WLC Was Wrong about Bergson Being (partly) Right about Relativity

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Introduction

The purpose of this paper is to correct some misconceptions about relativity present in William Lane Craig's paper entitled "Bergson Was Right about Relativity (well, partly)!". The first thing I'd like to address is more of a meta-point about how to engage with and constructively critique any theory of physics: as a general rule of thumb, don't base criticism of an established theory on what its discoverer said. In the case of relativity, many concepts and definitions have come and gone since Einstein as physicists have refined the theory and found which concepts and definitions are most useful. Criticizing relativity in this way is a bit like a professor grading a student's paper based on her rough draft instead of the final polished product that she turned in.

Also, this should be noted at the outset: If you predicate your philosophy of time on the belief that time was made for humans, then asserting the existence of a universal and absolute now (which in this paper I will refer to as "NOW" in all capitals) is fine. It still doesn't mean that it's necessarily correct, but it's at least a reasonable possibility.* For a philosophy of time that is not predicated on this belief, however, the assertion of the existence of a NOW is completely unjustified, and in this paper I will explain why. I assume that WLC prefers his philosophy of time to be coherent and plausible independent of the belief that time was made for humans, so let's continue.

Time as a Fourth Dimension

> "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."

It appears to me that WLC possibly conflates adding time as a fourth dimension and taking a tenseless view of reality. This, I think, is mistaken. Minkowski convinced Einstein to unify space and time into spacetime because it made the math of special relativity (SR) much more elegant, and it also enabled us to come up with clear and simple geometric analogues to Euclidean geometry (but with an important difference). Whatever Einstein's personal views were, the elegance and utility of the spacetime model is indisputable. For example, if you connect two points on a piece of paper with a curve, the distance along that curve does not change no matter how you rotate the piece of paper. Similarly, if you take two events in spacetime and connect them with a curve (an example of two events could be the starting and stopping of a stopwatch, and the path through spacetime that the stopwatch took could be the curve), then the "distance" along that curve (which happens to be the stopwatch's elapsed time) is invariant with any "rotation". In the language of relativity, and in this example, "distance" would be replaced with "proper time", and "rotation" would be replaced with "boost". The important point is that the math behind both of these sets of concepts is nearly identical, with the only difference being a single minus sign.

Another great example of the utility of the geometric approach is how we can use it to settle the "twin paradox" (which, as most people who are familiar with the paradox are aware, is not an actual paradox). In the geometric approach to relativity, the different ages between the twins once they're reunited is no more

*It will also necessarily imply that the flows of individual personal nows must vary when compared to the flow of NOW, which I personally find a little disconcerting, but that's neither here nor there.

mysterious than different odometer readings on two brand-new cars that both started in Santa Monica and ended in Chicago, where one car simply took Route 66, but the other made a detour through Alaska.

But the geometric approach didn't just help make SR more elegant, it also made possible Einstein's formulation of general relativity (GR). If modeling gravity as accurately as Einstein did isn't downright impossible without this geometric spacetime, then it would at least be indescribably more complicated, clunky, and seemingly arbitrary than GR as we know it, which models spacetime as a four-dimensional pseudo-Riemannian manifold endowed with a metric (*i.e.* a function that takes two nearby points as input and outputs a distance) as well as a metric-compatible connection (*i.e.* a way to compare the tangent spaces of nearby points).

Let me take a moment to describe the beauty of GR. Most physicists who have studied GR would say that it's one of the most if not *the* most beautiful theories in physics. It's a theory that says the universe and the stuff in it and how that stuff moves around can be modeled entirely by lines drawn on a curved a two-dimensional surface. Of course that's not true— as I just said, it's actually modeled as a four-dimensional pseudo-Riemannian manifold endowed with a metric as well as a connection. I used "two-dimensional surface" initially because a lay-person understands what is meant by that phrase but has no idea what a four-dimensional pseudo-Riemannian manifold endowed with a metric and a connection is, whereas to a mathematician there's not much difference. The biggest mathematical difference is actually the minus sign (what makes it pseudo-Riemannian instead of simply Riemannian). I have personally experienced the beauty of the theory in studying it, and it leaves me in awe of the Creator who wrote these laws (or, more likely, deeper laws from which the "simple" rules of GR emerge in our more "everyday" astronomical observations).

As for whether the concept of "temporal becoming" is real or not, the math of GR has nothing to say in the matter. To say that taking seriously the model of our universe in which time is made a fourth dimension (though still very uniquely different from the other three) necessarily commits one to a tenseless view of reality is, in my view, incorrect. In GR's geometric view, saying that a chair began to exist around the time of its assemblage, that it ceased to exist around the time of its combustion (I had a bonfire), that its end occurred after its beginning, and that its combustion occurred in my absolute past (as well as yours) is completely non-problematic. These statements rely on the concept of the light cone, which in relativity is what determines causal structure. Events lying within or outside of each others' light cones is a symmetric relation. So if event P lies within the light cone of event Q, then Q will also lie within P's light cone. Any such pair of events can be called "timelike separated". Alternatively, if P lies outside of Q's light cone, then Q will also lie outside that of P's. Since no information can travel faster than light, any event that occurs outside of P's light cone is causally disconnected from P. These events can be called "spacelike separated", and their sequence, or more relevantly, whether or not they can be considered simultaneous is wholly dependent on reference frame.

Defining Simultaneity

> "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'... 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."

It appears that WLC misunderstands Einstein's definition of simultaneous, but in any case, I'll reiterate what I stated before: it's bad form to criticize a theory based on what its discoverer said. If an understanding of relativity had been gained by studying the modern literature, then one would recognize that there are actually two distinct but related concepts that Einstein, in my opinion, does not explicitly distinguish in his 1905 paper. There is "simultaneous", which applies to events and doesn't need to involve clocks at all, and

then there is "synchronized", which, in relativity, only involves clocks. To be clear, a relativist will tell you that these related concepts are mere conventions, and there are *different* conventions for synchronizing clocks that will give you different ideas of simultaneous. This is true, but it's only the simultaneity associated with the Einstein synchronization method that matches our intuitive understanding of simultaneous.

Here's the Einstein synchronization method stated as clearly as I can: We have two spatially separated clocks, both at rest in the inertial frame of our choosing. Call them clocks A and B. We will emit a light pulse from A towards B, and have it be reflected from B back to A. Call the time on clock A at the moment of emission t_{A1}, the time on clock B at the moment of reflection t_{B1}, and the time on clock A that the reflected light gets back to it t_{A2}. Once this is done, go over to clock B. Call B's currently displayed time t_{Bc}. You can then reset clock B such that the displayed time is equal to the quantity $1/2(t_{A1} + t_{A2}) + t_{Bc} - t_{B1}$. This will ensure that these clocks are synchronized, at least by the Einstein convention. By definition, if an event at the location of clock A occurs when the clock reads some time we'll call t_o, and a different event at the location of clock B occurs when B also reads t_o, then those two events are *simultaneous*. I do not see the definiendum appearing in the definiens here. But if you like, I can define "simultaneous" in a mathematically equivalent but simpler way: events P and Q are defined to be simultaneous in the reference frame K for which the point of intersection of light pulses emitted from P and Q is equidistant from both events.

> "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.' Bergson thus makes it clear that he rejects the verificationist epistemology which underlay Einstein's re-definitions of time and simultaneity."

WLC seems to think that an operational definition of simultaneity is necessarily pitted against an intuitive definition. I would argue that they are not. Einstein's operational definition acknowledges that we humans have an intuitive understanding of simultaneity— it simply capitalizes on the fact that there happens to be something in the universe that always travels at the same speed in order to add precision to our intuitive definition for the sake of the physicist. I don't think any physicist upon hearing someone say, "Whoa, I just burped and farted at the same time," would reply, "How do you know they were simultaneous? Did you send light signals from each event?" We all realize that for the amount of precision needed in everyday life, our intuitive interpretation of simultaneity works just fine.

> "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 gante 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."

No physicist who understands relativity will make any *conceptual* distinction between "distant simultaneity" and "local simultaneity" because there isn't one— there is only a *precisional* distinction. Theories of physics ought to be put to the test by experimentalists, and every experimentalist knows that there are no instruments which are infinitely precise. Therefore, if a theoretical difference in some measurement is small enough, the experimentalist simply doesn't care. So in theory, simultaneity is a concept that applies to zero-dimensional mathematical points in spacetime which can be situated arbitrarily close to one another, and if every theoretical observer had measuring devices of infinite precision, then whether you're a microbe or a "supra-human", you will acknowledge that the simultaneity of spacelike separated events, if measured with infinite precision, is dependent upon reference frame alone, not the distance between the events. But the fact is, as slow and spatially concentrated as we humans are, and with our lack of care for superfluous

precision, we can easily get away with considering the entire Earth at 08:01:36 CST on 11/16/24 as a single event. Therefore, *from a practical standpoint*, any events that happened on Earth during that second are trivially simultaneous (at least to within a second) in the same way that two points in spacetime are trivially simultaneous if they are the same point. So from here on out, when I use the word "simultaneous", I will mean it in the non-trivial sense, *i.e.* in reference to two or more events which could be considered *precisionally distinct*.

> "The presentness of experience simply has nothing to do with inertial frames, relative motion, light signals, clock synchronization, and the like."

The presentness of one's *personal* experience has nothing to do with those things. As soon as you try to extend that presentness spatially, those things are absolutely necessary to *precisely* define the present. Saying light signals and clock synchronization have nothing to do with defining "now" is kind of like someone claiming that standardized measures have nothing to do with building a house. True, you don't *need* standardized tape measures to build a house, but if you want your house to be sturdier while using fewer materials and to look nicer, then you will *want* to use a tape measure.

Claiming that reference frames have nothing to do with defining "now", however, is a much deeper mistake since calling two spatially separated events "simultaneous" automatically assumes a specific inertial frame, whether you want it to or not. Maybe WLC means that having an *imprecise* idea of NOW does not require reference frames, to which I'd say he's still wrong. If your NOW is imprecise, it doesn't mean reference frames are irrelevant, it simply means the frame of reference itself that you're implicitly using is imprecise, or a little fuzzy around the edges. Which is fine. I've already mentioned that physicists don't care to be more precise than a given question requires. But the frame of reference is still very much relevant. This will be a very important point in this paper, so let me give a brief analogy: Imagine WLC says, "The global death toll of the pandemic by the end of 2021 was around eighteen million." We all know which pandemic he's referring to, but a pedantic microbiologist might respond, "You mean the pandemic caused by SARS-CoV-2? You really ought to specify which microbe you're talking about." WLC's claim that reference frames have nothing to do with defining "now" is like responding to the microbiologist with, "Microbes? Microbes don't have anything to do with the pandemic!"

Personal vs Extended Now

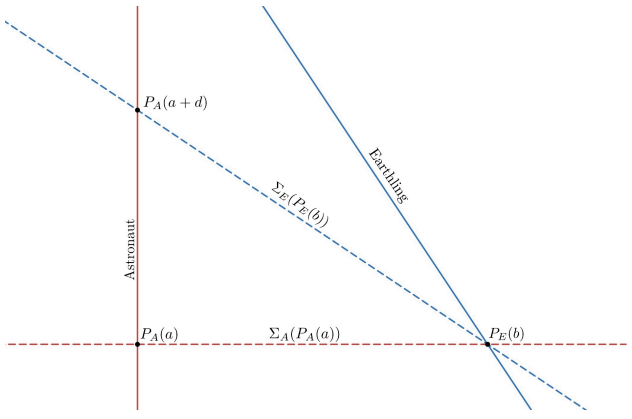
Let's now explore the two different concepts of "now" as well as whether or not there is a unique and natural way to get from one to the other. First, there's the personal "now" that each of us experiences. The fact that my now exists is almost as indisputable as the fact that I exist. Let me introduce some notation for the sake of clarity: my experience of my personal now at any particular moment is an event that I will call P_m (P for point or personal, and m for mine). If we wanted to refer to any of my past experiences of now, we would make P_m a function of my precise age, which we would then call $P_m(\tau_m)$, where τ_m would be the elapsed time on a hypothetical stopwatch I've been carrying since, say, my birth. For example, $P_m(10:216:14:26:52)$ would refer to the event of my experience of my personal now when I was 10 years, 216 days, 14 hours, 26 minutes, and 52 seconds old. To be clear, this is an event, or a point in spacetime, that occurs at a specific time as well as a specific location. The location would be wherever I was at that particular time. In contrast to the event of my personal now, there is the extended now, which, for me, is the set of events that includes $P_m(a)$ (*i.e.* my personal now at my age a), as well as all of the events throughout the universe that I would consider to be simultaneous with $P_m(a)$. Call this surface, or set of events $\Sigma_m(P_m)$. I'm describing it as a function of P_m because it clearly ought to change as P_m changes. What does not seem at all obvious to me is the idea that $\Sigma_m(P_m(a))$, which contains some event $P_y(b)$ (meaning your personal experience of now at some specific age b), ought to be the same set of events as $\Sigma_y(P_y(b))$. In other words, I don't see any reason to expect my extended now to look the same as yours. In fact, I'd go further and say that in a universe with gravity, the set of events that makes up even just my own extended now is (to an extent) *chosen* by me, as opposed to being naturally enforced in any universally inherent or unique way.

Let's start with my first statement, that we shouldn't expect different people's extended nows to contain (precisely) the same set of events. This is a simple result in special relativity. Imagine you are on a *very* fast train that's moving at a constant velocity. You're standing still in the middle of one of the cars. There are two lasers, one at each end of the car, aimed towards a sensor that's right by you in the middle. The sensor

is hooked up to a bomb. The bomb is programmed so that if the sensor receives the two light signals from the lasers at the same time, it will do nothing. But if the light signals arrive at different times, the bomb will explode. You, knowing that the speed of light is the same in all inertial frames of reference, and also knowing that the sensor is the same distance from each laser, pray to God that the lasers emit their light *simultaneously*. The lasers emit their light, and you aren't blown to smithereens. You breathe a sigh of relief and thank God that the two emission events both occurred in the same Σ_y. Now I was on the embankment when all of this happened. I also knew about the bomb, the sensor, and the two lasers, as well as the fact that light travels at the same speed in all inertial frames. I see the lack of explosion, and think about what that must mean for the emission events. After a minute, I thank God that the two emission events occurred in *different* Σ_m's. So the natural question is, if there really exists a NOW, did the two emission events occur in the same NOW, or in different NOWs? Some might be inclined to lean towards the latter since, as the embankment observer, the one with his feet planted firmly on the ground, my point of view ought to be privileged over your point of view from the train. But *why* should mine be privileged? After all, the Earth to which I'm attached is just in free-fall in the vacuum of space. Furthermore, we could imagine a hypothetical future in which we terraform and colonize mars, which then becomes more populated than Earth. How could we then justify privileging the point of view of someone simply because they're at rest relative to the surface of some planet on which only a minority of the human race resides?

Once again, if the belief that time was made for us humans informs how we view time, then we can get away with saying that the events which are truly simultaneous are simply those that seem simultaneous to most humans. The idea that this would be the case if we didn't assume time was made for humans seems absurd.

So why does it *feel* like we all share a common Σ? Simply because we're so slow compared to light, and we don't really care about the simultaneity of events that are distant from us. The fastest any human has ever traveled relative to the Earth is about 11 km/s (on Apollo 10). So if anyone ever had a significantly different Σ than the rest of us, it was them. And this is how it differed: eight billion kilometers* away in the direction of travel, their extended now differed from ours by about one second. We could also look closer to home. There would have been a $\Sigma_A(P_A(a))$ at age a of one of the Apollo astronauts. This set of events would have included an event $P_E(b)$ for someone on the opposite side of the Earth with an age of b. By construction, the event $P_E(b)$ is also necessarily included in $\Sigma_E(P_E(b))$, which itself contains some other P_A, say $P_A(a+d)$, where d is the difference in age of the Apollo astronaut from his initial personal now to his personal now that's included in the Earth person's extended now that was constructed from her personal now which was included in the astronaut's initial extended now. Don't bother re-reading that last sentence, you can just look at the diagram:



In this diagram, time runs upwards and spatial distance between the astronaut and the person on Earth runs laterally. I've also greatly exaggerated the relative speed between the astronaut and the person on Earth just to make the lines visually discernible.

*That's roughly the diameter of the orbit of Neptune, the furthest planet from the sun.

The time difference, d, is about 0.003 milliseconds. This is why the idea of a common Σ seems so natural to us. It just turns out that this is not the way our universe actually works.

Let's now try to establish what WLC's definition of NOW is.

> "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."

This is the clearest and most helpful definition of what WLC considers to be NOW that he provides in this paper. I especially appreciate the comparison to the clock lattice. This helps to elucidate his thinking as well as what he is not taking into account. I will show that the lattice cannot be used in the way that WLC thinks it can be, and even if it was used correctly, the lattice cannot be *extended* in the way he assumes it can be. Then I will describe a concept used in GR that is far more comparable to what WLC is envisioning in his definition, as well as the limitations that come with it.

The "hypothetical lattice of clocks" that he references is a tool that is used to help conceptualize a cartesian coordinate system *for a single inertial frame of reference*. Since the reference frames of literally every person on Earth are not inertial, this is really only suited for the people aboard the ISS.* Ok, so make this lattice of consciousnesses centered on them. Well, why them? Why not the hypothetical aliens aboard their ship that's passing by at $0.8c$ relative to Earth? WLC never gives any justification for privileging the frames of reference that he does. But even if he was able to justify it, this lattice cannot be naturally and uniquely extended in a universe with gravity. Let me explain why with an analogy.

Say an urban planner wants to make the roads in a city to form a rectangular grid. She realizes that the grid doesn't *have* to be aligned with the cardinal directions, but she makes the *choice* to do it that way to keep with convention. It's a pretty straightforward design, and she shouldn't have a problem drawing up the plans. There will, however, be a problem if the planner wants to extend that grid to cover the whole globe. There will actually be several problems, but the biggest one is geometric. Mathematically, there is no way to extend the roads in a manner which maintains the straightness of each road as well as the orthogonality of each intersection. If she tries, at some point she is going to have to start making choices between things like making this intersection not quite perpendicular or making this road curve a little northward because somehow it seems to be getting closer to the next road south that it's supposed to run parallel to. By the end of the project, she will have *designed* a spherical coordinate system made by the roads. If anyone suggests to her that those specific coordinates she came up with were somehow naturally enforced, that there really couldn't be any other sensible coordinate system, she would probably laugh.

Similarly, over small enough patches of space and short enough time scales, I can imagine being on the ISS, at rest with respect to a nice, neat cartesian coordinate system with a clock at each intersection of the coordinate lines where each clock is Einstein-synchronized to the clocks adjacent to it. First off, the idea that there's something innately special about the coordinates thus far, *i.e.* that there is something innately special about being at rest with respect to the ISS, is akin to the urban planner thinking there's something innately special about the cardinal directions.† In any case, I can try to sensibly extend those coordinate lines and keep those clocks synchronized, but eventually (or immediately, if I can achieve infinite precision),

*You might argue that relativists, including Einstein himself, have frequently used observers standing on trains and on the ground in examples that are supposed to apply to inertial frames. In these examples, we're not looking at all three spatial dimensions. In fact, most of the time, we're only looking at one spatial dimension. The direction along which we Earthlings are *not* inertial is the up/down direction, which is orthogonal to the space in which the train's motion is being examined, so it's not an issue. If we do want the frame we're working with to be fully inertial in all three dimensions, then a hypothetical accelerometer at rest in that frame would need to read zero, and that only happens in free-fall.

†Okay, the analogy admittedly breaks down here because on Earth, there *is* something innately special about the cardinal directions, namely Earth's magnetic field lines run North/South and, not coincidentally, the Earth rotates East/West. The analogy would work better if we placed the city planner on a planet that does not rotate.

something's going to have to give. I will inevitably be forced to start making choices on how to continue extending my coordinates. The most relevant choice will be how to keep the clocks synchronized. The variability of this choice is most easily seen in the vicinity of a black hole.

Say Alice, Bob, and Charlotte are hovering over a black hole at a safe distance in a spaceship (the thrusters would need to be on in order to maintain their distance). Charlotte falls out of the spaceship. Alice and Bob, who know their distance from the black hole, as well as just enough GR, decide to calculate Charlotte's distance from the black hole's event horizon at one-minute intervals. After several minutes, Alice, who is using Kruskal-Szekeres coordinates, says, "Okay, Charlotte has crossed the event horizon now." Bob, who is using Schwarzschild coordinates, replies, "I think your calculations are a little off. She's close, but hasn't crossed it yet." Bob continues calculating. An hour goes by. Then a day. Then a year. Then a billion years. Alice then says to Bob, "What about now? Has she crossed yet?" "Nope," says Bob.

Alice did not make an error in her calculations, and neither did Bob. Alice was not wrong in saying "Charlotte is crossing the event horizon now," and Bob would not have been wrong if he had said, "It doesn't matter how long we wait here, there will never come a time when Charlotte will cross the event horizon." They are simply using different coordinates to tell them how "now" is defined. Alice's coordinates are particularly well suited for seeing causal structure, and Bob's coordinates are well suited for seeing the rates of clocks that are hovering over the black hole like theirs, but terrible for giving information on clocks in free-fall, like Charlotte's.

All of this to say that gravity makes things very complicated and even more unintuitive than they were with simple SR. The concept in GR that would be more useful in WLC's definition of NOW than the clock lattice is what's called a "timelike congruence that is hypersurface orthogonal". Think of a bundle of parallel copper wires (they don't need to be straight) that are being 3D printed, so the length of the bundle is constantly growing. Each wire corresponds to a consciousness, the end of each wire directly under the printer is that consciousness's personal now, and the bundle's entire exposed surface under the printer is NOW.

But there are sill a couple problems with this. First of all, how does WLC plan on adding more consciousnesses to "[distribute] throughout the universe"? I assume WLC would imagine starting with a set of consciousnesses that are at rest with respect to the Earth's surface (but once again, I see no justification for why that has to be the case). But how would we add consciousnesses radially outward? Two miles above sea level— are the consciousnesses still supposed to be at rest with respect to the Earth's surface? What about one million miles above? The problem with this attempted congruence is that the speed of light is going to stop us from adding consciousnesses indefinitely. Once we get out to roughly Neptune's orbit, the speed required to complete a circle around the Earth in one day exceeds the speed of light. So this is not a valid timelike congruence.

I think the congruence that would best suit WLC's purposes would be one where the consciousnesses are all moving westward relative to the ground such that they complete one lap around their line of latitude each day. This basically cancels out the rotation of the Earth. OK, great. But we *still* run into the same two problems as before. First, we still have no way to justify making this particular congruence THE congruence to which time defers. And second, the universe has a bunch more stuff in it than just our planet. So just like we couldn't uniquely extend the lattice in the presence of gravity, there will be no natural or unique way to continue adding consciousnesses to this congruence when there are so many other things in the universe curving spacetime.

Co-existence

I wanted to address WLC's claim that the relativistic ideas of simultaneity, if taken seriously, imply that "only objects which are mutually at rest co-exist", which, as he correctly declares, is outrageous. This claim is so bizarre, that it didn't naturally fit into any of the other sections, so I decided to just address it by itself here.

> "For example, enduring entities E1 and E2 cannot be said to co-exist iff they are simultaneous in E1's reference frame because co-existence is a symmetric relation"

The word "simultaneous" is something that is attributed to events. Judging by the phrase "enduring entities" here, I take E1 and E2 to refer to physical objects which persist through time. If this is the case, then

simultaneity is a concept that cannot be applied to them because E1 and E2 are not events. For example, the sentence "The Earth and the sun are simultaneous in my reference frame" makes no sense. If instead, we say, "The astroid hitting the Earth was simultaneous with that solar flare in my frame of reference," then this is perfectly sensible. Alternatively, if E1 and E2 *are* intended to be events, then it doesn't make sense to talk about E1's reference frame since reference frames are not defined for events— they're defined for physical objects.

> "whereas in STR E2 may be simultaneous for E1, but E1 will not be simultaneous for E2."

The parts "E2 may be simultaneous..." and "E1 will not be simultaneous..." make it sound like they are both events, but "... simultaneous for E1" and "... simultaneous for E2" make it sound like E1 and E2 are physical objects.

> "If we say that E1 and E2 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."

I cannot judge the veracity of this whole statement because the meanings of E1 and E2 are unclear, and WLC's use of the word simultaneous appears confused. If a relativist wanted to define "co-existence" for physical objects A and B (which we shall assume have a beginning and an end to ensure that the fact of their co-existence is not trivially true), then it would go something like this: for a given P_A, iff B's worldline passes outside of the lightcone at P_A, then B co-exists with A at that P_A. Furthermore, for every P_B along the portion of B's worldline lying outside of the lightcone at P_A, A can be said to co-exist with B at each of those P_B's. In this definition, the relation of co-existence is always symmetric, and it obviously allows for the co-existence of objects that are not at rest relative to each other. This should suffice in refuting the idea that relativity implies that "only objects which are mutually at rest [can] co-exist".

Solipsism

In this paper, WLC presents three possible philosophies of time: the A-theory, the B-theory, and a solipsistic theory. The A-theory is the one WLC argues for, where there is a single NOW in which everything exists. The B-theory says that "now" is an illusion and that physical objects are really four-dimensional. So the whole 4d object of "me", which includes my birth as well as my death, is what really exists— not this illusory 3d slice that I might call "me, right now". Solipsism is the philosophy that my mind is the only thing I know to exist. In the context of WLC's paper, I assume he is using the word to indicate a philosophy of time that says only my personal now definitely exists.

Since I share in WLC's belief in the existence of the God of Christianity, I can understand if WLC wants to build his philosophy of time upon his theism. I just find the implications of his philosophy aesthetically displeasing. So much of our universe points not towards us, but towards our Creator. I therefore don't like the idea of making the behavior of time itself all about us.

My problem with the B-theory of time is not that I find it aesthetically displeasing, but that I find it utterly unconvincing. I see no reason to believe that my perception of now is illusory.

> "theorists who have attempted to marry objective temporal becoming to STR wind up reducing present reality to a space-time point, thus bringing upon themselves the charge that they advocate solipsism."

As someone who takes relativity seriously, I admit that "now" is only *uniquely* defined for a single worldline, *i.e.* for a single consciousness. However, I reject a philosophy of solipsism, that only my personal now is sure to exist. There is nothing in relativity that says that each and every worldline can't have its own "now". Relativity only says that how we relate those different "now" events to one another is not as simple as it was with Newtonian mechanics. I also reject the trichotomy that WLC presents— that our only three options are his A-theory, the B-theory, and solipsism. To me, it seems perfectly reasonable to believe that the personal now of each and every person really does exist, and that God is relating them to each other in a more complex way than a simple NOW. What that more complex way could be is the subject for a different paper.

Conclusion

GR is hard. It's hard for two reasons: the first is that we're dealing with a curved four-dimensional manifold. Imagining a curved two-dimensional manifold is usually easy. Imagining a curved three-dimensional manifold is extremely difficult. Imagining a curved four-dimensional manifold is virtually impossible. The best we can do is build up an intuition by working through the math. The second reason is that one of the dimensions in this manifold is unlike the others in a way for which we have no visual intuition whatsoever. Even if the manifold is a flat two-dimensional plane, the only way we can build an intuition for the combination of these two distinct types of dimensions is, once again, by working through the math. It's therefore completely understandable to me that someone would expect that comparing things here to things way over there would be simple and straightforward, but this is not at all the case in our universe. This is one of WLC's misunderstandings.

His other apparent misunderstanding is much more basic. WLC's Newtonian claim that we don't need to consider reference frames when thinking about the nature of time is very telling. Any time we talk about locations, distances, times, durations, speeds or velocities, we are necessarily specifying a reference frame to which those things belong, whether the specification is implicit or explicit. If you're going to go the implicit route, then expect to confuse others as well as yourself. The fact that WLC seems to think that reference frames are unnecessary indicates to me that he chose his frame not even implicitly, but unconsciously. He seems to think that there is something inherently special about being in close proximity with as well as at rest relative to the planet Earth. He then implicitly labors within only this privileged reference frame to draw his conclusions. Again, I see no problem with this as long as you realize what you are doing and qualify your philosophy of time with this idea, which I don't see that WLC does.

Other Misunderstandings

I put these last few quotes at the very end because they are not actually from his paper that the rest of this paper is responding to— they are from question of the week #485 "How Do I Interpret General Relativity Theory?" from WLC's Reasonable Faith website.

> It's true that Einstein tried to extend his principle of relativity to cover not only uniform motion (special relativity) but accelerated and rotational motion as well (general relativity).

This is simply wrong. First, SR can handle accelerated and rotational motion just fine. The difference between SR and GR is not in the motion of the particles you choose to look at, it is in the spacetime itself— *i.e.* is the spacetime flat or curved? Second, if you do attempt to foliate spacetime into surfaces of simultaneity for a helical worldline (*i.e.* a particle or observer traveling in a circle) in the same way you would for an inertial worldline, what you find is that there is no way to do it such that, one, each surface is orthogonal to the helical worldline at the event at which it intersects that worldline (which is what we would want in order to satisfy our intuitive notion of simultaneity), and two, every event in the spacetime lies on one and only one surface of simultaneity. Einstein's realization of this *started* him on the path to GR.

> [Einstein] did not succeed in enunciating a general principle of relativity or in relativizing all motion.

One, Einstein *did* succeed in formulating general relativity— it's why many physicists still learn it today. And two, the relativity of motion itself (all of it) is called the *principle* of relativity and even Newtonian mechanics is built upon this axiom.

> What he did do was discover a new theory of gravitation to replace Newton's. The name 'general theory of relativity' is thus recognized to be a misnomer, a historical vestige. It is a gravitational theory, not a relativity theory.

Yes, general relativity does model gravity more accurately than Newton's model. This does not mean, however, that it is not an extension, or *generalization*, of special relativity because it most certainly is. Special relativity is called "special" because it's only meant to apply in the *special* case where gravity can be ignored, *e.g.* in deep space, or when we're only looking at motion in directions orthogonal to the pull of

gravity. The spacetime that the model uses is flat. Einstein discovered that if you let the spacetime be curved, then the curvature is related to the matter/energy content of the universe in a way that's encapsulated in the Einstein field equations. So it's still relativity, but *generalized* to include gravity.