

Essay Review of *What Makes Time Special?*, by Craig Callender. Oxford: Oxford University Press (2017). Cloth, xx+343pp.

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From the perspective of the future development of the philosophy of time, Craig Callender's truly excellent *What Makes Time Special* is almost certainly the most important book to be published in decades. Ambitious, broad, and extremely erudite, the book provides as compelling an answer as seems possible, given the current state of science, to a question that he attributes to Carnap: can we explain the "peculiarities of man's experiences with respect to time" through a combined inquiry into the structure of time within our best physical theories and empirical psychology?

This is a deeply important project. It is also a valuable corrective in a literature that has too long pursued theories of time that either recommend changes to physical theory based on intuitive (or, perhaps better, "folk") conceptions of what time is like without first exploring either the cognitive and psychological bases for those conceptions; or else, as Callender argues in the penultimate chapter, wall themselves off from empirical science so thoroughly that they become explanatorily inert.

The book has roughly three parts. The first part, consisting of Chapters 1 through 5, sets up the primary tension of the book, which is what Callender calls the "two times" problem, in analogy with Eddington's famous "two tables" problem. On the one hand, we have what Callender calls "manifest time", which is time as we conceive of it in everyday life. Callender introduces manifest time in Chapter 1, taking special care to separate various aspects of temporal language and culture that might be thought to influence how some people think of or talk about time from a small handful of features of temporal experience that he argues are universal and characteristic of manifest time. He isolates three such features: (1) the existence of a distinguished, common "now" shared across all people (and, arguably, extending to distant regions of the universe); (2) that time "flows", i.e., that future events inexorably become present and then past; and (3) that there is an asymmetry between past and future, in the sense that the future is "open" but the past is not.

On the other hand, we have physical time. As Callender explores with wonderful depth and insight, contemporary theories of physics do not seem to invoke, require, or even accommodate anything quite like manifest time; and yet nonetheless, our immediate experiences of time seem to be universal and strongly felt, and the temporal concepts that we use to organize and navigate our lives are apparently successful. Chapters 2, 3, 4, and 5, explore whether one can identify a structure with the features of manifest time in various physical theories, including Newtonian gravitation (Chapter 2), relativity theory (Chapters 2 and 3), quantum mechanics (Chapter 4), or quantum gravity (Chapter 5). Callender concludes that none of these theories seem to offer up anything that quite fits the bill—and that some theories, such as relativity theory and some formulations of quantum gravity, seem outright hostile to manifest time.

Many, but by no means all, of the arguments in these chapters (especially Chapters 2 and 4) will be familiar from classic debates in the literature, and some others will be familiar to readers of Callender's previous work. But no one has put them all together in this way. Moreover, some of the classic arguments look different from the perspective that Callender adopts. For instance, he discusses the famous Putnam-Rietdijk argument that special relativity implies that *future events are determinate*

("real") in a sense that prohibits any notion of "becoming" (Rietdijk 1966; Putnam 1967); and he discusses the almost-equally-famous response by Stein (1968). For Callender's purposes, the key issue in this debate is whether one can define, within special relativity, anything with the structure of manifest time (he argues you cannot, citing a result due to Malament (1977)). This framing (and thesis) is different from what Stein at least – and likely also Putnam and Rietdijk – took to be at issue in the debate, and it highlights a distinctive feature of Callender's approach. Callender is not attempting to distill answers to metaphysical questions from our best physical theories, much less provide a systematic, physics-inspired metaphysics. Rather, his purpose is to understand whether manifest time is to be found somewhere in physics. This has metaphysical consequences downstream, but it is a different kind of consideration from the one that seems to motivate Putnam and many others.

The result is something more than the sum of its parts: indeed, one begins to wonder, reading these arguments in succession, what it would take to represent anything like manifest time within a physical theory—much less to do so in a way that somehow "directly" explains our experience.

Before moving on: there are occasional technical infelicities throughout these chapters, most of which are minor and have no significance at all for the cogency of Callender's arguments. One, however, deserves brief note, even though its overall importance to the arguments of the book is small. It concerns Callender's remarks about the "geometrized" reformulation of Newtonian gravitation known as Newton-Cartan theory. This theory is one in which space-time is "curved" in a sense strongly analogous to general relativity, and that curvature is related to the distribution of mass throughout space and time, also much as in general relativity.

In Section 2.1.3 of the book, Callender claims that on this formulation of Newtonian gravitation, unlike in the standard formulation, the "duration" between non-simultaneous events depends in some sense on the distribution of matter, and thus that time, or at least the behavior of ideal clocks, cannot be "absolute" in the sense of being "independent of the contingent matter distribution" (p. 42). Thus, he concludes, "Classical physics' relationship with manifest time may not have been as rosy as is sometimes thought" (ibid). This claim seems to be based on an error about Newton-Cartan theory. Although it is true that the curvature of space-time depends on the distribution of mass in Newton-Cartan theory, the *metric* structure of space-time, including, in particular, the temporal metric, which encodes facts about duration between events, does not depend on the distribution of mass. The situation concerning "the rate at which Newton's time flows" in Newton-Cartan theory is no different from that in any other formulation of Newton's theory that Callender discusses.

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The second part, consisting of Chapters 6, 7, and 8, raises a question that has received little attention in the recent literature (though as Callender observes, it was once a mainstay): What makes time different from space? In many ways, this question is orthogonal to the main theme of the book, concerning the two times problem; readers focused on just that problem might even consider skipping these chapters on a first read-through—though they absolutely deserve serious attention and study in their own right.

Chapter 6 discusses how Callender's own approach to this question – which is to look at differences between time and space *within* our physical theories – differs from how this question has been addressed in the past; and then proceeds to identify a number of such differences, such as dimensionality (time is, roughly speaking, "one dimensional", whereas space is three dimensional); the

mobility asymmetry (we can move freely in space but not in time); and the existence of an asymmetry between the directions of time that does not seem to have any analogue for the directions of space. He raises a fascinating question, which he calls the “Fragmentation Problem”, of whether this particular bouquet of differences necessarily hang together, or whether it could have been the case that, say, time could have a different dimensionality, and yet we would still see a mobility asymmetry and a directional asymmetry.

Chapters 7 and 8 offer a novel, promising, and important answer to the question raised in Chapter 6. This answer is, roughly, that time corresponds to those directions in a four-dimensional manifold of events along which the laws are “maximally informative”. Chapter 7 develops this idea in the context of the Best Systems account of laws, wherein Callender argues that the strongest systems of laws (in whatever sense of “strongest” one needs in the context of one’s preferred parsing of the Best Systems account) will be ones in which a particular direction is distinguished as the one that “tells the best stories”. Callender then argues that if this is what time is, then the Fragmentation Problem may be solved—because insofar as the laws pick out a particular direction as time, the laws will also provide whatever is needed to “bind” the various asymmetries between time and space noted in Chapter 6.

For my own part, I found the discussion in Chapter 7 less than compelling, though I suspect that a different reader – one who finds the Best Systems account of laws more compelling, or who has whatever mojo is needed to intuit what the “strongest” and “simplest” laws must be like – might react differently. Chapter 8, by contrast, was my favorite in the whole book, even though I take it to develop substantially the same view from a somewhat different perspective. This chapter examines the mathematical structure of the actual (non-quantum) laws that we believe govern our world, and makes the case that the particular class of partial differential equations of which those laws are examples *do* distinguish time from space in salient ways. (I say non-quantum, because those are the equations Callender considers; relativistic quantum field theories are systematically related to solutions of these non-quantum equations, and so one expects the morals Callender draws to carry over, *mutatis mutandis*.)

To be precise: these are equations that admit of a well-posed *Cauchy problem*, i.e., which have the feature that one can freely arrange data on certain three dimensional “slices” of the four dimensional manifold of events, and then the equations uniquely determine how data may be arranged on a four dimensional surface containing that “slice”. This makes precise the sense in which time is “maximally informative”: space consists of those directions tangent to the three dimensional surfaces on which anything goes; and time consists of those directions along which the laws then dictate what must happen.

I think this chapter is a major contribution, in and of itself, for several reasons. First, it identifies an important asymmetry between space and time featured by the actual laws of nature as we best understand them. The fact is that the equations whose solutions seem to describe possible global (four dimensional) histories in our universe distinguish space from time. This fact has not been broadly appreciated, or at least discussed, within philosophy of time or philosophy of physics. (The philosophical implications of such equations have been explored by others – such as John Earman and JB Manchak – but mostly in the context of discussions about determinism and prediction, and not in anything like the present context.) This is a major contribution. But perhaps more importantly, Callender invites us to a more sustained philosophical engagement with the mathematical properties of the known laws of

nature. I hope others accept the invitation, because I think deeper reflection on the structure of such equations will have major consequences for our understanding of many topics of interest in contemporary philosophy, including, in addition to time, modality, counterfactuals, causation, and, of course, laws.

Still, there are important ways in which Callender's discussion can be at best the first word on the subject, even in connection with the asymmetry between space and time that is his focus. The reason is that the class of equations that he considers – the second-order linear hyperbolic systems of partial differential equations – is too narrow to include equations that need to be included, and broadening the class in necessary ways undermines several of his claims. First, why does he consider this particular class of equations? The reasons seem to be that it is fairly broad, it includes equations, such as the wave equation, that are of clear physical significance, and it is particularly nice from the perspective of the Cauchy problem, because it permits maximal freedom in stipulating the state of the world “at a time”.

But this class does not include all of the equations we need. For instance, it does not include Maxwell's equations, which govern electromagnetic fields; these equations are *first-order* linear hyperbolic, and so they do not fit into the framework Callender considers. One can make them into second order equations, but if one does so they are no longer hyperbolic. This ends up having various consequences, including that (a) one cannot specify *arbitrary* initial data on a three dimensional surface (rather, consistent initial data must satisfy addition equations, known as “constraint equations”); and (b) to get unique evolution, one must supplement the second-order Maxwell equations with additional equations of unclear physical significance. (If one considers the Maxwell equations as first-order equations, one does not need to supplement them to find unique solutions, but initial data still needs to satisfy constraint equations.) Moreover, the constraint equations arising for Maxwell's equations and others are *elliptic*, not hyperbolic, which means that they have a very different structure, and it is boundary conditions at infinity that are analogous to “initial data” slices; from this perspective, it is *space* that is the great informer, since what happens at infinity, at least in some cases, determines everything about the “interior”.

This class also does not include systems of equations describing *interacting fields*, such as the Maxwell-Klein-Gordon equations, because these equations are not linear. And finally, this class of equations does not include Einstein's equation, which is second order, but is neither linear nor hyperbolic.

In some ways, focusing on the class of equations Callender considers amounts to a trade-off between simplicity and generality; moreover, I think much of Callender's discussion can be recovered in a more general context, though with quite a bit of added complexity and several still-unresolved issues. As a first step, one might move to the broader class of equations known as the first-order, quasi-linear, symmetric hyperbolic partial differential equations. (Callender briefly discusses these in Chapter 7, but leaves them behind in Chapter 8.) These, too, admit of a well-posed “initial value” problem, though the details are somewhat different. And they are general enough to include all known (classical) laws of physics, including systems of interacting fields—except for Einstein's equation, accommodating which requires new mathematical work. In general, for these equations one has to deal with constraints on initial data, the significance of which requires much more discussion than Callender provides. But as with the class of equations Callender considers, these equations, too, distinguish space from time; and there is a strong sense in which we know Einstein's equation does as well, in a way substantially similar to the other equations in this class.

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The final part of the book, consisting of Chapters 9 through 14, is where Callender brings an astounding battery of results from empirical psychology to bear on the core question of the book, of why manifest time is, indeed, manifest, given the physical world as we find it in our best physical theories. Recall that the three key features of manifest time that Callender identifies are: the existence of a distinguished “now”; the “flow of time”; and the closed past / open future asymmetry. Chapters 9 and 10 address somewhat different aspects of the present; Chapter 11 addresses the flow of time; and Chapter 12 addresses many (psychological) past/future asymmetries. The remaining two Chapters wrap things up, with Chapter 13 putting the arguments given thus far into the context of contemporary philosophy of time, and Chapter 14 trying to tie all the pieces – of which there are many – together.

The discussion in Chapter 9 specifically addresses the question: do we “experience” the present? An affirmative answer to this question motivates a great deal of work in defense of presentism and other “tensed” theories of time, and for some philosophers, suggests that there is some aspect of the world, accessible via direct intuition, which is not (yet) reflected by current physics. As Callender points out, much of the dialectic concerning this question in the literature has involved “detensors” who contend that there *can be no present* for one to experience, because such a notion is incompatible with, say, relativity; and thus their preferred theory wins by default. Callender aims to do better. He seeks to show that whatever our experience is, it is not “experience of the present”, at least not in the sense required for the “tenser” to run their argument.

To the contrary, Callender argues, the “present” as we ordinarily think of it appears to be constructed by our brains, and to have all sorts of features that seem to rule out anything like “direct intuition of (part of) the world at the present time”. The psychology and cognitive science is subtle and rich, and I will not attempt to summarize it. But the basic argument is that to construct the “present” in our experience, our brains synthesize information from different sensory modalities, which arrives at our sense organs from a single event at different rates (and thus different times); our brains fuse this information to create a perception of synchrony for events that are, objectively, certainly not synchronous. Moreover, these processes can be intervened upon experimentally to show that our judgments of, for instance, simultaneity and temporal order have none of the properties one would expect if we were directly intuiting a succession of present moments.

In the next chapter, Callender adds a further wrinkle: not only is our experience of the present cognitively constructed, but there is significant *disagreement* between different people concerning, for instance, the size of the temporal window within which events are “fused” so as to be perceived as simultaneous, which is reflected experimentally in significant and systematic disagreements between individuals about what events are simultaneous and about the temporal order in which events occur. In other words, there is no “common now”, in the sense of universal (or even general) agreement concerning what events are simultaneous with one another, much less what each of us experiences at a time. And this psychological effect is more pronounced than any disagreements arising from the “relativity of simultaneity” in special relativity, which is usually taken to be the principal challenge to the existence of a shared present. But if there is no “common now”, why do we *think* there is? Callender’s answer is simply that the differences are too small to make much difference in ordinary life, and that we are able to identify the differences only in carefully controlled experimental settings. There is no common now, but there is no harm for us to represent others’ mental states to ourselves as if there is.

Chapter 11 is the longest, and at once both the most intricate and the most impressionistic in the book. Here Callender seeks to explain our experience of the “flow” of time. His answer has several parts. On the one hand, he argues, we are instances of Information Gathering and Utilizing Systems (IGUSes), as discussed by physicist Jim Hartle, which are systems that gather and store information about the world at successive times and process that information to generate behaviors. An IGUS, he argues, has the resources to recognize change over time, and, with some extra bells and whistles, could be understood to “experience” things like duration or a specious present. Callender also draws on the “narrative theory of self” to capture the further idea that we represent ourselves as temporal agents, with memories and anticipations regarding the future, that persist in time; with this self-representation, we come to feel that we are moving through time, as anticipated events occur and new memories form. Callender acknowledges that the story is incomplete, but he urges that there is enough meat on its bones that one can get a sense of how the experience of flow could arise.

The final piece of the argument comes in Chapter 12, which addresses the temporal asymmetries, and in particular, the idea that we value the future and the past differently, in a way that reflects the idea that the future is open and yet to be experienced, while the past has already occurred and no longer exists. His answer boils down to two asymmetries that we find as facts about our world: namely, the causal asymmetry, that past events cause future events but not vice versa; and the knowledge asymmetry, that we have knowledge of the past but not the future. (I could not quite find him saying so here, but I suspect that if pushed, he would associate both of these asymmetries with the thermodynamic asymmetry, where entropy increases over time.) From these, he argues, we get the “affect asymmetry”, which is the idea that our feelings about things we can in principle control (i.e., the future) and about which we are highly uncertain (again, the future) are, and reasonably should, be different from our feelings about what we already know and cannot control. (He provides strong empirical evidence that our affect *is* asymmetrical in this way.) The idea is that emotions have evolved for, among other things, regulating behavior, and since our behavior is relevantly future-oriented, our emotions should be, too. From this he explains various other observed asymmetries, such as temporal discounting and relief that our dental appointments have ended.

Taken together, these arguments have enormous scope. And in my view, they are almost completely convincing. More details can and should be filled in, and surely the picture will continue to evolve as further research is done in cognitive science. But Callender succeeds in showing that the two times problem is, in effect, a myth: given a sufficiently subtle appreciation of the psychology of time, the fact that manifest time and physical time diverge presents no special problems at all—much less problems that demand some radical revision of physics to accommodate manifest experience. The arguments concerning our varied experiences of the present and the temporal asymmetries are especially convincing.

Still, I say “almost” completely convincing. In the end there remained a single point concerning Callender’s story on manifest time on which I felt dissatisfied. It concerns the idea of “flow”, which, I should immediately note, is the part of Callender’s story about which he expresses the most uncertainty himself. I am convinced by his arguments that agents like us – sophisticated IGUSes with narrative selves – can “experience” change and can make judgments about, or even “feel”, duration. I also buy how sophisticated agents could come to narrate their own lives, thereby representing themselves as persisting through a changing world. But what I still do not understand is how I, or anything else, get from one location or region of my worldline to any other. In other words, it is not merely that I

represent myself to myself as occupying successively different locations in spacetime, with different stimuli, etc. It is also that, wherever I happen to be in spacetime, I will presently be elsewhere, and then elsewhere, inexorably. How does that happen?

It is on this point that Callender is most wont to invoke metaphorical language or a sort that he criticizes others for using. He speaks of the narrative self “crawl[ing]” or “evolv[ing]” up its worldline (p. 247, 261, 268, 307). But I do not understand what this means any more than I understand what Santayana means when he writes that “the essence of time runs like fire along the fuse of time” (quoted on p. 227). I understand what it takes to crawl along some trajectory through space, but whatever else is true, crawling “through time” or “up my worldline” involves neither the same exertion of effort nor any bruised knees. Moreover, while I can see that my self-representation and the phenomenology of change are matters for psychology, I do not understand how I can perform anything analogous to crawling through time by means of narration or psychology, any more than I can narrate my way to the refrigerator.

And so I am left feeling that something is missing. Whether that “something” is more psychology, or new physics, or merely a reflection of the ways in which I remain in the grip of manifest time (as I suspect Callender would say) is an open question, at least for me. Of course, that Callender has not answered *all* the questions about why we experience time as we do given the physical world we live in, and has instead answered merely all but one of them, is hardly a knock against the book. To the contrary, it is an act of generosity. After such amazing progress, he has left just a little bit more for the rest of us to do.

#### Works Cited

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