

On the Meaning of the Question “How Fast Does Time Pass?”*¹

Bradford Skow

1 Introduction

There are philosophers who think that some views about the nature of time can be refuted just by asking this question (in the right tone of voice). Others think the question has an obvious and boring answer.¹ I think we need to be clearer on what the question means before we can say either way.

In this paper I will examine several different questions all of which have some claim to be precisifications of the question “How fast does time pass?” I will not identify one of them as the *correct* precisification of the question, because I do not think there is any such thing.

Still, for some purposes some of the precisifications are more interesting than others. Some philosophers believe in the reality of “objective becoming.” But objective becoming is notoriously difficult to make sense of, and asking “How fast does time pass?” is supposed to bring out one way in which it is obscure. I think it is important to figure out which interpretation of our question opponents of objective becoming intend (or should intend) to be asking. Not all of the interpretations I will look at can play the role in their argument that they want our question to play. If we are not sensitive to this point we may end up talking past each other. For suppose someone aims to defend objective becoming. As part of this defense, he

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¹Paradigm examples of the former kind of philosopher are Price [1996: 12-16] and Smart [1949]. Maudlin [2007] is an example of the latter kind.

plans to discuss the problem others mean to raise by asking “how fast does time pass?” It is important that he answer the (supposedly) difficult question that his opponents mean to ask, rather than a different question with an answer that no one will dispute.

So is objective becoming an intelligible notion? Looking at what theories that attempt to incorporate objective becoming say about how fast time passes can help us see which aspects of those theories threaten to make them unintelligible. One theory of time that attempts to incorporate objective becoming is the moving spotlight theory of time. The most straightforward way of formulating the moving spotlight theory uses primitive tense operators and says that time passes at one second per supersecond. But I think that the use of “superseconds” in the primitive tense operators threatens to render those tense operators unintelligible. At the end of the paper I explore an alternative version of the theory that does not use “superseconds” in its primitive tense operators. The alternative version says that time passes at one second *per second*. This theory faces the charge of unintelligibility for other reasons, and I attempt to defend it against this charge.

2 Introducing the Moving Spotlight Theory

Before discussing what someone might mean by asking how fast time passes, it will be useful to have on the table a standard version of a metaphysics that does without objective becoming and a standard version of a metaphysics that incorporates objective becoming. The **B-theory** of time does without objective becoming, and the **moving spotlight theory** incorporates it. I will take them as my standard versions of each kind of theory. In this section I will briefly describe each theory. (The presentation of the moving spotlight theory I give here is only a preliminary presentation. I will go into more detail in later sections.)

According to the B-theory, there are, to begin with, instants of time.² And all there is to the structure of time is the structure given by the temporal distances between pairs of times. Typically B-theorists also assume that there are infinitely

²Belief in instants of time seems to imply a belief in a relation of absolute simultaneity, and so to conflict with the theory of relativity. But in this paper I will ignore problems raised by the theory of relativity.

many instants of time, and that the instants and their distances are isomorphic to the real line.³ This is the version of the B-theory that I shall have in mind.

As I have stated it, there is no geometrically distinguished direction to time in the B-theory. No geometrical feature distinguishes one direction of time from the other. Some people (for example, McTaggart [1908] and Maudlin [2007]) reserve “The B-theory” for the theory that adds such a feature. The difference between these two versions of the B-theory will not matter for what I want to say.

The moving spotlight theory agrees that the instants of time and their distances are isomorphic to the real line.⁴ But it adds to the B-theory an extra fact: a fact about which instant of time is present, or NOW. (To say that this is an extra fact is just to say that this fact cannot be reduced to any facts that appear in the B-theory.) It also adds to the B-theory a geometrically distinguished direction to time. Thus for any two times there is a fact about which one is earlier and which is later. Times that are later than the time that is NOW are future times. Times that are earlier than the time that is NOW are past times. In addition, this theory says that the NOW⁵ moves into the future. So which instant is NOW keeps changing. It is in this way that the theory incorporates objective becoming.

How are we to understand the claim that the NOW moves into the future, on

³As I have defined “the B-theory,” B-theorists need not believe that there are infinitely many times. So a B-theorist could believe that there is just one time. How, then, does such a B-theorist differ from a presentist, who also believes there is just one time?

Although they have the same ontology, this B-theorist and a presentist have different ideologies: the presentist employs primitive tense operators (like “It will be the case that ...”), and the B-theorist does not.

⁴Strictly speaking, a defender of the moving spotlight theory could think that time is discrete (isomorphic to the integers), or that it has a beginning (so is isomorphic to the positive real numbers or the natural numbers) or an end; and there are still other possibilities besides.

⁵On the moving spotlight theory of time, “the NOW” is not a thing, like a rock or a pen or a paperclip, that is located first at one time, and then at another. I will, however, sometimes talk as if it is, because it allows me to abbreviate what would otherwise be more complicated sentences. All this talk, though, is just a shorter way to talk about changing facts about which time instantiates the property of being present.

this theory? This is an important question. But I want to postpone answering it until section 4. I have said enough about the theory to begin discussing precisifications of the question “How fast does time pass?” That is my next task.

3 Questions with Easy Answers

Let’s start by looking at questions that are similar in form to our question but are easier to answer. Looking at the procedure we follow to answer them may shed light on how to answer the question we are interested in.

As a first example, consider the question

(1) How fast does the Acela Express train move between Boston and New York?

How do we go about finding the answer to (1)?

Before proceeding we should distinguish between two readings of (1). On one reading, maybe the most natural reading, (1) asks for the rate at which the train usually travels, ignoring the (all too frequent) days when freight train traffic or a power outage causes an extreme delay. But I want to focus instead on requests for the speed of a particular train on a particular journey—say, train 2151, the 5:30am from Boston to New York on February 2nd, 2009.

If we are interested in a particular journey by a particular train when we ask (1), then the procedure for answering (1) is obvious. We want the average rate at which the train moves during some interval of time, so we (i) find the train’s location in space at the beginning of that interval, (ii) its location in space at the end of the that interval, (iii) determine the spatial distance between those locations (or the spatial length of the path it traveled between those two locations), and (iv) divide this distance by the temporal length of that interval. If we measure distance in meters and time in seconds, then our answer will be some number of meters per second.

(1) is a request for a rate of *motion in space*. But there is no need for questions requesting rates to have anything to do with movement in space. For example:

(2) How fast does Joshua read *David Copperfield*?

In this case the thing that is moving is Joshua. But instead of asking about his motion through space, (2) asks about his “motion” through a book. I put “motion”

in scare quotes because it may not be literally correct to say that Joshua moves through the book. Maybe this is only a metaphorical kind of motion. Still, the procedure for answering (2) is almost the same as that for answering (1): we find Joshua's location *in the book* at the beginning and at the end of a given interval of time. Maybe he is on page 5 at the beginning of the interval and one page 30 at the end. Then we find the distance between these locations (25 pages) and divide by the temporal length of the interval. Our answer will be some number of pages per minute.

We have looked at how we go about finding the answer to a request for a rate of motion through space, and a request for a rate of "motion" through a book. Now I turn to our target question,

(3) How fast does time pass?

(3) is not obviously a request for a rate of motion through time, though (as we will see) several interpretations of it make it a request like that. So just what are we asking when we ask (3)? In the rest of this section I will describe three questions we might ask (or that some philosopher has taken us to be asking) by uttering (3). All three are, in this context, metaphysically uninteresting. Let me explain what I mean by saying that they are metaphysically uninteresting.

Opponents of objective becoming (usually) discuss the rate of the passage of time when they are giving an argument against objective becoming. In a paper about the rate of the passage of time, Ned Markosian [1993] proposes the following as one of the arguments they mean to give:⁶

⁶I have changed the name of the argument and the wording of the first premise. Markosian calls this argument "The Second Rate of Passage Argument." *Note added after publication:* This argument has appeared in many places. Markosian extracts it from Smart's paper "The River of Time," which appeared in 1949. But C. D. Broad had proposed it already in 1938 [Broad 1938: 277].

The Rate of Passage Argument:

- (P1) If the passage of time is a real phenomenon (that is, if there is objective becoming), then it makes sense to ask how fast time passes.
- (P2) If it makes sense to ask how fast time passes, then it is possible for there to be a coherent answer to this question.
- (P3) It is not possible for there to be a coherent answer to this question.
- (C) Therefore, the passage of time is not a real phenomenon.

A metaphysically interesting reading of (3) is a reading that is suitable for use in this argument. A metaphysically uninteresting reading is not. (That is just what I mean, in this paper, by “metaphysically uninteresting.” It may still be true that for other purposes the questions I will discuss should be of great interest to metaphysicians.)

Now, if a reading of (3) makes sense and has a coherent answer even if the B-theory is true, then that reading of (3) is metaphysically uninteresting. There are two reasons for this. First, if a reading of (3) makes sense even if the B-theory is true, then it fails to be a request for the rate of “objective becoming,” because there is no objective becoming in the B-theory. But (3) as it appears in the Rate of Passage Argument is supposed to be a request for the rate of objective becoming. And second, if (3) means something that makes sense and has a coherent answer even if the B-theory is true, then B-theorists will not be able to defend (P3), and so will not be able to defend the rate of passage argument. A meaning for (3) like that is not a good one to use in the argument. A metaphysically interesting reading of (3), by contrast, will presuppose that there is objective becoming, and so will not make sense in a theory (like the B-theory) which says there is no objective becoming.

The first metaphysically uninteresting reading of (3) I will discuss emerges from considering a passage in a paper by Tim Maudlin. Here is what he says about how (3) should be answered:

Let’s begin by considering the logic of rates of change. If something, e.g. a river, flows, then we can indeed ask how fast it flows (how many

miles per hour, relative to the banks). To ask how fast a river flows is to ask how far the water in it will have gone when a certain period of time has passed...

On this basis, if we ask how fast time flows, i.e. how fast time passes, we must mean to ask how the temporal state of things will have changed after a certain period of time has passed. In one hour's time, for example, how will my temporal position have changed? Clearly, I will be one hour further into the future, one hour closer to my death, one hour further from my birth. So time does indeed pass at the rate of one hour per hour... [Maudlin 2007: 112]

What Maudlin says in the first paragraph of this passage agrees with what I said above about question (1). I want to focus on the second paragraph, where he applies these lessons to answering (3). To answer (3) he proceeds as follows. Let us choose as our interval of time the interval between 10am and 11am this morning. Maudlin then finds his temporal location at the beginning and at the end of this interval. At 10am his temporal location is 10am (he says), and at 11am his temporal location is 11am. The temporal distance between these temporal locations is one hour. And the temporal length of this interval is one hour. "So," Maudlin writes, "time does indeed pass at the rate of one hour per hour."

Let us pause to look over what has happened. Look back at how we answered (1) and (2). To answer (1) we identified the Acela Express's location (in space) at two different times. To answer (2) we identified Joshua's location (in *David Copperfield*) at two different times. Maudlin has identified *his* location (in time) at two different times. So the question Maudlin is answering most directly is

(4) How fast does Tim Maudlin move into the future?

Indeed, the first rate Maudlin mentions in the quotation above is the rate at which he moves into the future. Only then does he conclude, "So time does indeed pass at the rate of one hour per hour." So Maudlin thinks that asking (3) is just a way to ask (4) (or to ask something like (4), perhaps with some name other than "Tim Maudlin.")

Doubtless some people do mean some (4)-like thing when they ask (3). But I do not think it is what opponents of objective becoming mean to ask. That is because (4) is metaphysically uninteresting. If Maudlin's answer to (4) is correct, both B-theorists and moving spotlight theorists should accept it.

(Well, *is* Maudlin's answer to (4) correct? There are a few difficulties. Let's think about what sentences like "At 10am my temporal location is 10am" mean. Look first at the spatial analogue. Suppose someone wants to know where I am currently located and I reply that in New York City my current spatial location is New York City while in Boston my current spatial location is Boston. This is either false or nonsensical. One diagnosis of what has gone wrong is that my answer mistakenly presupposes that spatial locations are had relative to spatial locations. But they are not. The correct answer to the question is that my current spatial location is Boston, *full stop*. Still, if we wanted to be charitable, there is a straightforward way to make sense of the "in [blank] my spatial location is..." phrase: treat "in [blank]" as entirely redundant. So since my current spatial location is Boston, it follows that in New York City my current spatial location is Boston (and similarly for any other relativization you might choose). We might suspect that similar remarks apply to "At 10am my temporal location is 10am." The idea would be that temporal locations are not had relative to times at all. I am temporally located at all times between my birth and my death, and those temporal locations are not had relative to times. If we insist on speaking as if they are had relative to times, then the relativizations are redundant: At 10am, 11am, any time you choose, I am still temporally located at all times between my birth and my death. If all this is correct then it is wrong to say that at 10am my temporal location is 10am, and at 11am it is 11am, and so it is wrong to say that I am moving into the future at all.

There is, however, one interpretation of "At 10am my temporal location is 10am" I have heard that avoids these complaints. On this interpretation the effect of "At 10am" is to restrict the domain of quantification to 10am. Then "At 10am my temporal location is 10am" means that, ignoring times other than 10am, my temporal location is 10am. And that is true.)

I have said now the main things I want to say about questions like (4). But (4) does seem to me to come up a lot, so it is worth mentioning another well-

known philosophical passage in which something like it occurs. The passage I am thinking of occurs in J. J. C. Smart's famous paper "The River of Time." Smart is an opponent of objective becoming, and the following passage contains some of the reasons why he does not believe in it (see also [Smart 1980: 4]):

Contrast the pseudo-question "how fast am I advancing through time?" or "How fast did time flow yesterday?". We do not know how we ought to set about answering it. What sort of measurements ought we to make? We do not even know the sort of units in which our answer should be expressed. "I am advancing through time at how many seconds per—" we might begin, and then we should have to stop. What could possibly fill the blank? Not "seconds" surely. [Smart 1949: 485]

There is a lot going on in this passage, but I want to focus on what happens at the very beginning. Like Maudlin, Smart identifies a question like (4) (the question he discusses has "I" (referring to Jack Smart) in place of "Tim Maudlin") with question (3). He then becomes mystified about how to go about answering (4). This is supposed to be his defense of (P3) in the rate of passage argument.

But we have seen (in the quotation from Maudlin) how to go about answering the question, How fast is Jack Smart advancing through time? And, again, raising this question does nothing to cast doubt on the reality of objective becoming, because the procedure for answering it is one that both believers and unbelievers can follow.

In other places it is Smart's opponent who seems confused, and Smart who seems to appreciate the distinction between metaphysically interesting and metaphysically uninteresting readings of (3). For example, as part of a defense of objective becoming A. N. Prior defended the intelligibility of questions similar to (4) (and (6) below) and claimed that they are easy to answer: after complaining "was it Smart who started this?", Prior writes, "How fast does one get older? Surely the answer to this question is obvious. I am now exactly a year older than I was a year ago....the rate of this change is one time-unit per time-unit" [Prior 1958: 244]. In a much later paper Smart refers to this passage, and replies: "It is true, as Prior points out, that after one second I have got older by a second. But equally one could say

that a ruler gets larger in a left to right direction (say) by one centimeter per centimeter. There is no notion of ‘flow’ or ‘passage’ here” [1980: 4]. The question Prior and Smart are discussing here is

(5) How fast does Arthur Prior get older?

Smart’s remarks suggest that he sees that (5) is metaphysically uninteresting: it makes sense and has a coherent answer even if the B-theory is correct. By answering (5), then, Prior has not responded to the rate of passage argument. For we are to understand “How fast does time pass?,” as it is asked in that argument, to have a metaphysically interesting interpretation.

(4) is one metaphysically uninteresting precisification of (3). I want now to discuss two more metaphysically uninteresting precisifications.

One of them can be dealt with quickly. We might note that one hour from now, one hour will have elapsed, and conclude on this basis that time passes at the rate of one hour per hour. Then we are understanding (3) as

(6) How much later will it be one hour from now?

(Of course, (3) and (6) do not have answers with the same form: an answer to (3) is a rate, while an answer to (6) is just some amount of time. But to present (6) together with its answer is to present a rate, so I still count it as a precisification of (3).)

B-theorists and moving spotlight theorists alike will accept that (6) is intelligible, that “one hour” is the correct answer, and so that (in this sense) time passes at a rate of one hour per hour.

The third precisification of (3) that I want to discuss will require a little more stage-setting. Not all questions that begin “How fast...” are requests for a rate of change with respect to time—at least not directly. For example, one might look at an illustration of the decomposition of light into different wavelengths, with redder, longer wavelength light on the left, and more violet, shorter wavelength light on the right. Focusing on this variation of wavelength in space one might ask,

(7) How fast does the wavelength change?

This is a sensible question, and the answer may take the form: so many nanometers per centimeter. So here we have asked about the rate of change of a quantity (wavelength) with respect to spatial distance, rather than with respect to time.

(Of course it is possible to understand (7) by implicitly thinking in temporal terms: if one were moving from left to right along the page at a rate of one centimeter per second, how fast would one see the wavelength change? But I don't think we need to do this to understand (7). Also, one might insist that the spatial variation in wavelength in this example is not *genuine change*, and so "change" as it appears in (7) must be used in an extended, analogical sense. That is fine (and I will return to this point below); it is enough for now that (7) does make sense when "change" has this extended meaning.)

This example points the way to another way to understand (3). We can understand it as a request for a rate with respect to some non-temporal dimension. We answer the question by identifying two events involving some particular thing (me, say), finding the temporal distance between those two events, and dividing that distance by the distance along some dimension other than time. For example, we might ask

(8) How fast does time pass (with respect to distance run by Skow)?

Or, better, we might ask the more specific question,

(8') How fast did time pass this morning (with respect to distance run by Skow)?

This morning I went for a seven mile run. So to answer the question we first identify the time at which my run began (8am) and the time at which my run finished (9am). We then divide the temporal distance between these times (one hour) by the (spatial) distance run. We conclude that this morning time passed at a rate of 1/7 of an hour per mile run by Skow.⁷

⁷I have been asked: if tomorrow I run 8 miles in an hour, will that be because I will be running faster tomorrow than I did today, or because time will be passing more slowly tomorrow than it did today? On the present way of understanding our question, the answer is "both." That may sound odd; but since this rate is not a rate of objective becoming, it should not worry us.

This all makes perfect sense: (8') is a perfectly legitimate question and this is the obvious answer. And maybe (8) and (8') are more interesting than (4) or (7), since the answer to them is not guaranteed to be "one." But neither (8) nor (8') can be what opponents of objective becoming mean to ask. For even B-theorists would accept that these questions make sense and have obvious answers.

In a well-known paper Ned Markosian [1993] claims that (8) is a reading of (3) and that (8) is an intelligible question. He does this to show that believers in objective becoming can reject (P3) in the rate of passage argument.⁸ But I have said that (8) is metaphysically uninteresting. So the fact that (8) has a coherent answer cannot help believers in objective becoming respond to the rate of passage argument.

So it may look like I think that Markosian has confused a metaphysically uninteresting question with a metaphysically interesting one. But I do not think that what I have said applies directly to Markosian's discussion. Markosian thinks that when I say that I ran at a rate of seven miles per hour this morning, I have given my rate of motion with respect to the "pure passage of time." If that is what I have done, then an answer to (8') gives the rate of the "pure passage of time" with respect to distance run by Skow. But then this is not the same answer to (8') that B-theorists will give, since B-theorists do not believe in the pure passage of time, and so certainly do not think that there is some fact about the rate at which I ran this morning, measured with respect to the pure passage of time.

So it seems to me that Markosian and I understand (8') differently. I understand it so that the procedure described above on page 11 is the correct procedure for answering it. That is a procedure that does not presuppose that there is objective becoming, or the "pure passage of time." Markosian must understand it so that that procedure is not the correct procedure for answering it. So as far as I can tell, Markosian understands (8') in such a way that it is a metaphysically interesting question. If Markosian is right that (8') has a coherent answer when understood in this way, then believers in objective becoming can use what he says as a basis for re-

⁸Markosian's defense of objective becoming is actually more subtle. He does not endorse the response I have discussed. Instead he includes it in a list of several possible responses, and does not choose one of them as his preferred response.

jecting (P3) of the rate of passage argument. (I must admit that I do not have a firm grip on just how Markosian understands (8'). So while I think that (some) moving spotlight theorists can reject (P3) of the rate of passage argument, the grounds I will give for that rejection are different from Markosian's.)

That completes my discussion of three precisifications of (3) that make it a metaphysically uninteresting question. It is time to look at a precisification that makes it metaphysically interesting.

4 Two Versions of the Moving Spotlight Theory

My goal in this second half of the paper is to look at what the moving spotlight theory can say about how fast time passes. But before I can address this topic, I need to develop the moving spotlight theory in more detail.

The moving spotlight theory says that the NOW moves into the future. How is this part of the theory to be understood? There are several ways to develop the theory from here.

One approach is to introduce a new dimension that is similar to but distinct from time: supertime (or, as some authors call it, hypertime). This is **the moving spotlight theory with supertime** (MST-ST). Supertime is made up of infinitely many points, and there is a definite *supertemporal distance* between any two points. The distances between points in supertime make it isomorphic to the real line. Supertime and time both also have a geometrically preferred direction: the future directions in supertime and in time.

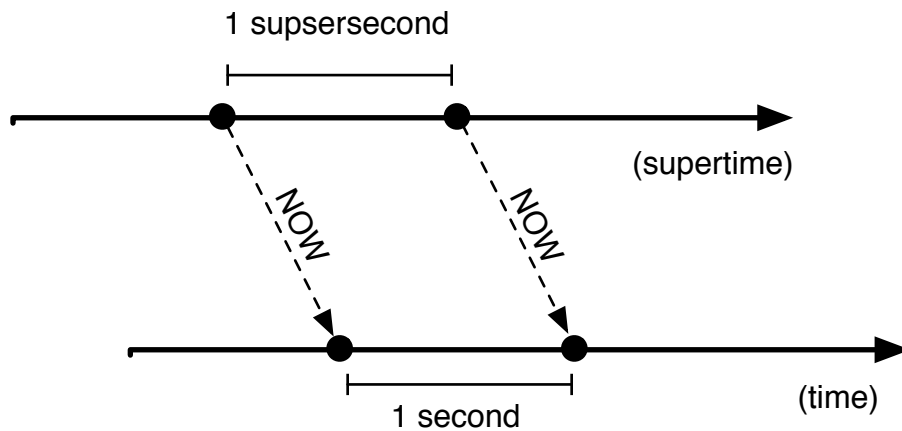
Supertime allows us to make sense of the motion of the NOW. No time is NOW "absolutely"; instead, a time is NOW only relative to a point in supertime. In more detail, the theory works like this. Relative to each point in supertime, exactly one instant of time is NOW. And there is a connection between the supertemporal distances between points in supertime and the temporal distances between the times that are NOW relative to those points:

(*) If t_1 is NOW relative to s_1 , and s_2 is r units of supertime later than s_1 , then the time r units of time later than t_1 is NOW relative to s_2 .⁹

⁹ Strictly speaking, distance in supertime and distance in time are incommen-

On this theory, then, to say that the NOW moves into the future is to say that at later points in supertime, later instants of time are NOW. Figure 1 contains a diagram of the picture of reality that goes with MST-ST.

Figure 1: MST-ST



That is one way to develop the moving spotlight theory. There are a few well-known problems with it. First, accepting it means believing in supertime; and that can seem ontologically extravagant. Second, one might complain that the objective becoming that the moving spotlight theory is supposed to capture does not appear in this theory. We have seen what it means, on this theory, to say that the NOW is surable on this theory. So saying that the temporal distance between t_1 and t_2 is equal to the supertemporal distance between s_1 and s_2 is like saying that my height is equal to my age. (Both are nonsense.) For simplicity I ignore this problem in the text. One way to solve the problem is to pick special units: even though it makes no sense to say that my height is equal to my age, it does make sense to say that my height *in meters* is equal to my age *in decades*. So we could say that (*) is true when supertemporal distances are specified in superseconds and temporal distances in seconds. That is how I will understand (*).

(A similar solution that does not depend on any particular unit of measurement is to state (*) using distance ratios rather than distances. These ratios are dimensionless—the same no matter what units we use to measure distances in time and supertime.)

moves into the future. But is what this theory says anything that an opponent of objective becoming would object to? In particular, why isn't this theory just a version of the B-theory with two time dimensions? The ordinary B-theory says that spatiotemporal reality is a four-dimensional "block universe" (one time dimension, three spatial dimensions); but this theory just says that spatiotemporal reality is a five-dimensional block universe (two time dimensions), and the moving spotlight is just a diagonal streak on the block.

I will not try to evaluate this complaint. To do that I would need precise criteria for distinguishing theories that incorporate objective becoming from theories that do not. But I have no such criteria. (The notion of objective becoming is, as I said, obscure.) Instead, I will present a version of the moving spotlight theory to which this complaint does not apply. This version does not postulate supertime; it is **the moving spotlight theory with primitive tense operators** (MST-PT). This version uses primitive tense operators to do the work that supertime does. When we develop the theory this way, we do not say that which time is NOW is a relative matter. Exactly one time is NOW, full-stop, not relative to a point in supertime or anything else. The property of being NOW is a fundamental, monadic property of instants of time. But even though only one time is NOW, it *will be the case that* a later time is NOW; and *it was the case that* an earlier time is NOW. That is what it is for the NOW to move into the future.

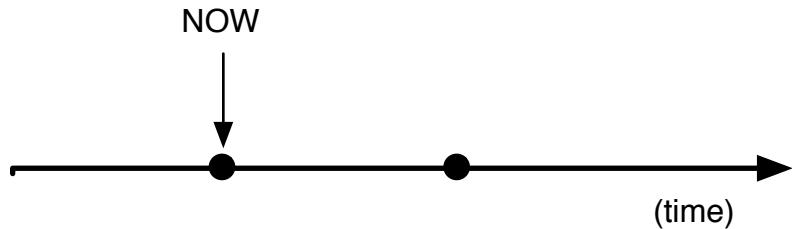
Let me go through this a little more carefully. The primitive tense operators in this theory are actually metric operators. For every positive real number r there are primitive tense operators "It will be the case that in r superseconds..." and "It was the case r superseconds ago that..." (You might wonder why "superseconds" appears in the tense operators, rather than (say) "seconds." I will address this question in due course.) A precise statement of the theory, then, is this:

- (a) It is always the case that (exactly one time is NOW). That is:
- Exactly one time is NOW.
 - For each positive r , it will be the case in r superseconds that (exactly one time is NOW).

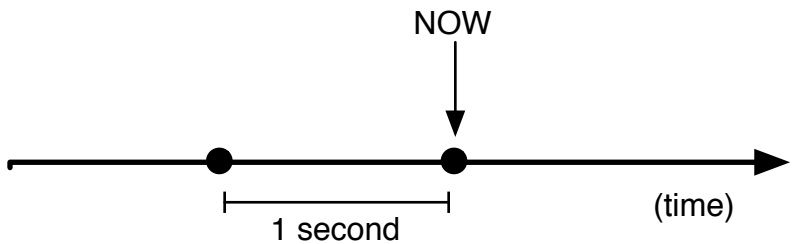
- For each positive r , it was the case r superseconds ago that (exactly one time is NOW).
- (b) For each positive r , the instant t that is r seconds later than the time that is NOW is such that: it will be the case in r superseconds that t is NOW.
- (c) For each positive r , the instant t that is r seconds earlier than the time that is NOW is such that: it was the case r superseconds ago that t is NOW.

It is claim (b) that entails that the NOW moves into the future. (Claim (c) says that the NOW arrived from the past.) Figure 2 contains a diagram of the picture of reality that goes with MST-PT.

Figure 2: MST-PT



It will be in 1 supersecond that...



The metric tense operators in this theory are primitive. Of course, if you believe in supertime, you can analyze them: “It will be the case that p ” means “At a

future point in supertime, p .” But if we adopt this analysis, MST-PT collapses into MST-ST.

Smart complained that if we say that time flows (that is, if we say that the NOW moves into the future) “we are postulating a second time-scale with respect to which the flow of events along the first time-dimension is measured....we will want to think of the second time-dimension as a stream also; now the speed of flow of the second stream is a rate of change with respect to a third time-dimension, and so on” [1949: 484]. But he is wrong about this. MST-PT does not postulate a second time-scale (supertime). Instead it uses primitive tense operators. Since there is no second time-scale (no supertime), we do not need to think of supertime as passing, we do not need to ask how fast supertime passes, and we are not stuck in a cycle of postulating ever more and more time-like dimensions.

I said that some might complain that MST-ST fails to incorporate objective becoming. Although I am not sure exactly what a theory must do to incorporate objective becoming, MST-PT seems less subject to this complaint. This is because it uses primitive tense operators. Deniers of objective becoming typically refuse to use primitive tense operators in their fundamental metaphysical theory.

5 Rate of Passage in the Moving Spotlight Theory

We are now in a position to see what the moving spotlight theory says about how fast time passes. Although I said that MST-PT is the superior version, I will start by looking at what MST-ST says.

When someone asks “How fast does time pass?” in an attempt to embarrass the moving spotlight theorist, he means to be asking

- (9) How fast does the NOW move into the future?

Unlike the previous interpretations of (3) we have looked at, this interpretation is only available to the moving spotlight theorist. So it is a metaphysically interesting question. (9) identifies the thing that is moving: the NOW. And it identifies the dimension along which it is moving: time. But (9) does not explicitly say whether we are asking about its change in temporal location with respect to time, or with respect to supertime. This makes a difference.

If we want to know how fast *in time* the NOW is moving into the future, then the question has a false presupposition. The false presupposition is that the NOW is located at different times relative to different times. (Remember that in order to answer (9) when it is a request for a rate with respect to time we need to identify the NOW's temporal location at two different times, and then divide by the temporal distance between those times.) But (relative to any particular point in supertime) the NOW is located at only one time. In this way the NOW is very different from you, or me, or Professor Smart: we *are* located at many different times. So while we can sensibly ask about the temporal distance between our various temporal locations, we cannot sensibly ask this question about the NOW. Understood as a request for a rate with respect to time, then, (9) has no answer in MST-ST. (For the same reason, it has no answer in MST-PT either.) It is as if during a strange physics experiment we managed to create a new fundamental particle that existed for just one instant, and then asked: how fast was that particle moving into the future? It wasn't moving into the future at all: it was temporally located at just one time.

On the other hand, if we want to know how fast *in supertime* the NOW is moving into the future, then the answer is easy to figure out. We pick two points in supertime, s_1 and s_2 , identify the NOW's temporal location relative to each of them, and divide the temporal distance between these times by the supertemporal distance between s_1 and s_2 . It follows immediately from (*) that the answer generated by this procedure will be the same no matter which s_1 and s_2 we choose: one second per supersecond.

(Of course, if we choose different units for measuring distance in supertime, the rate we get for the motion of the NOW will be different; but no matter what units we choose we will get a constant rate.¹⁰)

That is what MST-ST says about how fast time passes. The story is similar in MST-PT. Again, the NOW does not change its temporal location with respect to time. But (the theory says) it will be the case in one supersecond that the NOW is

¹⁰If we formulate (*) along the lines mentioned in footnote 9, then it will not follow from (*) that the answer is "one second per supersecond." In that case, the NOW's rate in seconds per supersecond will depend on just how we define "supersecond." But however we define it, its rate of motion will be constant.

located one second later. So the NOW moves at one second per supersecond. Question (9), then, has a coherent answer on the moving spotlight theory. So moving spotlight theorists can reject (P3) of the rate of passage argument.

(Perhaps it is worth nothing here that moving spotlight theorists are not compelled to formulate their theory so that the NOW moves at one second per supersecond. This is not the only possible answer they could give to (9). That the NOW moves at one second per supersecond follows from (*) in MST-ST and from claims (b) and (c) in MST-PT; but it would be easy to re-write these claims so that the rate was anything one wished. These alternative versions, with alternative rates of passage, are perfectly consistent.

Smart once observed that “it is a peculiar thing to say that [the NOW] moves if there is no logical possibility of [the NOW’s] not moving” [1953: 184]. He thinks he has found a disanalogy between the motion of the NOW in time and the motion of ordinary things (like jet planes) in space. It is logically necessary that the NOW move; not so for jet planes. The implicit suggestion is that the disanalogy shows that it cannot be literally true that the NOW moves in time. But what Smart says here does not apply to the moving spotlight theory as I have presented it. One could formulate the theory so that the NOW sped up, slowed down, and (occasionally) stopped. Logic alone does not force moving spotlight theorists to say that the NOW always moves.)

6 Some Questions about the Moving Spotlight Theory

So, no problem. The moving spotlight theory appears to have no difficulty with the question, “how fast does time pass?” But meditating on what the theory says about the rate of time’s passage does raise some additional questions.

One question that may have been nagging at you about MST-PT for a while is, why does “superseconds” appear in the theory’s primitive tense operators? This question points to two objections to the moving spotlight theory as I have formulated it.

The first objection applies to *any* theory that uses metric tense operators. These tense operators are part of the fundamental language for describing reality.

And surely the fundamental language should not make use of a particular unit of measurement, like the supersecond.

(Interestingly, MST-ST does not have this problem. According to MST-ST, there are distances in supertime, and the supersecond is a conventional unit for measuring those distances. So superseconds do not come in at a fundamental level on that theory any more than meters appear in a fundamental account of the geometry of space. (The principle (*) connecting distances in time and in supertime can be stated without using any particular unit of measurement; see footnote 9.))

There is a way to formulate the moving spotlight theory with primitive tense operators to avoid this objection. This is **the moving spotlight theory with non-metric primitive tense operators** (MST-NMPT). This theory makes do just with the operators “It will be the case that...” and “It was the case that...” The analogues of claims (a), (b), and (c) above (which are part of MST-PT) are more complicated on this version. They look like this:

(A.1) Exactly one time is NOW.

(A.2) It is not the case that (it will be the case that (either no time is NOW or more than one time is NOW)).¹¹

(A.3) It is not the case that (it was the case that (either no time is NOW or more than one time is NOW)).

(B) If $t1$ is later than NOW, and $t2$ is later than $t1$, then it will be the case that ($t1$ is NOW and it will be the case that ($t2$ is NOW)).

(C) If $t1$ is earlier than NOW, and $t2$ is earlier than $t1$, then it was the case that ($t1$ is NOW and it was the case that ($t2$ is NOW)).

¹¹It is not enough to say that it will be the case that (exactly one time is NOW). Intuitively, that only forces there to be one future point in supertime at which exactly one time is NOW. We want to force it to be the case that at every future point in supertime, exactly one time is NOW. (Of course, the tense operators are not to be understood as quantifiers over points in supertime; the supertime talk here is just an aid to understanding.)

If you want to believe in objective becoming but do not think that “superseconds” may appear in primitive tense operators, then you should take this theory seriously. One feature of this theory is particularly interesting. MST-NMPT says that the NOW moves into the future. But in this theory it does not make sense to ask “*How fast* does the NOW move?” (Although the theory says that the NOW will be at a later time, it does not say anything about how long it will take to get there.) It seems to be a common opinion among philosophers that the first premise (P1) of the rate of passage argument (if time passes, it makes sense to ask how fast it passes) is true. The existence of MST-NMPT shows that opinion to be false. Believers in MST-NMPT can respond to that argument by rejecting (P1).¹²

Let us now return to the question that started this discussion: why does “superseconds” appear in MST-PT’s primitive tense operators? I said that this question pointed toward two objections to that theory. I turn now to the second one.

Some may not be worried that a (name for a) unit of measurement—the supersecond—appears in the primitive tense operators. They may be worried, instead, that the *wrong* unit of measurement appears. Shouldn’t “seconds,” rather than “superseconds,” appear in them?

Well, should they? I can think of a couple of reasons one might have for preferring a theory that uses seconds rather than superseconds. “Supersecond” was originally introduced as a name for a unit measuring distances in supertime. But in this theory there is no such thing as supertime. So it is not clear that “supersecond” has any meaning at all.

And there is another problem, even if you are not worried about what “supersecond” means. Although “one second per supersecond” is a genuine *rate* (it is a ratio of two quantities), one might argue that it is not a genuine rate of *motion*. (Smart [1980: 4] makes a complaint like this.) Maybe, the worry goes, it is an analytic truth that a rate of motion is given with respect to time. (This is connected to the complaint that “change” as it appears in (7) is being used in an analogical sense.)

I myself do not think that the second of these reasons is very good. Moving

¹²Markosian [1993] proposes alternative grounds on which a believer in objective becoming may reject (P1).

spotlight theorists should just reject the claim that only variation in time is genuine change. In the moving spotlight theory with supertime this is obvious: it is part of the theory that both dimensions (time and supertime) are needed to capture all the ways in which the world changes. The same goes in the version of the theory with primitive tense operators: we need both time and the tense operators to capture all the ways in which the world changes.

In fact, that the NOW moves at one second per supersecond may be a virtue of this theory rather than a vice. Some philosophers have argued that one second per second is not a rate at all. They claim that $1 \text{ sec} / \text{sec} = 1$, since the “units cancel.” But 1 cannot be the rate of anything, and so certainly cannot be the rate at which time passes.¹³ Even if this conclusion is correct (and I will argue below that it is not), is it no objection to MST-PT. MST-PT does not say that time passes at one second per second.

What does this all add up to? I have looked at two reasons to think that the moving spotlight theory should use “seconds” in its primitive tense operators. I do not think that the second reason, that one second per supersecond is not a rate of change, is a good one. I am not sure what to think about the first reason—that “supersecond” is meaningless. So maybe it is worth thinking more about what a theory that uses “seconds” looks like.

This will be a second version of the moving spotlight theory with primitive metric tense operators; so I call it “MST-PT-2.” We know what MST-PT-2 should say. We take (a), (b), and (c) and replace “superseconds” everywhere with “seconds”:

(a') It is always the case that (exactly one time is NOW). (That is: exactly one time is NOW; for each positive r , it will be the case in r seconds that (exactly one time is NOW); and for each positive r , it was the case r seconds ago that (exactly one time is NOW).)

(b') For each positive r , the instant t that is r seconds later than the time that is NOW is such that: it will be the case in r seconds that t is NOW.

¹³See [Price 1996: 12-16]; [Olson 2009]; and [Van Inwagen 2002: 59].

(c') For each positive r , the instant t that is r seconds earlier than the time that is NOW is such that: it was be the case r seconds ago that t is NOW.

The picture of reality that goes with MST-PT-2 is almost the same as the picture that goes with MST-PT (see figure 2)—just change “superseconds” everywhere to “seconds.”

I have to admit, though, that I have trouble understanding MST-PT-2—especially claims (b') and (c'). The problem is the mirror image of the problem for MST-PT. If that theory is in trouble because “superseconds” has no meaning, MST-PT-2 is in trouble because “seconds” *already* has a meaning. Consider the time t five seconds to the future of the NOW. Time t is not NOW. But (MST-PT-2 says) it will be the case in five seconds that t is NOW. I find it hard to wrap my mind around the idea that the way things will be in five seconds is not completely exhausted by what the things are like at the time five seconds in the future.

A proponent of MST-PT-2 might respond by emphasizing that the tense operators in MST-PT-2 are *primitive* tense operators that cannot be analyzed in terms of quantifiers over times. “It will be the case in five seconds that P ,” we are reminded, does *not* mean the same in this theory as (or have the same truth conditions as¹⁴) “At the time five seconds after t , P ” (where t names the time of the utterance). But I do not think that this helps. It is fine to say that tense is primitive in your theory. But that is not enough for it to be legitimate to use “seconds” in your primitive tense operators.

So there is an obstacle that stands in the way of understanding MST-PT-2. But I think I have found a way around it. What I will do next is offer a way to make sense of MST-PT-2. I should say at the outset, though, that I am not convinced that what I am about to say succeeds in its aim. I offer it tentatively, in a spirit of metaphysical exploration.

¹⁴Ever since Kaplan’s work in semantics, B-theorists have stopped defending the claim that “It will be the case in five seconds that P ” is *synonymous* with “At the time five seconds after t , P ” (where t names the time of the utterance). They say instead that in any context these two sentences express the same proposition. (See the papers in [Oaklander and Smith 1994].) That is what I mean by “have the same truth-conditions.”

The first step is to look back at MST-ST and MST-PT, and the relationship between them, for guidance. What does MST-ST add to the B-theory? Two things: supertime, and the relation *t is NOW relative to s* (where *t* is a time and *s* a point in supertime). And MST-PT uses primitive tense operators and the (monadic) property *t is NOW* to do the work that supertime and *t is NOW relative to s* do in MST-ST.

Now the primitive tense operators in MST-PT-2 do *not* do the work that supertime does in MST-ST. That is because MST-PT-2 uses “seconds” rather than “superseconds.” This suggests a way to understand MST-PT-2: understand it to stand to some (as yet unstated) theory in just the way that MST-PT stands to MST-ST.

I shall now describe the theory we need: **the moving spotlight theory with time-as-supertime** (MST-TST). What work does supertime do in MST-ST? We want the NOW to move, and (to put it in neutral terminology) in order to move in time the NOW needed to be located at different times relative to different “indices.” In MST-ST, points in supertime played the role of these indices. But in MST-TST points in supertime do not play this role. (There are no points of supertime in MST-TST.) Instead of moving up a level to supertime, in MST-TST time itself plays this role.

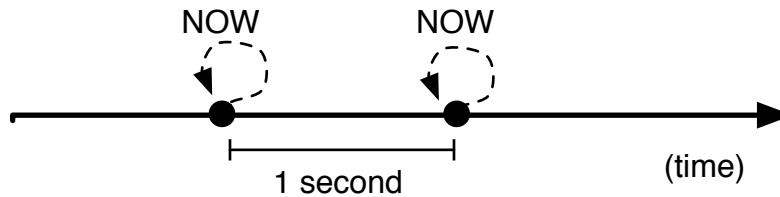
So in MST-TST time will play the role of supertime. We also need something to play the role of the relation *t is NOW relative to s*. In this theory that role is played by a new relation, *x is NOW relative to y* (which is instantiated by pairs of times). MST-TST makes the following claims about this relation:

- (i) Each time bears *x is NOW relative to y* to exactly one time: itself.
- (ii) The relation *x is NOW relative to y* is not identical to the relation *x and y are simultaneous*.

Figure 3 contains a diagram of the picture of reality associated with this theory.

I will need to say something about item (ii). But first let me finish the story I am telling. In MST-TST, when we ask how fast time passes, we can be asking how fast the NOW moves with respect to time. Since the NOW’s location relative to the time *t* one second in the future is *t* itself, the NOW moves at one second per second.

Figure 3: MST-TST



MST-TST, of course, can be accused of failing to genuinely incorporate objective becoming for the same reasons that MST-ST can. But I will not pause to evaluate this accusation, because I am not interested in MST-TST for its own sake. I am interested in MST-TST because I think it might help us understand MST-PT-2.

To wrap up explaining how it might help: just as the tense operators (with “superseconds”) and the property *t is NOW* in MST-PT play the role played by supertime and *t is NOW relative to s* in MST-ST, the tense operators (with “seconds”) and the property *t is NOW* in MST-PT-2 play the role played by time and *x is NOW relative to y* in MST-TST.

Whether looking at MST-TST helps make MST-PT-2 intelligible depends (in part) on whether MST-TST is itself intelligible. The biggest obstacle it faces is resistance to claim (ii). The theory says that the relations *x is NOW relative to y* and *x and y are simultaneous* are distinct. Now, these relations are certainly distinct if it is possible that some time is not NOW relative to itself. For each time is necessarily simultaneous only with itself. And this possibility is consistent with MST-TST as stated. Clause (i) of the theory says only that each time is in fact NOW relative to itself, not that this is necessarily the case.

But we may not want MST-TST to admit these possibilities. Can we defend (ii) even if we say that *x is NOW relative to y* and *x and y are simultaneous* are necessarily coinstantiated? Anyone who denies that there are distinct but necessarily coinstantiated relations will think that MST-TST is inconsistent. But there are grounds for thinking that there are (or can be) relations that are distinct but necessarily coinstantiated. Kit Fine [1994] has argued that individuals have “real

definitions.” An individual’s real definition says what that individual is. And he has argued that it does not follow from the fact that I have some property P necessarily that it is definitional of me that I have P . As a motivating example, he asks us to consider Socrates and the set {Socrates}. It is necessary that Socrates is a member of {Socrates}, and (so) also necessary that {Socrates} has Socrates as a member. There is a symmetry in which properties each has necessarily. But there is an asymmetry in their real definitions: while it is definitional of {Socrates} that it contain Socrates, it is not definitional of Socrates that he be a member of {Socrates}.

We can say something similar on behalf of MST-TST. Like individuals, properties and relations have real definitions. The relations x and y are simultaneous and x is NOW relative to y are distinct because they have distinct real definitions. It is definitional of x and y are simultaneous that each time bears this relation only to itself. But this is not definitional of x is NOW relative to y .

Suppose that everything is in order with MST-TST. Does reflecting on it succeed in dispelling doubts about the intelligibility of MST-PT-2? For myself, sometimes it does, but at other times the doubts continue to linger.

There is one final thing I would like to say about MST-TST and MST-PT-2. These theories say that the NOW moves into the future at a rate of one second per second. But I mentioned earlier an argument that one second per second is not a rate. If that argument is sound, then something is wrong with these versions of the moving spotlight theory. But I do not think that the argument is sound. I will use an example to help explain my reasons for thinking this.¹⁵

Suppose some sociologists become interested in the distribution of age in the population. They gather a lot of data, and start tracking a new quantity: the most common birth year. They look at the birth years of all the people in the United States and find which birth year is most common. They might find, for example, that in 2009 the most common birth year was 1950.

Which year is the most common birth year changes, of course. After gathering their data the sociologists might then become interested in the rate at which the most common birth year (“the MCB” for short) is moving into the future. Suppose they find that in the 1990s the MCB was moving at a rate of one year per year; but in

¹⁵See [Maudlin 2007] for a different response to this argument.

the first decade of the new century the mortality rate among older people increased, and as a result the MCB moved faster, at two years per year. (We could suppose that they found that the MCB was 1945 in 1995, and 1946 in 1996; by 2000 the MCB was 1950, but in 2001 it was 1952.)

Now if “units cancel” and if numbers cannot be rates, then what these sociologists are saying is nonsense. For then when they say that the rate at which the MCB moves into the future is two years per year they are just saying that the rate at which the MCB moves into the future is two, and two is not a rate. But I think it is clear that what these sociologists are saying is not nonsense. For the same reason, I think it is clear that what moving spotlight theorists are saying is not nonsense either.

It might help to make the analogy between the what the sociologists are doing and what moving spotlight theorists are doing explicit. To explain the analogy I will look at MST-TST. First I will re-describe what the sociologists are doing in a more abstract and more awkward way (but a way that is more illuminating for our purposes). The sociologists are interested in a relation between years: the relation is *x is the most common birth year in y*. Call this relation “*R*.” Suppose that year *Y1* bears *R* to year *Y2*. Then the sociologists want to know: how many years are there between *Y1* and the year that bears *R* to the year that follows *Y2*? They express their answer by saying that the MCB moves at a rate of so many years per year.

When we talk about the rate of the NOW’s motion in MST-TST we are doing an exactly analogous thing. We are interested in a relation between times: *x is NOW relative to y*. Call this relation “*S*.” Suppose that time *t1* bears *S* to time *t2*. We want to know: how many seconds are there between *t1* and the time that bears *S* to the time that is one second after *t2*? We express our answer by saying that the NOW moves at a rate of one second per second.

The only difference between what the sociologists are doing and what the moving spotlight theorists are doing is that the relation the moving spotlight theorists are interested in is a fundamental relation while the relation the sociologists are interested in is not. But I do not see how this difference could be used to show that the sociologists are making sense while the moving spotlight theorists are not. I conclude, therefore, that I have not been speaking nonsense when I said that in

MST-TST and MST-PT-2 the NOW moves at one second per second.

7 Conclusion

The question “How fast does time pass?” can mean many things. Under some interpretations, this question is not very interesting or very hard to answer. Under other interpretations, it is supposed to present a challenge to the moving spotlight theory. I have investigated just what challenge it poses. MS-NMPT says that this question does not make sense, and so the question poses no challenge to it. MST-PT, on the other hand, says that time passes at one second per supersecond. But the appearance of “supersecond” in this theory’s primitive tense operators is a problem. I concluded by examining a fourth version of the moving spotlight theory, MST-PT-2. This theory says that the NOW moves into the future at a rate of one second per second. I am not sure I fully understand this theory, but I suggested that reflecting on MST-TST might help make MST-PT-2 intelligible.¹⁶

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