

PRESENTISM, RELATIVITY, AND SIMULTANEITY

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Abstract

The A-theory of time insists that there is some real ontological fact about what is present. It is often alleged that this theory is inconsistent with the theory of special relativity. The conflict originates with the radar definition of simultaneity (RDS in my paper). I argue that the only argument for RDS is the argument for the dispensability of absolute rest; there is no good reason to accept the Newtonian concept of absolute rest and we can do perfectly well without it. I argue that there may be reasons to accept absolute rest. The notion seems to play an important part in our understanding of certain possible worlds. I go on to argue that it isn't at all clear that the B-theory of time is consistent with special relativity. It accepts the empirically unverifiable entity called minkowsky space-time. It is thus ostensibly committed to there being facts that go beyond merely what we can measure with RDS.

Keyword: Philosophy, Philosophy of Science, Philosophy of Time, Relativity, Time

The two broadest categories in the philosophy of time are the A-theory and the B-theory. The labels come from John Mctaggart. He believed that there were two characteristics which one might ascribe to time. Let's think of time as a sequence built out of discrete portions called time slices. One rather obvious feature of the sequence is that the individual slices are ordered. At least part of what it means for a time sequence to have happened is that the time segments that compose it were ordered in a certain way. When I see the lightning bolt at some time, t_1 , and hear the thunder at some time t_2 , it seems right to say that t_1

is earlier than t_2 . This aspect of time is what Mctaggart calls the B-relations. These relationships include *being earlier than, being later than, or being simultaneous with*. It might also be thought, however, that there is more to time than just the linear ordering of instances of time. Perhaps there is some fact of the matter about what time is actual, real, or present. It seems natural, for example, for us to say that dinosaurs do not exist, although they once did. On the face of it, this seems to indicate that the present is ontologically privileged; that the past is less real. If this way of speaking reflects the deep metaphysical facts, then

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in order to tell the whole truth about the timeline of our world, one would need not only the facts about how the time slices (and the events that occupy them) are ordered, but also facts about which of the times is the real ‘now’. The A-properties include the properties of *being past*, *being present*, and *being future*. The B-theorist, then, is one who believes we can build an accurate and complete theory of time using only the B-relations. The A-theorist, on the other hand, believes that a satisfactory theory of time must appeal to A-properties. One common objection to the A-theory of time is that it is inconsistent with one of our best, most well confirmed scientific theories, the theory of special relativity (SR hereafter).¹ In this paper, I will attempt to offer a plausible response to this objection. In section 1, I explain Einstein’s radar definition of simultaneity (RDS hereafter), and examine his reasons for accepting it. In section 2, I will clarify the relativity objection and offer an example of it from the literature. As we will see, the problem is that the A-theory is inconsistent with RDS, which is an integral part of SR. In section 3, I cast doubt on Einstein’s argument for RDS. I argue that the proponent of the relativity objection against the A-theory has more work to do to make the objection cogent. In section 4, I will argue that it is unclear that the B-theory is consistent with RDS. I conclude that the special relativity objection to presentism is unpersuasive.²

Section 1. The Radar Definition of Simultaneity

Einstein begins his 1905 paper with a

brief discussion of the problem that motivates his new theory. He is troubled by “certain asymmetries in classical physics” that arise from the relative motion of a magnet and an electric conductor.³ In classical physics, the explanation for a certain electromagnetic phenomena depends on which of them is ‘really’ in motion. “For if the magnet is in motion and the conductor at rest, there arises in the neighbourhood of the magnet an electric field with a certain definite energy, producing a current at the places where parts of the conductor are situated”.⁴ If, on the other hand, the conductor is moving, we find, not an electric field, but an “electromotive force” that “assuming the equality of relative motion gives rise to electric currents of the same path and intensity”.⁵

Examples of this sort, together with the unsuccessful attempts to discover any motion of the earth relative to the “light medium”, suggest that the phenomena of electromagnetics as well as mechanics possess no properties corresponding to the idea of absolute rest.⁶

There is some debate about how and to what extent the Michelson-Morley experiments influenced Einstein’s theorizing about the issue.⁷ What seems clear from the text, however is that there are two facts that seem to license Einstein’s denial of absolute rest: (1) “absolute rest” had given rise to a difference that made *no empirically verifiable* difference to the prediction of electric currents and (2) there had been a failure to detect absolute rest.

Einstein then offers two postulates upon which he will build his new theory. One is the relativity postulate, which he accepts in part in virtue of parsimony.⁸ He

thinks that it is simpler to assume that not merely some, but all of nature's laws are relative.⁹ There are different ways of formulating these postulates, but for present purposes, the following will do:

(R) All inertial frames are indistinguishable

(L) Light travels at a constant velocity in all frames.¹⁰

Einstein notes that there seems to be a problem here. It seems that L is in conflict with R.

The reason the light postulate seemed to contradict the relativity postulate was that if a signal moved at a finite velocity c regardless of its source's motion, then a receiver moving toward the source at velocity v should measure the signal's velocity at $c+v$ and a receiver moving away from the source should measure the signal's velocity at $c-v$.¹¹

The problem here is not that the velocity of light does not vary from frame to frame. As Craig says, this would be in harmony with the principle of relativity rather than ostensibly contradictory to it.¹² The problem is that the velocity of light is independent of its source. In classical mechanics, the measurement of the velocity of two objects in relative motion is determined by adding and subtracting their velocities. If a car is moving at 50 mph, and I am moving in the same direction at 30 mph on a bicycle, then I ought to measure the speed of the car at 20 mph. If, on the other hand I am moving at 30 mph toward the car and the car is moving at 50 mph toward me, then I ought to measure the speed of the car at 80 mph. "Only if the signal were traveling at zero or infinity would the law of

addition (or subtraction) of velocities fail".¹³ If the law of the addition of velocities holds and the speed of light is constant, finite, and non-zero, then contrary to the relativity postulate, there ought to be a way of distinguishing inertial frames of reference from one another. We would be able to distinguish inertial frames by measuring our velocity relative to the speed of light. As we will see, this problem will be solved through his new RDS, which relativizes the durations used to calculate velocities within frames.

Einstein, showing his verificationist tendencies, indicates that he would be perfectly happy to define local time as "the position of the small hand on my watch", but he notes that this will not do for spatially distant events, since we have no way to ensure that the clocks in question will be synchronized.¹⁴ Einstein takes the occurrence of local simultaneity as a primitive, declining to "discuss the inexactitude which lurks in the concept of simultaneity of two events at approximately the same place...".¹⁵ He then establishes, "by definition" that the velocity of light in one direction is constant.¹⁶ With these two tools in hand, Einstein then offers us a definition of the synchronicity of two spatially distant clocks. Suppose that two observers, A and B, are in spatially separated non-inertial motion with one another. Suppose that at a specified time, t_a , A sends a light signal to B, which B reflects back to A at another specified time, t_b , and is then received by A at a specified time t_a' .¹⁷ The clocks of A and B are "defined to be synchronized if $t_b - t_a = t_a' - t_b$ ".¹⁸ Equivalently $t_b = 1/2(t_a' - t_a)$.^{19, 20}

It follows then, that what events are

simultaneous depends on one's state of motion. Consider Einstein's famous example of the moving train. Consider two persons, one of whom is standing on the platform and the other is riding on top of the moving train. There is a mark in the exact middle of the platform, and the man on the platform is standing on this mark. As the train passes the platform, and the two men are aligned, two lightning bolts strike, one directly in front of the train, and the other directly behind it. If we define simultaneity, as we have above, as the reception of light signals, what shall we say about the lightning bolts? Were the two lightning strikes simultaneous? As the two bolts of lightning are equidistant from the man on the platform, he will judge them to be simultaneous. The person on the train however, because he is in motion toward one of the bolts and in motion away from the other, will first observe the light from the signal in the front of the train. He will judge that the lightning bolt in the front of the train struck before the bolt in the rear of the train. Of course, because all possible observers of the events in question will be observers who are themselves in motion or at rest relative to the other frames, there is, in principle, no experimental way to decide which events are *really* simultaneous. Because, according to Einstein, there is nothing more to simultaneity than the reception of light signals, we ought to say, not just that the observers disagree, but that there is no fact of the matter.

With RDS in hand, we now have the resources to deal with the problem of the ostensible conflict between R and L caused by the addition of velocities. You will re-

member that it was alleged that a person in motion toward a light signal ought to measure the velocity of the light signal at $c+v$ while someone moving away from the light signal should measure it at $c-v$. If this were so, then, R would be false. The problem was that we had assumed that the time used to calculate velocity within the one frame is equal to the time used to calculate velocity in the other. Using the present definition, this is simply false.

Many A-theorists have alleged that Einstein's Radar Definition of Simultaneity (RDS) is based on "profoundly verificationist assumptions".²¹ Remember, Einstein seems to have based his rejection of absolute rest on two facts (1) "absolute rest" had given rise to a difference that made no *empirically verifiable* difference to the prediction of electric currents and (2) there had been a failure to detect absolute rest. Certainly (1) and (2) are compelling reasons to abandon the concept of absolute rest if one is a verificationist about meaning. Is Einstein's abandonment of absolute rest here merely some kind of verificationist inference from the fact that we have not (or cannot?) detected absolute rest which is then used to draw the conclusion that either it does not exist or it does not have meaning? There is evidence that suggests an affirmative answer. As the philosopher of physics Amit Hagar notes:

Einstein's "principle" approach to physics in STR [Special Theory of Relativity] differs from the constructive approach of Lorentz in two major ways. As the late eminent CERN physicist John S. Bell (1987) notes, there is a difference in style and a difference in philosophy... The difference in philoso-

phy is that since the question of which uniformly moving reference frame is *really* at rest is experimentally undeterminable, Einstein--later to be joined by the logical positivists such as Schlick and Reichenbach--declares the notions "real rest" and "real motion" as meaningless.²²

In this same book, Einstein states: THE PURPOSE OF MECHANICS IS TO DESCRIBE HOW BODIES change their position in space with time'. I should load my conscience with grave sins against the sacred spirit of lucidity were I to formulate the aims of mechanics in this way, without serious reflections and detailed explanations. Let us proceed to disclose these sins. It is not clear what is to be understood here by "position" and "space"... In the first place, we entirely shun the vague word "space" of which, we must honestly acknowledge, we *cannot form the slightest conception*, and we replace it by "motion relative to a practically rigid body of reference".²³

From this quote, it seems that Einstein wants to get rid of the old Newtonian concept of absolute space and replace it with something concrete and empirically verifiable, like a "practically rigid body of reference".²⁴ On the other hand, there are those who contend that Einstein, at the time of his 1905 paper, intended to take no stance toward the ontological status of space and time. In a letter to Paul Ehrenfest, in 1907, Einstein remarks:

The Principle of Relativity or--more exactly put--the Principle of Relativity

together with the Principle of the Constancy of Light Velocity is not to be conceived as a 'closed system', indeed not as a system at all, but merely as a heuristic principle, which in and of itself contains only statements about rigid bodies, clocks, and light signals.²⁵

Here it sounds as if he has a merely instrumental view of his theory, and believes it to have little to tell us about the deep metaphysics of space and time.²⁶ I do not know what Einstein's metaphysical beliefs were, though I find it likely that they varied greatly over time.²⁷ It is widely accepted that Einstein wanted to get rid of the concepts of absolute space and time. But even this reading of Einstein remains unclear to me. It is not clear, for example, whether Einstein viewed the concept of absolute rest as "meaningless" or as merely "superfluous".^{28,29} Clearly, all meaningless concepts are, in some sense, superfluous, but arguably, a concept cannot be both meaningless and vague.³⁰ What is clear is that Einstein was deeply influenced by positivistic thinkers like David Hume and Ernst Mach.³¹ Perhaps we should view Einstein here as a positivist before positivism was cool.³² Or perhaps we should see him as an Occamist, influenced by verificationism, who is offering us a not wholly unpersuasive dispensability argument against the traditional Newtonian concepts.³³ Perhaps, that is, Einstein's thought was simply that, since we can do physics perfectly well without the concepts of absolute rest and duration, considerations of parsimony dictate that we ought to dispense with them. Because "verificationism has retreated into the ob-

scurity it so richly deserves”, it is tempting for the A-theorist to objugate Einstein’s RDS as merely verificationist.³⁴ But I think this is mistaken. Although heavily influenced by verificationistic philosophy, considerations of parsimony and theoretical elegance clearly played a role in his thinking. There were other explanations for the failure of physics to detect the absolute frame, e.g. the contraction hypothesis of Lorentz, but Einstein rejected this move as “ad hoc and artificial”.³⁵ He accepted R in part, because he thought that it would be, a-priori, implausible that the principle of the relativity would apply so well to some laws (motion) and not to others (electrodynamics). He seems to have accepted L, at least in part, on the basis of experimental evidence.³⁶ Furthermore, as has been noted, Einstein’s adoption of RDS does play a theoretical role of resolving the apparent inconsistency of R and L that arises when one considers the addition of velocities. The matter is by no means settled, but I think that the strongest argument to be made here for RDS is an argument from parsimony. To be more precise, there are two considerations here. First, absolute rest, were it to exist, would be experimentally undeterminable, and therefore, we don’t have any evidence of it.³⁷ Furthermore, Einstein has shown us that, by adopting RDS, we can do away with the Newtonian concept of absolute rest. So, since we have no reason to believe in absolute rest, and we can do without it, we ought to reject it, and adopt RDS in its place. In the following section I will attempt to bring out more clearly how SR comes into conflict with A-theory and the role that RDS plays in that conflict.

Section 2. What’s the problem?

Theodore Sider, in his book, *Four Dimensionalism*, considers the relativity objection to be the “fatal blow to presentism”.³⁸ He sums up the objection as follows:

The notion of the present time that is so crucial to presentism is meaningless within Minkowski spacetime, in which there is...no observer-independent notion of simultaneity”.³⁹ ...I have said that simultaneity is not well defined in Minkowsky space-time, but what is strictly speaking true is that absolute simultaneity is not well defined. A *relative* notion of simultaneity can be defined via the Einsteinian ‘radar’ definition of simultaneity for a given observer...Simultaneity thus defined varies depending on the state of motion of the observer...⁴⁰

The A-theorist believes that in order “to tell the full truth about time...one must avert to the A-properties”.⁴¹ For the A-theorist, the facts about what events are simultaneous with the present confers a very important ontological status upon them. The problem is that according to RDS, the facts about what events are simultaneous vary depending on one’s state of motion. The A-theorist, it seems, faces quite an unpalatable consequence. It seems she must say that the events bearing the special A-theoretic property of *being present* vary from frame to frame, depending on one’s state of motion. Now this is rather bizarre because it means she will have to say that the facts about which events are imbued with a special ontologi-

cal status will depend on one's frame of reference. The presentist, for example, believes that all and only those events that are simultaneous with the present exist. The presentist, then, must say that what there is in the world, depends on our state of motion. From our current frame of reference, it is true that dinosaurs do not exist, but perhaps there are frames of reference from which it is the case that dinosaurs do exist.⁴²

The A-theorist believes that the fact that an event is present endows it with a special ontological status that is not shared by events that take place at other times. For the presentist, this special status is existence, but presentism is only one kind of A-theory. Other A-theorists believe that other times have some reality. According to one theory, time is like a growing block. The past and the present exist, but the future does not. The edge of the growing block marks the boundary between existence and non-existence. Thus, if the growing block A-theorist says that the events constituted by the edge of the block vary depending on one's state of motion, she too will be forced to say that the facts about what events exist are dependent on one's state of motion. According to another theory, all times, past, present, and future, have some sort of reality but it is merely that the present moment is 'illuminated' by a spotlight. The flow of time, the change from *will be*, to *is*, to *was*, can be thought of as the movement of this spotlight across the various times. The present illuminated moment is somehow more real than the others. Again, it is strange to think that the events which possess the special reality of the present will vary with frames of refer-

ence. SR poses a problem for any A-theory of time. Because SR, via RDS, leads to a relativization of the simultaneity of events, it also leads to a relativization of the A-theoretic properties of those events. It seems implausible, however, that such ostensibly objective facts about the ontological status of events, i.e. which events are real or exist, should depend on something as varied and contingent as one's velocity. The A-theorist then, must either reject a well-confirmed scientific theory, or accept the consequences. In the next section, I attempt to offer the A-theorist a way out of this dilemma. As we saw in section 1, there are two persuasive reasons to accept RDS. The first is that we have no reason to accept the Newtonian notion of absolute rest. The second is that we can do perfectly well without it by accepting RDS. In the next section, I will try to undercut this support for RDS. I will attempt to provide some reason to hold on to the Newtonian concept of absolute rest and to reject RDS *as a metaphysically appropriate notion of simultaneity*. I will argue that, while Newton may have no place in our physics, we ought to welcome him in our metaphysics.

Section 3. Dear is Einstein, dearer still is truth

As we have seen, Einstein's reasons for rejecting the Newtonian concepts of absolute rest and duration are twofold. First, he argues, we have no reason to believe that there are properties that correspond to these concepts. Second, we can do very well without them. The argument here, against the Newtonian concepts, consti-

tutes an argument for RDS in that RDS is the means by which we are able to dispense with Newton in our physics. In this section, I want to question Einstein's dispensability argument. Is it really true that we have no reason to believe that there is such a thing as absolute rest? There is no empirical reason to accept that there is any such thing as absolute rest, but empirical reasons aren't the only ones we can have. Consider the following 3 worlds that are nomically very similar to ours:

World 1: A world where there are only two spheres attached to a string and in rotation. Clearly there is a difference between this world and the world where the two spheres are not moving. In the world where they are moving, there will be an inertial force that causes a tension in the string.⁴⁴

World 2: A world in which there exists only two fluid spheres A and B. Sphere A is rotating and B is at rest. There will be a difference between the spheres. Intuitively, sphere A will experience a bulge and B will not. Yet, their relative motion is identical. This world is distinguishable from other worlds where B moves and A is at rest, worlds where both spheres are in motion, and worlds in which neither sphere is in rotational motion.⁴⁵

World 3: All of space-time is filled with fluid matter. It seems that there is a possible world in which all of the matter is uniformly rotating. And it seems that this world is distinct from the world in which the matter is not rotating.⁴⁶

Of course, there are things that can be said here in response. And space does not

permit of a more thorough treatment of the issue. If push comes to shove, the proponent of RDS can always deny that these worlds really are possible. My aim here is not to refute Einstein's dispensability argument, but merely to cast doubt on it. While it may be right that there are no *empirical* reasons to believe in absolute rest, it seems wrong to say that there are no reasons. The objection to A-theory we are considering is that the A-theory is inconsistent with SR because it is inconsistent with RDS. The only argument to be found for RDS depends on the premise that there is no reason to believe in absolute rest. A *prima facie* reason to believe in absolute rest, however, can be found in the ostensive possibility of worlds like 1, 2, and 3. Perhaps these are, in the end, incorrect, or unpersuasive reasons for believing in absolute rest, but it won't do to merely assume this. If the B-theorist wants to make the relativity objection stick, she needs to give us some reason to accept RDS *as a metaphysically informative notion of simultaneity*. If she wants to use Einstein's dispensability argument, then she owes us some argument as to why worlds 1, 2, and 3 do not constitute a reason to believe in absolute motion.

Section 4. Is B theory consistent with Relativity?

If SR poses a problem for the A theory, that problem arises from the fact that the A-theory seems inconsistent with RDS. But why should we think that a B-theory of time fares any better? The B-theorist believes that all of the time slices exist and have an equivalent ontological status.⁴⁷ She believes

further that some of these time slices and the events that are their contents bear the relationship to one another of *being simultaneous with*. If she accepts RDS, she also accepts that the events that bear this relationship depend on one's state of motion. This relationship may obtain or fail to obtain depending on one's state of motion. Intuitively, it is the existence of the events and the times, or perhaps individual spacetime points, that serve as the real 'truthmakers' for the relationship,⁴⁸ but the existence of the times and events does not change depending on one's state of motion. If the relativization of the A-properties according to RDS seemed troublesome, it's not so clear that the B properties are more well-behaved. Of course, B-theorists are welcome to accept RDS and thus attempt to make sense of the B-relations relativized to frames of reference. A-theorists can (and do) play that game as well. My point is that, on the face of it, there doesn't seem to be any reason to think that the B-theory is more hospitable to RDS than A-theory and I'm surprised that this point seems to go entirely overlooked.

I believe there is a deep tension between the spacetime realism that underlies the B-theory, and the kind of reasoning that might lead one to accept RDS. As we have seen, the only argument to be found for RDS involves a deep skepticism about something as unverifiable as aether or motion relative to it. B-theory, on the other hand, requires us to accept a notion of spacetime that is just as unverifiable. We can understand the parsimonious tastes of the 1905 Einstein, influenced by verificationist epistemology, attempting to lay waste to all unverifiable entities. We can

understand why *he* would accept a more or less operationalist notion of simultaneity. But why, once one has made the arduous journey from the parsimonious 1905 Einstein to the acceptance of 'unverifiable' entities like Minkowski spacetime,⁴⁹ would one feel the least bit inclined to accept RDS as anything more than a useful tool for the measurement and calculation of velocities? It is easy to see how someone who is skeptical of absolute motion could come to believe that all there is to simultaneity is the reception of a light signal under certain conditions. Einstein makes an absolutely lucid and compelling argument for RDS that begins with the rejection of absolute motion. But, once we have accepted that there is such a thing as spacetime, how can we buy into the rest of Einstein's argument for RDS? In the B-theory, all of the spacetime points are out there.⁵⁰ The events that occur in spacetime or the properties instantiated at each point are *real*. The major virtue of the theory lies in utilizing these facts to ground a simple and elegant semantics for tensed language. Once we have accepted that there are such facts, why would we continue to think that the only relations that exist between events are the ones that could be detected through the measurement of a signal by an observer within space-time? As we saw in section 1, the only real argument for RDS involves the rejection of absolute rest on the grounds that we have no reason to accept it and that we can do without it. It seems to me that the B-theorist must reject both of these assumptions. Presumably the B-theorist holds that there are good reasons to believe that spacetime really exists. If spacetime really exists, then so does abso-

lute motion relative to spacetime, regardless of whether or not it is empirically verifiable.⁵¹ If there is such a thing as motion relative to spacetime, then it seems natural to think that there may be such a thing as absolute simultaneity, regardless of whether or not it is in principle verifiable. If we think that there is a real thing out in the world called spacetime in which events occur and objects move, it no longer seems plausible that the only temporal relations that exist between these events are the ones that might be measured by RDS.⁵²

Einstein, in his revolutionary 1905 paper, might have thought that the best explanation for why absolute rest and simultaneity remained undetected was that they do not exist. The acceptance of spacetime, however, gives us a powerful alternative explanation that seems equally plausible. Ultimately, this explanation has to do with the geometry of spacetime.⁵³ Perhaps the shape of spacetime conspires against us to conceal these facts.⁵⁴

CONCLUSION

The relativity objection is that the A-theory is inconsistent with SR because it is inconsistent with RDS. The strongest reason, if not the only reason, to accept RDS comes from the supposed dispensability of the Newtonian concepts of absolute rest and simultaneity. It is not clear, however, from a metaphysical point of view, that the concepts really are dispensable. They may play an important theoretical role in our understanding of certain possible worlds. If the B-theorist is to make the objection persuasive, there is more work to be done.

What is needed is some argument for RDS as a metaphysically adequate account of simultaneity. Furthermore, it seems unclear that the B-theory of time is compatible with RDS. Taking the realist attitude toward spacetime that the B-theory requires seems not only to undercut any reason for accepting RDS, but also seems to give us a reason to reject it. Perhaps there is some way for the B-theorist to patch things up and render the objection cogent, but as things stand, it seems entirely unpersuasive.

Endnotes

¹A few examples of these are Putnam 1967, Weingard 1972 (both of which are summarized in Nasmith, 2011), and also, more recently Ted Sider, 2001.

²It is important to note that the special relativity objection applies, not just to presentism, but to any A theory. As we will see, however, the objection is generally thought to be more serious for presentism. For this reason I spend much of the paper talking about the objection as it applies to presentism, rather than the A theory in general.

³William Lane Craig, *Time and the Metaphysics of Relativity*.

⁴On the Electrodynamics of Moving Bodies, pg 37, in *The Principle of Relativity*. Translated by W. Perrett and G.B. Jeffery.

⁵*Ibid.* My thanks to Aung Kyi Win and an anonymous reviewer for helpful corrections on this point.

⁶*Ibid.*

⁷For an interesting discussion of the matter see Craig's *Time and the relativity of Metaphysics* pg 21-23.

⁸He views it as improbable that the principle would apply so precisely in one domain and not another. "The principle of relativity must therefore apply with great accuracy in the domain of mechanics. But that a principle of such broad generality should hold with such exactness in one

domain of phenomena, and yet should be invalid for another, is a priori not very probable". (Einstein 1923, pg 13)

⁹Relativity. A. Einstein. Pg 13.

¹⁰In Relativity he seems to cite empirical reasons (pg 18), but in his seminal 1905 article, he says very little about his reasons for accepting it.

¹¹Craig, 2001a, pg 26.

¹²Ibid.

¹³Ibid

¹⁴Einstein, 1923, pg 39.

¹⁵Ibid.

¹⁶Einstein 1923, pg 35.

¹⁷I take this example from Craig 2001a, pg 28.

¹⁸Ibid

¹⁹Einstein's acceptance of the number 1/2 here as true by definition has sparked a lot of debate about whether the definition is conventionalist or not. If so, then the relativity of simultaneity should have followed more directly without the need for the further deduction in Einstein's paper. A.A. Robb has shown that the number 1/2 "is not arbitrary, but uniquely definable within the metric of Minkowsky spacetime" and Malament later showed that it is the "only simultaneity relation so definable..." (Craig, 2001a, pg 30 and 31). Tooley, 1997, rejects these claims, rejecting Malament's conclusions as "metaphysically unsound" due, in part, to the counterfactual concept of causal connectibility and difficulties in grounding it (pg 363). Craig holds that Einstein's definition is conventional in the context of "Einstein's search for a theory which will deal satisfactorily with the problems he has posed..." but not "within the context of SR as a completed theory". (ibid)

²⁰He also assumes the symmetry and transitivity of the synchronistic relationship Einstein 1905 pg 40. The three brother's paradox appears to show that the relationship is not transitive (Craig, 2001a, 59).

²¹Dean Zimmerman. Presentism and the Space-Time Manifold, pg 36.

²²Relativity, introduction pg xiv. Brackets mine.

²³Relativity. A. Einstein. Pg 9&10.

²⁴It seems that spacial descriptions are meaningless unless they are defined in this way in terms of real, physical objects. Relativity, pg 4, 5, and

7. "Every description of events in space involves the use of a rigid body to which such events have to be referred". Relativity, pg 8.

²⁵Craig, 2001, pg 24.

²⁶It would be great news for the A-theorist if this were the case. For I think this is the attitude that they ought to take toward the theory.

²⁷I think he was deeply suspicious of unverifiable entities, as we should all be, but perhaps lacked clarity about what was wrong with them, e.g. are they meaningless, false, or vague, or superfluous?

²⁸"...Einstein-later to be joined by the logical positivists such as Schlick and Reichenbach-declares the notions "real rest" and "real motion" as meaningless". Relativity, introduction pg xiv.

²⁹"The introduction of a 'luminiferous ether' will prove to be superfluous inasmuch as the view here to be developed will not require an absolutely 'stationary space'..." Einstein 1923, pg 38.

³⁰"Slivey Toves" are theoretically superfluous, but not because they are in principle experimentally undetectable. I don't understand what it would mean for a concept to be meaningless. It seems more proper to say that certain words are meaningless in virtue of their failure to refer to a concept.

³¹Craig, 2001a, pg 122.

³²Einstein 1923, introduction pg xiv. And then later a non-positivist before that was cool (xvii).

³³Einstein 1923 intro pg xvi. "Einstein saw Mach's principle...as a modern version of "Occam razor" [sic]: unobservable theoretical entities that do no explanatory work in a physical theory are superfluous, hence should be eliminated from the theory".

³⁴Plantinga, pg 7.

³⁵Craig 2001a, 23.

³⁶Relativity, pg 18.

³⁷The rejection of absolute rest and absolute simultaneity are deeply connected. If there were such a thing as absolute rest, then one would be able to define a notion of absolute simultaneity.

³⁸Sider, 2001, pg 42

³⁹Sider, 2001, pg 42

⁴⁰Sider, 2001, pg 44.

⁴¹Zimmerman, pg 1

⁴²From here the dialectic continues, as per usual, by asserting that there is no acceptable way

for the A-theorist to privilege a frame of reference (Sider 45-52). Many interesting questions arise: When does going beyond what is in a scientific theory constitute *contradicting* the theory (Zimmerman, 2011)? Is postulating more intrinsic structure to spacetime the only way for the A-theorist to privilege a frame (Zimmerman 2011, Craig, 2001 a&b)? (and what does intrinsic mean anyway?), and Is revising relativity in certain ways such a bad thing (Craig, 2001a, Tooley, 1997, Nasmith 2001, Balasov and Janssen 2003, and Crisp 2003)? It is interesting to note the tension in the dialectic. RDS is, arguably, “based on profoundly verificationist assumptions (Zimmerman, 2011 pg 36)”. On the other hand, the B-theorist takes the geometrical representations of relativity so seriously that to add or take away from them is anathema. It seems that the A-theory is ‘oddly shaped’, not realist enough for some and not operationalist enough for others.

⁴³Here and in what follows, when I refer to accepting or rejecting (or arguing for) RDS. I am, of course, not talking about it’s place in scientific theory. Clearly SR works, and so does RDS. I am talking about RDS as a metaphysical definition of simultaneity. The issue here is not the purely scientific question about whether RDS is empirically adequate, but rather the philosophical question of how much metaphysical content RDS has. Should we view it instrumentally, merely as a way to do good physics, or should we think that it tells us the deep metaphysical truth about time?

⁴⁴Craig 2001a, pg 196. Craig 2001b, pg 199.

⁴⁵Ibid.

⁴⁶This example comes from Zimmerman in Haslanger and Kurts, pg 195.

⁴⁷It doesn’t matter, for present purposes, if time can’t be sliced. If there is an objection to there being an absolute relationship of simultaneity that proceeds from some facts about the structure of spacetime, that is a quite different argument than is here being addressed.

⁴⁸Or for the proposition that expresses the relationship, i.e. a proposition of the form ‘x is simultaneous with y’.

⁴⁹Or some GR spacetime of which Minkowski is an approximation.

⁵⁰Spacetime does explanatory work. One of the more impressive arguments for accepting

Minkowsky spacetime over a Neo-Lorentzian spacetime is that Minkowski spacetime explains “the fact that the laws effectively governing different sorts of matter all share the property of Lorentz invariance”, whereas this fact is left unexplained in the A-theoretically friendly neo-lorentzian interpretations. It also provides us with an explanation of why Newtonian simultaneity is unverifiable (Balashov & Janssen 2003, pg 24). For a response see (Nasmith, 2011).

⁵¹Tooley, 1997, 335.

⁵²I want to leave open the possibility that the A-theory somehow runs afoul of SR or GR in some way that doesn’t depend on RDS. It could be, for example, that something about the actual structure of spacetime conflicts with A-theory. It could be that our universe is a non-foible Godel universe.

⁵³Balasov & Janssen, 341 & 342. Really, the acceptance of Gallilean relativity, the finite velocity of signals, and the fact that all clocks measure time using motion, ought to have been enough to show us why Newton’s true time can’t be revealed to us by clock measurements.

⁵⁴It conspires to conceal it, at least through clocks. It has been found that the universe is expanding. The rate at which space is expanding has the same measurement, regardless of one’s frame of motion and this fact has helped scientists discover the age of the universe. The cosmic time recorded by this constant rate of expansion seems to reveal something like true time, and plausibly could be used by the A-theorist to empirically uncover the privileged frame of reference.

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