Time's Discourse:

Special Relativity and the Puzzle of Passage

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Of time you would make a stream upon whose bank you would sit and watch its flowing.

Yet the timeless in you is aware of life's timelessness,

And knows that yesterday is but today's memory and tomorrow is today's dream.

And that that which sings and contemplates in you is still dwelling within the bounds of that first moment which scattered the stars into space.

-Kahlil Gibran, *The Prophet*

FOREWORD

What Gibran elegantly illustrates in verse, philosophers must carefully spell out in prose. How best can we, as philosophers, elucidate the nature of time? Modern physics has complicated this answer. There are two competing pressures involved: those derived from our dynamic experience of time and those derived from our leading empirical and theoretical understandings of physics. As such, there are two distinct methods of explanation: either we can investigate time *as we experience it,* or we can investigate time *as it is best modeled* to fit the empirical data. These two approaches lead to drastically different theories of time which appear, at first, to be incompatible – but how can it be that time has such contradicting qualities?

Einstein's special theory of relativity is intuition's greatest adversary and the primary challenge to the philosophy of time that I will focus on in this paper. The alterability of time within the context of astrophysics is incredibly peculiar when, here on Earth, we all experience the flow of time in the same manner: the iconic one second per second. Special relativity speaks of spacetime as a four-dimensional manifold: three spatial dimensions and one temporal dimension. In this mathematical framework, time is treated in the *exact same* manner as space. This paired with the fact that the universe has a speed limit – the speed of light – leads to peculiar consequences like the relativity of simultaneity. In light of these discoveries, our two methods of understanding time appear impossible to reconcile; either, it seems, we adopt a version of time that appeals to experience and ignores science, or we adopt a version of time that appeals to science but ignores our experience. Therein the problem lies.

McTaggart first noticed a primordial form of this dichotomy in his seminal 1908 work "The Unreality of Time" in which he argues that there are A-theories and B-theories of time. Broadly

speaking, the A-theories reduce the temporal ordering of events to A-series in which times are a part of the *past*, *present*, or *future.* The B-theories reduce the temporal ordering of events to a binary relation – either being *earlier* or *later* than other events. To extend an analogy, A-theories are like considering a train car at a given point on the tracks: there is a past and future behind and in front of where the train is *currently* located. B-theories cannot contextualize a past or future because there is no objective location of the train car; we can see *earlier* and *later* parts on the tracks, but they are not solidified into *past* or *future*. As such, the A-theories commit to time as it most easily accords with our experience: there is a past, there is a future, and we experience the changing sliver of a present in between the two. The B-theories are less easily reconciled with our intuition, but as we will see, they more closely aligned with time as modern physics encourages us to model it.

Contemporary views on the nature of time will largely appeal to one of these two categories. The challenges a given perspective will face depend on which temporal genus the view falls under. We will see dynamic A-theories like presentism – the view which argues for only the existence of the present moment – struggle to keep up as science diverges from intuition and experience: how can only the present moment exist if observers experience the present moment differently? How can there be a universal present if the ordering of spacelike separated events is not objective? B-theories better accord with the science, but we will see them fail to keep up with our phenomenological experience of time's passage.

My background in astrophysics has given me Einsteinian intuitions, and as such, I started my philosophical investigation sympathetic to *four-dimensionalism*, a B-theory of time. This view argues for a block universe, consisting of a set of three-dimensional temporal parts. For example, Einstein has temporal parts located in 1895, just as he has temporal parts located in 1905; both are

equally real and legitimate. Everything exists *at once*, so to speak. Einstein's identity is the set of all his temporal parts: the spacetime worm that exists as the fusion of his temporal slices between the year 1879 and the year 1955. Thus, this perspective of time is inherently static; there are no moving parts. As we will see, this is its greatest virtue and vice.

To the four-dimensionalist, everything across time exists equally, so change can only be defined between successive temporal parts, not within them. This makes it easier to allow for the bizarre conclusions of special relativity, but it has one serious flaw: how do we explain our dynamic experience of time? According to this view, there is no objective moment in which we live: 2024 is no more real than 1924 or 2124. There is no flow within the four-dimensional river of time; it is frozen solid. To continue with the train metaphor, there is no train car – just the tracks. This clearly disagrees with our phenomenological experience of time. In a very Moorean manner, we can cite change in time to prove its dynamic nature. But that leaves us where we started: trying to reconcile the present moment with scientific theories that go against common sense.

Thus, there is an apparent disagreement between time as we experience it and time as it is best modeled to account for the consequences of relativity. As much as we might hope, no single theory can give us everything that we want; each has its advantages and disadvantages. So, where does that leave us? Ultimately, I argue that truth is found in the synthesis of these ideas, told from different perspectives. To best illustrate the value of these different perspectives – i.e., different reference frames – I explore this synthesis through a dialogue. Dialogue is the origin of philosophy, and science bloomed from that philosophical sprout. There is no better way to discuss a subject as elusive as time than through a conversation – one motivated by research and thought.

We will view time through two vastly different lenses and, in so doing, come to further understand its nature. There are two characters involved in this analysis: Antares and Boötes.

Neither character is supposed to completely represent a single theory, though they each have a personal favorite; rather, they encapsulate a philosophical framework and methodology from which to approach time. Antares will approach our exploration with an emphasis on time as we perceive it: dynamic, based in the present moment between past and future. This perspective will most naturally align with *presentism*. Boötes will approach it with an emphasis on time as it is best explained and modeled scientifically: static, with concepts of earlier and later for events that are timelike separated, keeping flexibility for relativity. This will be most clearly aligned with *four-dimensionalism*.

This conversation will be an efficient way to view time through two very different lenses. These two characters represent how vast our formalizations of time can be if we only prioritize one characteristic over another. We will put on Antares's glasses to prioritize the phenomenal experience of time and Boötes's to prioritize the explanatory nature of time. As we look at this dimension of experience through both lenses, the smudges on each lens – so to speak – will be revealed. Ultimately, we will only be able to completely understand the nature of time by using and appreciating *both*; what we once thought was a problem that needed to be reconciled, we will see is in fact null. The scientific and manifest images of time – to borrow the nomenclature of Wilfred Sellars – are not incompatible; they are one.

SCENE: Antares and Boötes sit face-to-face on a train between Geneva and Vienna; it is painfully behind schedule.

ANTARES: If this train doesn't speed up, we are going to be late!

BOÖTES: Is it even possible for Swiss trains to be behind schedule?

ANTARES: Apparently so…

BOÖTES: Well, it doesn't matter: time is meaningless!

ANTARES: What an outlandish claim!

BOÖTES: It was but a joke, my friend. However, you taking it so seriously makes me think you have some opinions on the matter. I have some opinions myself, you know.

ANTARES: Well then, I suggest we turn our discussion to the subject of time! That should fill the duration we have left on this voyage. I begin with this basic assertion: here we are, in the present moment – *now*, as some call it. What exists is what we find in the present, and it is everchanging.

BOÖTES: Bold assertion! I am afraid I must challenge you from the start.

ANTARES: How can you deny that we are here, *now*, in this dynamic present moment? We see the world changing around us. Trees pass by on this train. Basic mechanics tell us that one cannot have motion without change over a variable of time. Velocity itself is defined as a change in space over change in time. Zero elapsed time leads to more than just no change; it leads to an undefined function. Without the river of time, what could give rise to our experience of change?

BOÖTES: I am not suggesting a timeless universe.[1] Rather, I am here to argue against the flow of the river you speak of. I have deduced that we live in a static, block universe. That is, everything is not in the past, present, or future – it just *is*. With this in mind, I must concede that your final question will be the most challenging for me to answer. I will give you my best response, but first allow me to provide you with your most difficult question: how will you reconcile your concepts of past, present, and future when we leave the Newtonian paradigm? At some point, our philosophy of time must leave the 17th century in favor of our own.

ANTARES: If it is the discoveries of special and general relativity in the 20th century that you speak of, I do admit you are correct in your assessment: this will be the most difficult problem for me to solve. Modern physics is difficult to reconcile with *almost all* dimensions of common sense, including presentism.[2] Seeing as my view is in line with common sense, I am happy to respond to your troubles first; there is no point in needlessly creating outlandish theories of time unless our

[1] McTaggart argues against the existence of time – A series and B series – in his seminal 1908 work "The Unreality of Time". Instead, he argues that what we experience as time is either a non-temporal C series or there are truly no series to speak of.

[2] The largely intuitive view that only what is found in the present exists; the past is gone, and the future is yet to be created (Markosian 2006).

common sense cannot properly be defended. What troubles you most about presentism and other dynamic theories in Einstein's universe?

BOÖTES: I am most concerned with the peculiar implications of the fact that the speed of light – *c*, as it is notated – is constant in all reference frames. The speed of light cannot be added like other velocities.[3] I take it you are aware with the consequences of this fact?

ANTARES: Certainly. If *c* is always *c*, then even simultaneity is relative. Two equally valid reference frames could disagree on whether two events are simultaneous or even the order in which those events occurred.[4]

BOÖTES: And there can be no privileged reference frame, correct? We can infer, then, that there is no universal present moment and no objective ordering to spacelike separated events, though the same cannot be said for timelike separated events.[5] Everything is relativized to one's own reference frame, and without God – which is the subject of another debate – there can be no

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[3] Imagine a situation in which Antares is standing on a train that is moving at five meters per second, and Boötes is standing beside the tracks. If Antares throws a ball in the direction of the train's motion at five meters per second, that ball will move at five meters per second away from Antares. This contrasts with Boötes on the ground, who will see the addition of the velocities of the train and the ball, resulting in a ball that is moving at ten meters per second. These two reference frames disagree with each other, and they are both correct. The same logic does not apply to the speed of light: we cannot add or subtract velocities in relation to the speed of light. *c* is *c*, in all reference frames. If Antares points a laser in the direction of the trains motion, both Antares and Boötes will measure the speed of that beam to be the same: three hundred million meters per second. See Hartle (2003) for further discussion.

[4] Imagine two apples fall from a tree, and they hit the ground at *around* the same time. Which apple hits the ground first depends on your frame of reference – i.e., your perspective. If Newton is sitting under one of the trees, it might look to him like the apples hit the ground at the same time. But if Einstein is riding by on a relativistic bike at near the speed of light, then from Einstein's frame of reference, it is possible for one of the apples to hit the ground first. Neither frame of reference is privileged, so they are both right. See Hartle (2003) for further discussion.

[5] *Spacelike* and *timelike* are terms that refer to the quantity of the spacetime interval. In special relativity, the spacetime interval [$\Delta S^2 = -\Delta t^2 + \Delta x^2 + \Delta y^2 + \Delta z^2$] is an invariant quantity, while space and time themselves become distorted relative to different reference frames. The relativity of simultaneity only applies to spacetime interval quantities for which $\Delta S^2 > 0$, meaning that two events are spacelike separated and cannot be causally connected. The ordering of timelike separated events, where $\Delta S^2 < 0$, is objective in all reference frames. See Hartle (2003) for further discussion.

privileged reference frame. Not even the Cosmic Microwave Background can ground any one reference frame into universal truth.

ANTARES: You take these conclusions to their extreme, but I do see the issue. Allow me a moment to defend presentism and other dynamic theories from these discoveries. I find that there are two ways to defend our intuitive experience of time from the peculiar results of special relativity: either we deny the philosophical soundness of special relativity, or we attempt to reconcile our experience of the everchanging present moment with the fact that simultaneity and – by extension – the present moment are somehow relative. This very issue is discussed by Ned Markosian. In his 2004 paper "A Defense of Presentism" he decides to approach this problem via the former method.

BOÖTES: But it would be foolish to deny the soundness of the special theory of relativity! It is a theory that has substantial evidence working in its favor.

ANTARES: I agree, that would certainly be foolish. Markosian does not deny the soundness of the special theory of relativity in general; rather, he argues that whether the special theory of relativity entails the nonexistence of absolute simultaneity will depend on how "philosophically rich" the special theory of relativity is. We must recognize that abstract, theoretical science often has philosophy baked in without us realizing it, and it is crucial that we recognize if it does. Thus, he puts forward two possibilities: a philosophically robust version of the special theory of relativity (STR+) and a version that lacks the philosophical baggage to make such bold claims as, "there is no absolute simultaneity" (STR-). He argues that the empirical evidence you bring up, Boötes, works in favor of both versions of the theory, but STR- has additional *a priori* evidence working

in its favor. If STR- is in fact true, then we must reject the premise that there is no absolute simultaneity: we can only measure things relative to their own reference frames, not deduce that there is no absolute reference frame. How can we extrapolate from disagreements between reference frames that there is no absolute simultaneity?

BOÖTES: I hate to shoot the proverbial messenger, Antares, but I am afraid that argument is rather rushed and unfounded. Do you really expect me to accept an argument that rejects one of the primary postulates of special relativity?

ANTARES: You must admit, at least, that drawing the conclusion that there is *no* absolute simultaneity from the premise that simultaneity is relative is a bit *bold*, if nothing else. If there is absolute simultaneity, then simultaneity can be as *relative* as it wants to be from different reference frames; most all reference frames will be wrong in their assessments, but the present moment is safe.

BOÖTES: If that were the case, you would be correct, my friend, but I am afraid that what you think is knight's armor is in fact nothing more than bubble wrap. What you fail to understand is that with the existence of disagreement between reference frames, it cannot be the case that one is true and the other is false. Special relativity *must* conclude that there is no privileged reference frame and therefore no absolute simultaneity. It would be different, of course, if God exists; God *should* have the absolute frame of reference, but like I said, that is the subject of another debate. Surely, you have a better argument to defend your dynamic theories. Instead of rejecting a premise

in an incredibly well-founded theory, do you perhaps have a way to make your dynamic theories compatible with it?

ANTARES: I admit, Boötes, that the only way to survive as a presentist in today's world is to adapt: we must loosen our grip on the present. Let's use tense as a means to further our conversation. I maintain that there are such concepts as past, present, and future, so there are objects that were, are, and will be. This is no linguistic analog; it is literally true. The trick will be creating a system in which such talk is possible given what Bacon (2018) termed *hypersurface egalitarianism.*[6] I think this is a term you too will be keen on adopting. In a relativistic framework, the rejection of hypersurface egalitarianism leads to consequences that are somehow stranger than the consequences of relativity alone. If not all hypersurfaces of spacetime are equal, then there are certain times and *places* that are privileged over others. This means, sure, there might be something special about *now*, but there could also be something special about the reference frame of one travelling between Earth and Sagittarius A* at exactly 0.973*c,* for example – a very bizarre conclusion. So, within the framework of special relativity, let's work with what we have and treat all time and space as equal. If our goal is to hold to our dynamic theories of time while loosening our grip on the present *and* staying true to hypersurface egalitarianism, I believe there are two courses of action. First, we could completely relativize the present moment to each reference frame. Seeing as no reference frame is privileged, there is nothing stopping us from creating a truth-relativistic theory of time and tossing our hands into the air to declare, "Sure, there is no *shared* present moment, but that does not mean each individual does not experience their own

[6] Andrew Bacon coins this term in his 2018 paper "Tense and Relativity" where he explains *hypersurface egalitarianism* as: "All regions of space-time are metaphysically on a par (at the fundamental level or otherwise)" (Bacon 669).

objective present." I have my present, and you have yours, Boötes, and in our case they are rather similar because we have similar coordinates in time and space. Everyone on this Earth of ours shares a *fairly common* present, as if we are in a bubble of temporal consistency within an otherwise temporally disturbed universe. But relativity points out that this is simply because we exist within approximately the same, *mostly* inertial reference frame on this globe of ours. As soon as we leave, this sense of consistency disintegrates. So, we could relativize the present and say that we all flow down a similar river here on Earth, but I think that is only satisfying within this specific domain; as soon as we leave our metaphorical bubble, a relativized theory starts to make little sense. It is chaotic, at the very least. It *is* a solution, but it is not the solution I think we are searching for.

BOÖTES: Certainly, I agree that is an unsatisfactory answer. Philosophers are not too keen on relativism – be it moral, aesthetic, epistemic, or temporal. We search for definitive answers. Relativism is like declaring "to each their own" regarding the nature of the universe – which, to me, feels cheap. Nature is as it is, regardless of how we observe it.

ANTARES: So, a relativized theory of time is a solution, but I think we agree that it is not a very elegant one. Elegance and simplicity in a theory is something to be valued after all – I believe William is a mutual friend?

BOÖTES: Of Ockham? Of course! Thou shall not multiply entities beyond necessity.[7]

[7] In reference to Ockham's Razor.

ANTARES: Then let's move on to the second course of action we could take to loosen our grip on the present, and hopefully it will stand up to that sentiment. I suggest that we broaden the scope of the present moment to allow for the mess that is the relativity of simultaneity. Instead of the present moment being a sliver between past and future, I suggest we broaden its domain. Are you familiar with the concept of the specious present?

BOÖTES: Yes, there is a distinction to be made between the present as it is formally defined – i.e., the mathematically infinitesimal sliver that lives between your past and future – and the present as it is phenomenally defined,[8] which may be a bit more two-dimensional. If the formal present is a point, then the specious present is a line; it has duration.

ANTARES: Precisely! While the mathematical present may exist, I find it more likely that it is simply an abstraction. The mathematical present is perhaps no more likely to exist for us than a true circle. What is far more important is the present *as we experience it*. It seems likely to me that the present moment in finite and scalable; we are phenomenally aware of events within a certain duration of time, and that duration depends on scale. You more than anyone, Boötes, will be inclined towards treating time like a dimension, no? So, let's do just that! Why would the temporal dimension not scale proportionally to the spatial dimension? Special relativity treats these four dimensions – time and the three spatial dimensions – equally; that is why four-vectors are so useful for physicists working with relativity.[9] Anyway, here is what this scalable present would look like:

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[8] As is described in Barry Dainton's 2011 paper "Time, Passage, and Immediate Experience".

[9] Four-vectors are a way of representing positions in spacetime. They are formulated such that the *unprimed* four-vector can be converted to another reference frame using Lorentz transformations:

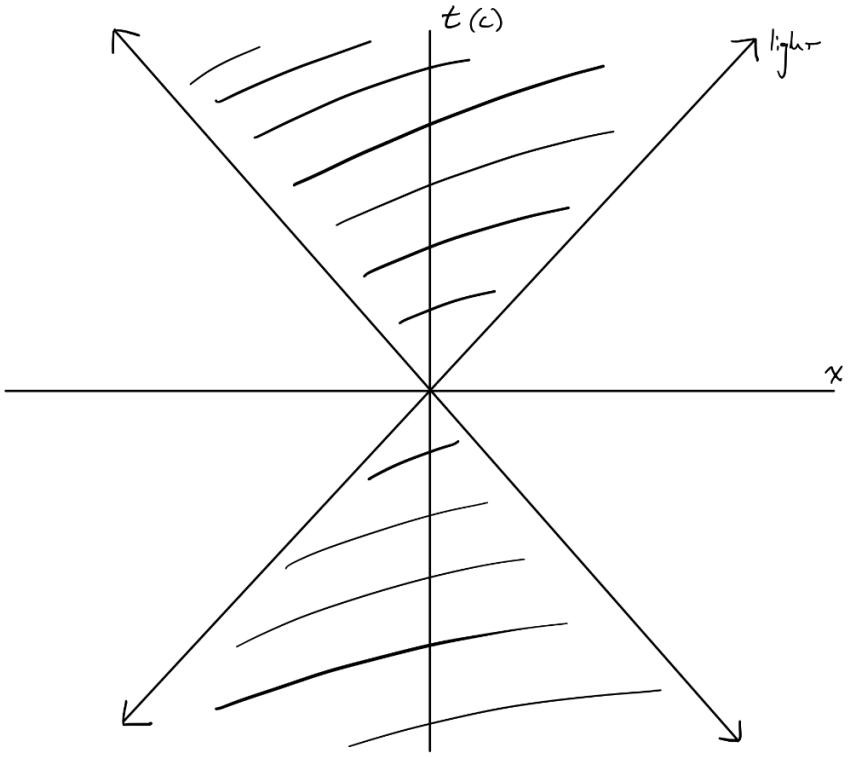
$$\begin{bmatrix} t \\ x \\ y \\ z \end{bmatrix} \rightarrow \begin{bmatrix} t' \\ x' \\ y' \\ z' \end{bmatrix}$$

on smaller scales, the specious present will be scaled down, and vice versa. Here in human bodies, our specious present is, gambling a guess, a few milliseconds, but what does the specious present look like on quantum scales? It may very well turn out to be something along the lines of Planck Time – the shortest meaningful unit of time in quantum mechanics. At these scales, the specious present is miniscule. But what, then, is the specious present at the scales of the observable universe? It would have to be quite substantial. Perhaps, it is substantial enough to account for the bizarre consequences of relativity that we have spent so much time discussing. This would give us a relativistic safety net. Within a large enough specious present, the lack of objective ordering between spacelike separated events would not matter; it is just one big glob of a present moment, expanding into the future.

BOÖTES: I appreciate your appeal to dimensions, Antares, but I must ask what grounds you have for such an outlandish claim. It feels unnecessarily speculative!

ANTARES: And I appreciate your diligence, Boötes. I know it seems farfetched, but this *is* speculative metaphysics we are doing here. I am simply proposing that we make our analogy between the spatial and temporal dimensions complete: let them scale! Thinking through this, I am reminded of light cones commonly drawn on physicists' chalkboards. Here, let me draw it in my notebook. Here is a flash of light – we'll put it at the origin. If we imagine an x-axis denoting change in space and a y-axis – standardized to the speed of light – denoting change in time, then the path that a beam of light takes will intersect the origin at 45 degrees in both directions. If we shade in the triangles that touch the y-axis, we have our lower-dimensional representation of a light cone. Points on our plot represent events – things with spatial and temporal coordinates. If you

draw a line between any two events, you can know whether they could possibly be causally connected. If they fall within the light cone, they are timelike separated, and if they fall outside the light cone, they are spacelike separated. Timelike events can be causally connected, and they have objective ordering within special relativity. Spacelike events are relativized to the reference frame. I am simply suggesting, Boötes, that we scale our specious present in the same way that our light cone scales by nature of its geometry, then our problem could very well be solved.



BOÖTES: I am not sure what you are smoking, Antares, but I surely must compliment your creativity. However, do not forget that you yourself brought up our friend William. Do you not think he would be slightly disappointed by how many entities you have multiplied within your

formulation of time? How many present moments must you create before you bring tears to our poor friend's eyes! I understand what you are attempting to do, but this theory of yours seems needlessly complicated – not particularly parsimonious. I would never concede to the existence of the present moment, *but* if there were one, and it were specious, I would think that duration would be universal in much the same way the speed of light is universal.

ANTARES: I hear your concerns, my friend, and I concede that this idea of mine is half-baked.

BOÖTES: I think you forgot to preheat your oven entirely.

ANTARES: Please Boötes, let's keep things civil! We must tolerate each other for *at least* a few more hours on this train. But frankly, you may very well be right, and I am afraid I am tired of hearing my own voice. It will go back into the oven of thought for now. I suggest we move to your perspective on time. I am not giving in, but let's *say* that there is no way to reconcile our dynamic theories of time with special relativity: how do you suggest we move forward in our understanding?

BOÖTES: I suggest we turn to *four-dimensionalism* as our solution to this quandary. It is a very elegant, static theory of time: no moving parts. Within this framework, we treat time as a dimension in the very same way we treat space. You alluded to this idea just now in your proposal, but you forgot one crucial point: if we are to treat these dimensions as equal, time itself must be static when viewed all at once. Save the expansion of the universe, the spatial dimensions are not dynamic on our scales, are they? Thus, we have four dimensions of experience: *x, y, z,* and *t.* The four-

dimensional story of the universe can be told through its spacetime worm: the set of time slices between $t = 0$ and $t = \infty$.[10] Similarly, the history of you and I, Antares, can be told through our own spacetime worms. We have temporal parts located at all times between our births and our deaths, and none of them are privileged. Me "here-and-now" is not any less real than me "in 5 minutes" or me "5 minutes ago". Our spacetime worms – not unlike our worldlines[11] – are interacting at *this* time, for we have roughly the same temporal and spatial coordinates. Our spacetime worms are moving along the same train tracks, but our spacetime worms did not meet this morning before we got on the train. All temporal parts are equally valid, just as all spatial coordinates are equally valid. It would be ludicrous to say that our spatial coordinates here on Earth are any more privileged than the spatial coordinates on the planet Kepler-16b, for example. Similarly, it would be ludicrous to say that the temporal coordinates in 1905 are any less privileged than the temporal coordinates in 2005 or 2105. Forget the present moment as we think of it; that is a concept of the past – so to speak.

ANTARES: You must be careful with your words in the four-dimensional paradigm, eh Boötes?

BOÖTES: Save your jokes, Antares! But yes, I am afraid so. That is a mere technicality, however. Sure, within my framework, there is no past, present, or future as we tend to think about it, so it is difficult to speak using those terms. There are only *earlier* events and *later* events, but with no present to ground them, we cannot admit fundamentally tensed language. Special relativity has thrown a wrench into even the formulation of *earlier* and *later*, but it does remain true for timelike

[10] See Ted Sider's 2001 book *Four Dimensionalism: An Ontology of Persistence and Time* for an extensive discussion and defense of four-dimensionalism.
[11] Worldlines illustrate the paths that one takes through time and space, as presented on spacetime diagrams.

separated events; there is an objective ordering. But even for spacelike separated events, where simultaneity is relative, the static nature of four-dimensionalism helps us a great deal: if the universe is static, then any problems that arise regarding simultaneity are simply a matter of perspective, not reality. I dare say the static nature of four-dimensionalism is its greatest virtue.

ANTARES: Oh, but my friend, it may very well turn out to be its greatest vice as well! You neglect to consider our phenomenology of time! We see things changing all around us, do we not? I cited the moving train earlier – surely you didn't forget?

BOÖTES: We certainly do experience change, but we cannot let that fool us! Our perception misleads us frequently. Looking out the window of this train, if we relied on perception alone, we could just as easily deduce that the world is moving backwards as we could that we are moving forwards. Regardless, I think there is a solution to the puzzle of passage in a static universe. You see, I am not convinced that the appearance of succession requires there be a succession of appearances. That is to say, I do not think that there must be an event *A* followed by an event *B* in order to give the experience of event *A* followed by event *B*. Michael Pelczar discusses this very issue in his 2010 paper "Must an Appearance of Succession Involve a Succession of Appearances?" where he argues that everything we experience is some form of succession – events followed by more events. You see, the appearance of change is the appearance of succession. But if our phenomenology is sequential, then there had to have been a *first* appearance. This first appearance could not have been a part of a succession, for it began from naught. At some point in your life, you had your first phenomenal experience, and no experience came before it. Appearance of succession comes prior to succession of appearances. Therefore, according to Pelczar,

appearance of succession does not require succession of appearances. In the context of our argument, that is rather important. In a static block universe, there could be no dynamic succession of appearances, but this argument concludes that this fact does not matter. We are able to experience change within such a static environment. Everything can exist at once, as it does, and still result in the experience of change.

ANTARES: A rather interesting idea, for in some sense the analogy to human phenomenology mirrors the origin of time as well. The Big Bang is said to have created the spatial and temporal dimensions, so at some point, there was a *first* time in the universe. By your logic, that does not involve a succession of appearances but still results in an appearance of succession, in one form or another. However, I am not quite convinced, my friend, for there seem to be a few issues with this line of thinking. Let's discuss them in ascending order of importance. First, you seem to be ignoring the fact that every appearance that follows the first is one of succession. Sure, there may have been a first appearance that was not initially a part of the succession, but as soon as another appearance followed, it was a part of the succession. It feels rather like appearance is undefined at $t=0$, so it does not apply to this argument – would you not agree?

BOÖTES: Just because there is only one appearance of succession without succession of appearances does not mean that we can simply *ignore* it. It does not start undefined; it starts as nothing and becomes something, whence the issue arises. It does not matter if every following appearance is one of succession; the first one is not, and this one instance is enough to legitimize the fact that appearance of succession need not involve succession of appearances.

ANTARES: You bring up a fair point, my friend, but you are not yet in the clear. My second issue with your take lies in one of your utterances. You said, "Everything can exist at once and still result in the experience of change" – but this, to me, seems implausible without the existence of another temporal device. If everything exists at once, there is no way that we can have a linear experience, with some events appearing to take place after others in our minds. Everything would be phenomenally scrambled. Yet, here we are, engaging in conversation where we are not speaking over one another. In both of our minds, only one of us speaks at once; there is no layering of events. Nor are we in Geneva and Vienna at once; right now, we are moving in between.

BOÖTES: You are very right in saying that our phenomenology is not scrambled. Making sense of how we don't experience being in Geneva and Vienna at once is as follows: for everything to exist at once in nature and have it result in the appearance of succession in our minds there must be a mind-exclusive time. It reminds me of Billy Pilgrim in Kurt Vonnegut's *Slaughterhouse-Five.* He is unbound in time, and as a result, he jumps from one point of his life to another at random. In his universe, everything exists at once, so his future is as decided as his past; his spacetime worm is set in stone. However, he continues to build memories as he jumps from one point in his life to another – does he not? This is something Vonnegut himself fails to explain, but David Lewis has a model: *external* time and *personal* time.[12] There was a first time that Billy Pilgrim experienced event *A*, and there was the x^{th} time that Billy Pilgrim experienced event *A*. There are, thus, two timelines in this idea: the time in which he exists as a being in the world – fixed in place

[12] See David Lewis's "The Paradoxes of Time Travel" for further discussion.

– and the time which he experiences as he jumps from memory to memory. The latter would be his personal time, a time deserving of its own spacetime worm within this framework of discussion.

ANTARES: A very interesting idea, Boötes, but let us remember that this framework is *fictional*; in our world, there are no temporally unbound beings.

BOÖTES: The framework need not be fictional, for we can apply it to the time of *four-dimensionalism.* In the same way that Lewis applies his *personal-external* distinction to resolve the paradoxes of time travel, we can apply it to our issue of trying to explain dynamic experience within our static, block universe.

ANTARES: You may be right, but it is speculative, and if you want it to be more than just an extended metaphor, it will take quite some argument. It seems far more likely that our experience of time would be causally linked to time *as it is*, and I do not see how that could be the case within a static dimension of time. A mind-exclusive, personal time may have good explanatory power, but you fail to provide an actual argument for it. Your appearance of succession is not enough. This relates to my final point, so let us return back to the original Pelczar argument. This argument concerns appearances of succession and succession of appearances, but it says nothing about the actual world. Perhaps you have proven that the appearance of succession does not require the succession of appearances, but you have not proven that the appearance of succession does not require the succession of states of affairs. Like I said, there must be a causal link between the world and how we experience it. Your argument has existed only in the realm of phenomenology and fails to reach out and interact with the real world. What matters is events in the world and how

they act in succession to manifest our appearance of succession. Without that, I fail to see how you can reconcile your *four-dimensionalism* with our dynamic experience of time.

BOÖTES: You have a keen mind, Antares, as this is an issue Pelczar himself brings up in the paper. While I do believe he succeeds in arguing for his original point, for the purposes of our discussion, it does not help as much as I would like; it does not *quite* give a satisfactory answer for how he can have dynamic experience in a static world. This is tragic, I admit, and perhaps personal time is the solution, but you are right in saying that it is quite speculative. I do, however, have one alternative theory that might please you more than what I have said so far. In some sense, it is the synthesis of dynamic and static theories of time: the moving spotlight theory. It combines the existence of an everchanging present moment with the block universe that is put forth by *four-dimensionalism*. While this theory uses the block universe I described previously, it also recognizes a special, everchanging present moment – like a spotlight moving across the block and illuminating the present moment as the world changes. In theory, this synthesis could take the best properties of both theories: the dynamic nature of time as we experience it with the flexibility of the block universe for accommodating special relativity. But because it still uses a present moment in some form, it requires modification to be compatible with relativity. We have *prima facie* confidence, for the design of this theory gives us a safety net on each edge of the present moment – the past and future already exist – but that alone will not be enough. Bradford Skow attempts this modification in his 2009 paper "Relativity and the Moving Spotlight" where he suggests that our moving spotlight become a moving *floodlight*. To do this, Skow uses another fictional device – a metaphor, really – known as *supertime*. It is from the perspective of this distant dimension that we can look at our time from "above" – so to speak. The problem is that we cannot properly describe

our relativistic spacetime with classical supertime; we need a relativistic, Minkowski superspacetime. If we look at the moving spotlight from the perspective of an equally relativistic superspacetime analog, then we can allow for non-objective ordering of spacelike separated events within the moving spotlight theory.

ANTARES: I appreciate your appeal to *reason*, Boötes – attempting to incorporate the present as we experience it into your beloved block universe – but I think that your attempt unfortunately fails on two fronts. Firstly, you know that I am happy working with the present moment, but I find the application of it here to be rather forced. The only reason that the concept of the present moment works in my dynamic presentist theory is because *that is the theory*. When you attempt to incorporate it into the block universe, you are saying that the past and future exist along with the present, but the present is somehow everchanging. To make one time slice the present at one moment and another time slice the present at the next, you must give each present time slice some metaphysical *privilege.* All at once, you are saying: the past, present, and future are equally real, but the present moment has one additional, special property – namely, for now, the floodlight is shining on it. That goes against the *hypersurface egalitarianism* that we agreed to cherish. So, what gives any such time that special property? It almost feels, then, more logical to have the floodlight illuminate the entirety of the block universe – but then we are back to your originally proposed *four-dimensionalism*. All of this leads me into my second issue with this theory: it lacks parsimony! In fact, it lacks parsimony in much the same way my scalable specious present does. Oh, how disappointed our companion William must be! If only he were here now to set us straight! Part of what makes presentism and four-dimensionalism so strong as contending theories of time – and simultaneously what makes their downfall so frustrating – is that they are both beautifully simple.

They *attempt* to explain this phenomenon of time and they do so by generally representing the two camps we have discussed so far: dynamic and static theories of time. Wouldn't you agree, Boötes?

BOÖTES: To both of your points, I would absolutely agree! In part I proposed the moving spotlight theory to test your reaction. You passed. I myself found it to be a very promising theory until I truly stopped to think about it. It has very appealing qualities, but it is not satisfactory. I just as easily could have proposed to you a relativistic adaptation of the growing block theory,[13] and I gander that you would have had a similar reaction to it as well. It simplifies matters slightly by ignoring the future, but the interaction between the past and present lacks sufficient explanation for now. Within the philosophy of time, there is *immense* value in keeping the theories simple – not multiplying entities beyond necessity. The more moving parts, the more possible points of failure. That is why, I agree with your assessment, Antares: we shall adopt *four-dimensionalism* outright. Let "no moving parts" be our mantra! This has turned out to be a very productive conversation, my friend!

ANTARES: Not so fast, Boötes! I must admit, I am quite surprised by your persistent short-sightedness; you may need a visit to the optometrist. As much as you may want to, I am not convinced that it is possible to simply ignore time *as we experience it*. I appreciate your attempts to use an alternative theory that goes against common sense – I really do – but I am not quite sure that it works here. Time is simply too crucial a dimension of experience for us to ignore its most obvious quality: it is dynamic.

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[13] Where the moving spotlight theory suggests that the present moment is "illuminated" within the pre-existing block universe, the growing block theory proposes that the block universe "grows" into the future – like inflating the balloon used to make a balloon animal. For further discussion, see Michael Tooley's *Time, Tense, and Causation*.

BOÖTES: I appreciate that, Antares – I really do; however, we cannot forget where we were earlier in the conversation when you had the floor. I am not convinced that you are truly able to reconcile the dynamic appearance of time with the special theory of relativity. It is paramount that we align our philosophy with our best science. Philosophy is the soil from which science grew, and it is still the job of philosophy to provide for that which spawns from it. To do that, we must work with what the empirical data tells us, and that empirical data tells us the present moment requires *severe* revision. There is too much evidence in support of special relativity to ignore it. Static theories of time fill the gap left by relativity more seamlessly.

ANTARES: Yes, but once again, your static theories fail to align with the phenomenology! It seems like there is no single theory that can give us everything we need: we always end up sacrificing a crucial characteristic of one theory when we move to another.

BOÖTES: At least not yet. Right now, it is almost as if the truth value of our respective genre of theory – be it static or dynamic – depends on our reference frame, the lens through which we choose to view time. But such truth relativism is impermissible! Can anything be salvaged from this wreckage?

ANTARES: Relax, my zealous companion. It mirrors the very relativity of simultaneity that has burdened us with this problem to begin with. If there are two spacelike separated events – A and B – my reference frame shows A coming before B, whereas your reference frame favors B before A. From my frame of reference within this literature on the philosophy of time, the phenomenology

of time comes before its physics. Through your lens, it is the opposite. I don't know what to say, my friend: it seems like we might just have to *compromise*.

BOÖTES: Is such an act even *possible* within the discipline of philosophy? I have never seen it done.

ANTARES: I am not sure, but we must try – even if it means something *unforeseen* and *devastating* happens as a result. Though, I am not sure of the first step – what do we do?

BOÖTES: I think it is crucial to first notice that we are viewing the world through two vastly different lenses. You prioritize the world as it appears before us, and I prioritize the world as it is best explained given the empirical data. This reminds me of something: are you familiar with the work of Wilfred Sellars?

ANTARES: Yes, with his distinction between the scientific and manifest images? I had not thought of it, but you are quite right! His dichotomy is very relevant here: the scientific image is meant to represent the world as it is explained by science, and the manifest image is meant to represent the world is it manifests itself before us.[14] There is certainly an infamous disagreement between the two, you see, for they seldom agree. Astrophysicists, for example, tell us that the universe is composed of mostly dark energy, but it certainly does not *feel* that way. I don't see any dark energy around, do you?

[14] Bas C. van Fraassen discusses Wilfred Sellars' dichotomy in his paper "The Manifest Image and the Scientific Image" from the 1999 book *Einstein Meets Magritte: The White Book – An Interdisciplinary Reflection*.

BOÖTES: Certainly not, but I assure you it is there.

ANTARES: But therein exactly lies our problem! When each of us chooses to prioritize one image, it makes the other seem foolish! At least the manifest image has some sense of consistency! It does not *change* every few decades. That is why I find it somewhat unsatisfactory that Sellars concluded the scientific image is superior and should replace the "inferior" manifest image. The manifest image is really all we have.

BOÖTES: I certainly agree with you regarding Sellars' conclusion, but the manifest is veritably not *all* that we have. That ignores all that we have discovered! The scientific image expands on the world as we experience it.

ANTARES: That may be true, but it is also often wrong! We must remember, too, that scientists are ultimately left with only one tool: their perception. Everything reduces to perception! The manifest image becomes the scientific image when we extrapolate beyond what we experience.

BOÖTES: We are becoming lost in the details, my friend. You must allow me the floor for a moment, for I bring up Sellars not to defend his conclusion; I bring him up only to mention his formalization of the *alleged* dichotomy. Far more interesting discussions are being done in objection to Sellars' conclusions. When we look up at the daytime sky, what you call "the Sun" I call the star at the center of our solar system. Are both not ultimately, correct? Are these not just two lenses through which we can interpret the same object? At its simplest, the Sun *is* a star at the center of our solar system, *and* it is a nuclear furnace, but that nuclear furnace gave rise to

conditions in which we evolved to give it a name based on how we experience it. I am inclined to believe that the scientific and manifest images are compatible, after all, and to defend this claim, I bring to the stand the work of Bas C. van Fraassen. For van Fraassen, the job of science is to account for the phenomena we experience. It is not meant to be a perfect representation of the world; it is simply accounting for observables. In this view, we do not even need to commit to the ontological existence of unobservables.

ANTARES: Interesting…time is both an observable and unobservable, is it not? As a phenomenon, it is observable, but as a dimension, it is as unobservable as the spatial dimensions: we only experience what is found in those dimensions, not the dimensions themselves. They are no different than a black hole or a quark. We can observe the hands tick on my watch here, but we cannot directly perceive the so-called *flow of time*. But apologies, my friend! I have become distracted. How does it relate back to the dichotomy?

BOÖTES: Well, you see, Sellars had a favorite example of this dichotomy that van Fraassen elaborates on in his paper. If you think of a pink ice cube, your perception – the manifest image – is telling you that the ice cube is pink all the way through. However, if we chop the pink ice cube up, it will reveal that the individual flakes are colorless. The manifest image cannot explain how we derive color from colorlessness or tell us when the colorless flakes become pink, so Sellars uses this to try to bolster the scientific image. Similarly, we can say that the manifest image fails to explain how we experience time in a universe without objective ordering, but that might be a mistake. According to van Fraassen…hold on, I have the exact quotations written down somewhere…according to van Fraassen, “The two images are of worlds which cannot both be real,

for as described the pink ice cube cannot be identical with any object in the world described by science" (1999, p. 5). So, he concludes, "Just as ordinary thoughts about the pink ice-cube were never wedded to pinkness-through-and-through, so ordinary thought was never wedded to a denial of Einsteinian relativity" (1999, p. 14).

ANTARES: I see! So, to adopt these two images and perpetuate the dichotomy is to fall into the trap of scientific realism. Any phenomenon that cannot be explained by science is just a phenomenon that *has yet* to be explained by science. But science is not converging on the truth; it is simply attempting to provide models that are empirically accurate and *save the phenomena*, as van Fraassen says. But ultimately, the world is the only *perfect* model. The only issue is that from the perspective of van Fraassen, there is no truth in scientific inquiry – only empirical adequacy. By extension, there is no truth to special relativity, only empirical adequacy. As you have mentioned, there is quite a lot of empirical adequacy behind it, but as of yet, there is no explanation of the phenomenon that is the dynamic passage of time. Ultimately, across the history of philosophy, one can find many friends who would agree with me in saying that experience is the bedrock of what we know. But that is not to say it is *everything*. I think an addition to our nomenclature will be useful here. Ronald N. Giere has some interesting thoughts on van Fraassen's response to scientific realism in his 2005 paper "Scientific Realism: Old and New Problems". One issue that scientific realism faces is the reconciliation of searching for *capital-t* Truth from a subjective human perspective. Within the framework of van Fraassen's constructive empiricism, scientists are not searching for *capital-t* Truth; we aim to know that a theory is empirically adequate – not that it is *literally* true. Giere helps us formulate van Fraassen's thoughts on this by distinguishing between the *acceptance* and *belief* of and in a theory. We accept theories based on

their empirical adequacy, but we can believe in the truth of our experience. Within our temporal quandary here, *four-dimensionalism* is more empirically adequate, but *presentism* aligns more closely with our experience. Our *acceptance* of static theories of time perhaps does not need to clash with our *belief* that our phenomenal experience corresponds to a truly dynamic world.

BOÖTES: I really appreciate that distinction you have brought up, my friend! I had forgotten about Giere! And to connect it back to a point you mentioned earlier, we must remember that science is modeling the world, but the only perfect model is the world itself. Thus, there is only one correct model of time: time itself. However, the true nature of time is not entirely accessible to us because, as you mentioned, we are subjective human observers. We, therefore, do our best in attempting to *save the phenomena*, as we tried over the course of this conversation. And while we have not been able to claim, "*This* is the *correct,* True theory of time – it solves all the problems!" we have done something else quite important, don't you see? We have formalized the boundaries of the potential models of time! You have presented dynamic theories with experience as their epistemic bedrock, and I have presented static theories with empirical data as the bedrock. Truth – i.e., the one true model of time: time itself – is to be found between these two boundaries. We have both presented alternative views that try to incorporate each other's stories, but as we have seen none of them is exact. Exactness is only found in nature, but the fact that *it is* in nature means that this is not an impossible problem to solve. We all experience a dynamic present *in spite of* the relativity of simultaneity, so we know it is possible. The apparently unreconcilable is reconciled by nature.

ANTARES: I find your presentation convincing, Boötes, but what use is it that we have set the bounds between two extremes? There must be some additional utility. Is it possible that our two theories, despite being on opposite ends of the spectrum, are in fact literally compatible?

BOÖTES: I am glad that you have brought this up because Giere actually responds to a similar idea.[15] As Giere does, we can draw analogy to instrumentation and observation within the sciences: if we observe a pulsar in X-ray light, does that nullify the data that we receive from the same pulsar in optical light? Of course not! They are working together to construct the complete picture of what that pulsar truly is. Can we not adopt the same approach for theories as we do instrumentation? Afterall, what we are doing here, my friend, is constructing a theory of time. We have two that *appear* incompatible, but they are no less compatible than observations in X-ray versus optical light. These two families of theories are just two means of observing and modeling the same thing; they work together to form the complete image.

ANTARES: So, perhaps the seemingly unreconcilable is reconciled by nothing more than nature itself! There is no problem – no inconsistency or need for reconciliation – within nature itself. Nature functions flawlessly until we attempt to model it. We have these puzzle pieces that do not formally fit together, but nonetheless, we have a complete image.

BOÖTES: Indeed, but we cannot let that stop us from partaking in the fun that is extreme metaphysical speculation! Hold on…I have a perfect quote for this. As Ted Sider writes in *Four-Dimensionalism* (2001, p. xiv), "Science is certainly relevant to metaphysics since inconsistency

[15] For further discussion see Giere's 2009 paper "Scientific Perspectivism: behind the stage door" where he responds to Matthew Brown's review of Giere's book *Scientific Perspectivism.*

with a firmly established scientific theory is as good a reason against a theory as one could ask for. But science invariably leaves many questions open." That is where the speculation comes in! I keep returning to this idea of personal time; there must be some way to make it work! It seems to me like our experience of time could be some sort of mathematical projection of the four-dimensional spacetime worm. We don't *feel* the static nature of reality because what we experience is a lower dimensional projection of what *is*. In the same way the shadow of a sphere is a circle, perhaps our dynamic time is a projection of the higher-dimensional static time.

ANTARES: I like the way you are thinking, Boötes, but we surely cannot reduce our philosophy of time to the mechanics of a film projection system! What would be the driving force of such a mathematical projection?

BOÖTES: This, I am not sure – though the expansion of the universe could be involved. There is interesting work left to be done on the analog between space and time as dimensions. If we are to treat them as equal, then it seems strange that we would ignore the colossal fact that space is expanding radially but time does no such thing. I myself am guilty of such ignorance! Time's passage appears to be linear, like train tracks. For any observer, any reference frame in the universe, it is always the case that further galaxies appear redder, and at the same time, in their own reference frame, it appears to them that one second passes every second. I sound like *you* as I utter these words, but it is true that there are dynamics built into the universe's dimensions, and I feel that could act as the driving force. But alas, this is *very* speculative metaphysics! It seems I am the one who forgot to preheat their oven this time. Into the thought oven it goes.

ANTARES: That is a fascinating idea, my friend. It had not occurred to me that time and space both have directionality in some sense: space has radial passage – expansion – and time has forward passage. It is certainly peculiar that their directionality differs in that regard. It seems we both have some ideas that will require further precision of thought and language to reach their *telos*. Apologies in advance for the word usage, but this will come with *time*.

BOÖTES: This has, in fact, turned out to be quite a productive conversation, my friend! Perhaps our delay on this train is a blessing after all. And we will be in Vienna soon enough…the future is near.

ANTARES: So, you think there's a future?

BOÖTES: Only colloquially, of course.

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