but he proceeds to turn the tables on Piéron: in order to establish Piéron's point about the imprecision of our judgements of simultaneity concerning external events, "it is to psychological observations of simultaneities—imprecise again—that it is necessary to turn: without these no instrument readings will be possible."[54] The same arguments used to undercut our perception of the tense of events could be used to undermine our perception of tenseless temporal relations among events. But then we could not know that we do not perceive the world veridically. More importantly, however, Piéron failed to deal with the central point that because we infallibly perceive the presentness of at least our own experiences, therefore absolutely present events exist. Bergson's argument thus emerges unscathed.

Conclusion

For the reader who is chiefly acquainted with Bergson's views on time in terms of his infamous misinterpretation of Einstein's STR the Parisian dialogue comes as quite a surprise. Bergson's argument for the unity of time based upon consciousness is insightful, defensible, and, I think, sound. It

does prove that there exists an absolute present, irrespective of reference frames, light signals, clock synchronization, and the rest. We are far more certain and far more warranted in believing that our inner experiences are present than we are in thinking that simultaneity is to be defined along Einstein's operational lines. Indeed, Bergson showed that Einstein's re-definition cannot displace the intuitive notion of simultaneity because it itself employs the intuitive notion in its *definiens.* Bergson should then have advocated a Lorentz-Poincaré interpretation of STR rather than his pure relativity. Had he done so, his position would have been eminently defensible. But his positive argument for the unity of time and relations of absolute simultaneity remains untouched. The desperation of Einstein's response—denying , in effect, the mind-independent status of the external world—only serves to underline the power of Bergson's argument. Bergson was right about relativity—at least in part.

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[1] Henri Bergson, *Duration and Simultaneity* [1922], trans. Leon Jacobsen, with an Introduction by Herbert Dingle, Library of Liberal Arts (Indianapolis: Bobbs-Merrill, 1965).

[2]"La théorie de la relativité," *Bulletin de la Société Française de Philosophie* 17 (1922): 91-113. That portion of the dialogue involving the exchange between Bergson and Einstein has been translated as "Remarks concerning Relativity Theory," in *Bergson and the Evolution of Physics*, ed. P.A. Y. Gunter (Knoxville: University of Tennessee Press, 1969), pp. 123-135. Page numbers for the Gunter translation will be in brackets.

[3] Ibid., p. 103 [128-129].

[4] Ibid. [129].

[5] Concerning Minkowski spacetime, Wenzl cautions:

> "From the standpoint of the physicist, this is a thoroughly consistent solution. But the physicist will (doubtless) understand the objection, raised by philosophy, that time is by no means a merely physical matter. Time is, as Kant put it, the form not merely of our outer sense but also of our inner sense . . . .

Should our experiences of successiveness and of memory be mere illusion . . . ?" (A. Wenzl, "Einstein's Theory of Relativity, Viewed from the Standpoint of Critical Realism, and its Significance for Philosophy," in Albert Einstein: Philosopher-Scientist, ed. P.A. Schilpp, Library of Living Philosophers 7 [LaSalle, Ill.: Open Court, 1949], pp. 587-88).

[6]Isaac Newton, Sir Isaac Newton's 'Mathematical Principles of Natural Philosophy' and his 'System of the World,' trans. Andrew Motte, rev. with an Appendix by Florian Cajori, 2 vols. (Los Angeles: University of California Press, 1966), 1:6.

[7] John McTaggart Ellis McTaggart, The Nature of Existence, 2 vols., ed. C.D. Broad (Cambridge: Cambridge University Press, 1927; rep. ed.: 1968), 2: 9-10.

[8] Mark Johnston "Is There a Problem about Persistence?" Aristotelian Society Supplementary Volume 61 (1987): 112-113. Johnston's terminology was brought into the philosophical mainstream by David Lewis, On the Plurality of Worlds (Oxford: Basil Blackwell, 1986), p. 202.

[9] Trenton Merricks, "Endurance and Indiscernibility," Journal of Philosophy 91 (1994): 165-84; William R. Carter and H. Scott Hestevold, "On Passage and Persistence," *American Philosophical Quarterly* 31 (1994): 269-283.

[10]Once having encountered Minkowski's geometrical formulation of the theory, Einstein became an outspoken realist concerning spacetime. Regarding reality as four-dimensional seemed more natural to him than the complicated maneuver of relativizing presentness to reference frames. He wrote,

"Inertial spaces, with their associated times, are only privileged four-dimensional co-ordinate systems, that are linked together by the linear Lorentz transformations. Since there exist in this four-dimensional structure no longer any sections which represent 'now' objectively, the concepts of happening and becoming are indeed not completely suspended, but yet complicated. It appears therefore more natural to think of physical reality as a four-dimensional existence, instead of, as hitherto, the evolution of a three-dimensional existence" (Albert Einstein, Relativity: The Special and the General Theory,

15th ed. [New York: Crown Trade Paperback, 1961], p. 150).

Again, in a work co-authored with Leopold Infeld, Einstein rejects his own original formulation of STR in 3+1 dimensions in favor of the spacetime ontology depicted in two dimensions on a Minkowski diagram: "We must not consider space and time separately in determining the time-space co-ordinates in another CS [coordinate system]. The splitting of the two-dimensional continuum into two one-dimensional ones seems, from the point of view of the relativity theory, to be an arbitrary procedure without objective meaning" (Albert Einstein and Leopold Infeld, The Evolution of Physics [New York: Simon & Shuster, 1938], p. 219). Thus, relativity theory was "distinctly in favor of the static picture and found in this representation of motion as something existing in time-space a more convenient and more objective picture of reality" (Ibid., p. 217). The seriousness with which Einstein took this conception may be seen in the fact that when his life-long friend Michael Besso died, Einstein sought to comfort his bereaved family by reminding them that for physicists Besso had not ceased to exist, but exists tenselessly as a permanent feature of the spacetime reality. Of Besso's death Einstein wrote, "This signifies nothing. For us believing physicists the distinction between past, present, and future is only an illusion, even if a stubborn one" (cited in Banesh Hoffmann with Helen Dukas, *Albert Einstein: Creator and Rebel* [London: Hart-Davis, MacGibbon, 1972], p. 258).

[11] "La théorie de la relativité," p. 107 [133].

[12]D. H. Mellor, Real Time (Cambridge: Cambridge University Press, 1981), p. 26. Ironically, Mellor's argument, if successful, would undermine not only our observation of tense, but also our observation of B-relations between events, which Mellor defends. A very well-known problem with using magnitude of luminosity to calculate distances to galaxies is that a more distant galaxy may have the same apparent magnitude as a nearer one, because it is larger; in such a case one would not know that the events observed in the larger one are actually earlier than, rather than simultaneous with, the events observed in the smaller galaxy.

[13] See Alvin Plantinga, "Reason and Belief in God," in Faith and Philosophy, ed. Alvin Plantinga and Nicholas Wolterstorff (Notre Dame, Ind.: University of Notre Dame Press, 1983), pp. 59-60.

[14]Mellor, Real Time, p. 6

[15]Ibid., p. 26.

[16]Unfortunately, Mellor's account of the distinction is skewed by his peculiar view that we do not form the basic belief that external events are present. Mellor confuses our experience of presentness (which involves external events) with the presentness of our experience (the self-reflective awareness of the presentness of one's mental states). When we observe an external event, we are not enjoying the presentness of our experience, but experiencing the event as present. When we experience the presentness of our inner experience itself, that just is the presentness of experience. The distinction which Mellor wishes to draw does not obtain within the mental realm, but only between experiences of the external world and the inner realm.

[17]Mellor, Real Time, P. 53.

[18]In D.H. Mellor, "MacBeath's Soluble Aspirin," Ratio 25 (1983): 92.

[19]Mellor does argue that the A-theorist can provide no alternative explanation of the presentness of our experience. "If events can in reality have a range of tenses, I see no good reason for experience to be confined as it is to present events" (Mellor, Real Time, p. 54). But Mellor's demand for an explanation of the presentness of experience is not at all clear. As Hestevold observes, how could an experience be anything but presently experienced? Even memories and precognitions are themselves experienced as present (Hestevold, "Presence of Experience," p. 549). Perhaps Mellor is demanding why on the A-theory only present experiences are experienced as present, rather than past and future experiences. But the obvious A-theoretical answer is that only present events exist, and so one cannot be having past and future experiences. Mellor grudgingly accepts this explanation, but complains that such an explanation fails to tell us why external events which we experience as present may really be past, whereas our experiences alone are restricted to the present. Perhaps I am missing something here, but the obvious answer seems to be that sensory data of external events are transmitted to us at finite velocities, so that by the time we see the supernova or hear the gunshot, the event itself is

past. Through their traces we can experience events which are no longer present. Future events, because they have no traces, cannot be experienced until they occur. Since the apprehension of mental events through introspection involves no transmission of signals, there is no delay involved in the presentness of experience.

Indeed, Mellor's argument seems to turn against him. For all he has provided is a putative solution to why our present experiences are present. Taken de dicto that is a tautology. But if we take the reference to our present experiences to be de re, Mellor has provided no answer why these mental events are being experienced by us as present rather than other, equally real mental events elsewhere in the B-series.

[20] “Tense and the New B-Theory of Language.” *Philosophy* 71 (1996): 5-26; "On Truth Conditions of Tensed Sentence Types." *Synthese* (forthcoming).

[21] In Mellor's amended account of the presence of experience, given in response to MacBeath, Mellor makes no advance in the argument for a defeater of our basic belief in the presentness of our experiences. So far as I can see, he merely adjusts his account to make the belief cognitively significant while remaining in content a tautology. But he gives no further reason to distrust our basic belief in the presentness of our inner experiences, and so his proposed defeater remains vitiated by the five considerations mentioned above.

[22]"La théorie de la relativité," p. 113 [135].

[23] See, for example, Hilary Putnam, "Time and Physical Geometry," *Journal of Philosophy* 64 (19670: 240-247 and the much more rigorous formulation by Yuri Balashov, "Enduring and Perduring Objects in Minkowski Space-Time," *Philosophical Studies* (forthcoming).

[24] Steven F. Savitt, “There’s No Time like the Present (in Minkowski Spacetime)," paper presented at "The Prospects for Presentism in Spacetime Physics," Philosophy of Science Association biennial meeting, Kansas City, October, 1998; cf. Rom Harré, "There Is No Time Like the Present," in *Logic and*

Reality, ed. B. J. Copeland (Oxford: Clarendon Press, 1996), 389-409.

[25] See Howard Stein, "On Einstein-Minkowski Spacetime," *Journal of Philosophy* (1968): 5-23; idem, "On Relativity Theory and the Openness of the Future," *Philosophy of Science* 59 (1991): 147-167.

[26] Lawrence Sklar, "Time, Reality, and Relativity," in *Reduction, Time and Reality*, ed. Richard Healy (Cambridge: Cambridge University Press, 1981), p. 140; Robin Le Poidevin, "Relative Realities," *Studies in History and Philosophy of Modern Physics* 28 B (1997): 541-546.

[27] "La théorie de la relativité," p. 103 [129].

[28] Thus, Builder remarks that the only version of STR which is experimentally verifiable "is the theory that the spatial and temporal coordinates of events, measured in any one inertial reference system, are related to the spatial and temporal coordinates of the same events, as measured in any other inertial reference system, by the Lorentz transformations" (G. Builder, "The Constancy of the Velocity of Light," Australian Journal of Physics 11 [1958]: 457-80; reprinted in Speculations in Science and Technology 2 [1971]: 422), a statement which is underdeterminative with respect to the various physical interpretations of the theory.

[29] "La théorie de la relativité," p. 104 [129].

[30] Ibid., p. 103 [129].

[31]Ibid., p. 104 [129].

[32] H. A. Lorentz, "Deux mémoires de Henri Poincaré sur la physique mathématique," *Acta*

mathematica 38 (1914): 293ff, in Collected Papers, , ed. P. Zeeman and A. D. Fokker (The Hague: Martinus Nijhoff, 1934), 7: 262.

[33] Paul Langevin, "L'Evolution de l'espace et le temps," *Revue de métaphysique et de morale* 19 (1911): 455-456.

[34] For a defense of the viability of a Lorentz-Poincaré interpretation of STR, see my "The Metaphysics of Special Relativity: Three Views," (forthcoming).

[35] "La théorie de la relativité," p. 104 [130].

[36] "La théorie de la relativité," p. 104 [130; N.B. the "not" omitted in translation].

[37] See abundant documentation in Gerald J. Holton, "Mach, Einstein and the Search for Reality," in Ernst Mach: Physicist and Philosopher, Boston Studies in the Philosophy of Science 6 (Dordrecht: D. Reidel, 1970), pp. 165-99: idem, "Where Is Reality? The Answers of Einstein," in Science and Synthesis, ed. UNESCO (Berlin: Springer-Verlag, 1971), pp. 45-69; the essays collected together in idem, Thematic Origins of Scientific Thought: Kepler to Einstein (Cambridge, Mass.: Harvard University Press, 1973).

[38] "La théorie de la relativité," p. 105 [130-131].

[39] Henri Poincaré, "The Measure of Time," in Foundations of Science, trans. G.B. Halstead (Science Press, 1913; rep.ed.: Washington, D.C.: University Press of America, 1982), pp. 228-229. Cf. a similar remark by H. A. Lorentz to A. Einstein, January, 1915, cited in Jozsef Illy, "Einstein Teaches Lorentz, Lorentz Teaches Einstein. Their Collaboration in General Relativity, 1913-1920," Archive for History of Exact Sciences 39 (1989): 274.

[40] Newton made quite clear in the General Scholium to the Principia, which he added in 1713, that absolute time and space are constituted by the divine attributes of eternity and omnipresence:

> "He is eternal and infinite . . .; that is, his duration reaches from eternity to eternity; his presence from infinity to infinity . . . . He is not eternity and infinity, but eternal and infinite; he is not duration or space, but he endures and is present. He endures forever, and is everywhere present; and, by existing always and everywhere, he constitutes duration and space. Since every particle of space is always, and every indivisible moment of duration is everywhere, certainly the Maker and Lord of all things cannot be never and nowhere" (Newton, Principles of Natural Philosophy, 1:545).

[41] Tyler Burge has remarked that "the central event" in philosophy during the last half century has been "the downfall of positivism and the re-opening of discussion of virtually all the traditional problems in philosophy" (Tyler Burge, "Philosophy of Language and Mind," Philosophical Review 101 [1992]: 49). Richard Healey observes that ". . . positivism has come under such sustained attack that opposition to it has become almost orthodoxy in the philosophy of science" (Richard Healey, "Introduction," in Reduction, Time and Reality, ed. Richard Healey [Cambridge: Cambridge University Press, 1981], p. vii). To see why consult Frederick Suppe, "The Search for Philosophic Understanding of Scientific Theories," in The Structure of Scientific Theories, 2d ed., ed. F. Suppe (Urbana, Ill.: University of Illinois Press, 1977), pp. 3-118.

[42] "La théorie de la relativité," p. 105 [131].

[43] Ibid., p. 106 [132].

[44] Ibid., p. 106 [132-133].

[45] Albert Einstein, "On the Electrodynamics of Moving Bodies," trans. Arthur I. Miller, Appendix to Arthur I. Miller, Albert Einstein's Special Theory of Relativity (Reading, Mass.: Addison-Wesley, 1981), p. 294.

[46] Ibid., p. 293. See comment by Miller, Einstein's Special Theory, p. 194.

[47]"La théorie de la relativité," p. 107 [133].

[48] See documentation in sources in note 37.

[49] "La théorie de la relativité," pp. 107-111.

[50] Ibid., pp. 110-111.

[51] With respect to the Meyerson's first concern--the affirmation of a 3+1 ontology rather than a four-dimensional world, in view of STR's supposed tendency toward the "spatialization" of time, *i.e.*, abrogating a direction to time--Einstein's reply is evasive. He says simply, "In the continuum of four dimensions it is certain that all the directions are not equivalent." But apart from a difference in sign (which indicates merely that the four-space is pseudo-Euclidean rather than Euclidean) the temporal dimension is structurally identical to the spatial dimensions in Minkowski spacetime, and these can even be interchanged, as in the Schwarzschild metric. Given a tenselessly existing four-dimensional structure it is difficult to see any non-conventional basis for temporal asymmetry or a direction of time. Cf. É. Meyerson, *La déduction relativiste* (Paris: Payot, 1925), pp. 97-110 and Einstein's response in *Revue philosophique de la France at de l'étranger* 105 (1928): 161-166, both translated and re-printed in *The Concepts of Space and Time*, ed. Milic Capek, Boston Studies in the Philosophy of Science 22 (Dordrecht: D. Reidel, 1976), pp. 353-367. Einstein here denies that time is another dimension of space, but he does not endorse Meyerson's belief in the objectivity of temporal becoming, as Capek seems to think (Milic Capek, "The Inclusion of Becoming in the Physical World," in *Concepts of Space and Time*, p. 502).

[52] "La théorie de la relativité," pp. . 111-112.

[53] Ibid., p. 112.

[54] Ibid., p. 113.