

Book Review

The Nature of Time, by Ulrich Meyer. Oxford: Oxford University Press, 2013. Pp. ix + 161. H/b £35.00.

In 1908 Hermann Minkowski began an address to a congress of German natural scientists and physicians with the following now-famous words: ‘Henceforth space by itself and time by itself are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality’. This union is known, reasonably enough, as *space–time*, and the investigation of the nature and structure of space–time has been central to the development of the general theory of relativity, one of the two foundational theories of current physics.

In the other foundational theory, quantum mechanics, space and time generally appear quite distinct, and even in the context of relativity theory some physicists still maintain that time (independently of space) is the bed-rock reality while others claim time is a mere emergent phenomenon. Minkowski’s prophecy has not as yet been fully vindicated, even on its home turf.

In other fields, like philosophy, space and time are still considered separately. We have a Philosophy of Time Society, for instance, but not a Philosophy of Space Society. Philosophical investigations of time are typically pursued quite independently of any consideration of space. One might think that philosophers are just retrograde in this respect, but one remarkable line of thought in Ulrich Meyer’s book, *The Nature of Time (NT)*, is a series of arguments with the upshot that space and time *must* be considered quite distinct. Space is a manifold or collection of three-dimensional points but time is something else entirely. Time, or the set of times, is in Meyer’s view more like the set of possible worlds of modal logic than the set of time points that Minkowski imagined would be folded into space–time.

My plan in this short review is to describe *NT* with a particular eye to the development and evaluation of Meyer’s modal view of time. The reader should be aware, however, that this small book contains a wealth of finely crafted and challenging arguments, more than I can begin to do justice to here in a brief review. *NT* is a must-read for any philosopher with a serious interest in, well, the nature of time.

After an introduction, chapters two and three of *NT* attack the main rivals to the modal theory of time, the view that times are like spatial points. The

rival view comes in two venerable versions, relationist and substantialist. Philosophers who build relationism on events face a dilemma, presented in chapter two. Either events have time as an element in their analysis, in which case events cannot be used in turn in an analysis of time; or events are characterized independently of time, in which case it is difficult to see why they cannot repeat, like properties. Meyer concludes from these lines of argument that 'Event relationism about time is untenable' (p. 20). An alternative kind of relationism can be based on relations between the temporal parts of objects, but such a view is, he says, merely an ontologically extravagant version of the modal theory of time that he favours. (I anticipate an extended discussion of Meyer's critique of event relationism in a critical notice of *NT* by Tom Pashby that will appear in *Studies in the History and Philosophy of Modern Physics*. I have profited from email discussions of *NT* with Pashby.)

Classical substantialism, discussed in chapter three, is the view there are basic spatial and temporal points that exist independently of the objects or events, on which they confer spatial and temporal location. Meyer endorses the Leibniz 'shift' argument against the existence of time points. Since our basic physical theories are time-translation invariant, the postulation of time points would entail that each time-shifted set of events is a different history though there would be no physical distinction between any two such histories.

Meyer rejects, however, the analogous Leibniz shift argument against the existence of spatial points because spatial points (or 'Absolute Space') do have (or do seem to have) a physical use, as Newton pointed out in his *Principia*. Acceleration, especially rotation, with respect to such points seems the best way to explain the existence of certain sorts of inertial forces. There is no analogous argument for the existence of temporal points. This asymmetry of arguments in pre-relativistic physics clears conceptual space for the possibility of 'hybrid' theories, theories that combine a substantialist view of space with a modal view of time, contrary to the nearly universal but perhaps tacit conviction that as space goes physically or metaphysically, so goes time. We will return to hybrid theories shortly.

Chapters four to six contain Meyer's positive view. In chapter four he presents the basics of modal and temporal logics, in particular a system of temporal logic called *Z*. The theorems of this system (or perhaps the theorems of this system augmented by the apparatus of quantifier logic discussed in chapter eight) capture precisely what we know a priori about time. It is remarkable (as sect. 4.3 makes clear) just how little we know a priori of the nature of time if *Z* is our arbiter. We do *not* know whether time is linear or circular, whether it branches or not, whether it has a beginning or end, or whether it is discrete or dense.

In chapter five Meyer raises but then rejects the question as to whether propositions are tensed or tenseless. 'The contrast between temporal and eternal propositions', he writes, 'is one that involves time, but is not about

the nature of time itself' (p. 52). In much the same vein he also rejects *the truthmaker principle*, the claim that truth supervenes on being, as being no help in establishing a metaphysics of time (or a metaphysics of any sort, really). In his view, 'truth supervenes on how things *were, are, and will be*, and that is all that can or needs to be said about this' (p. 55). For what it is worth, I believe he makes a compelling case for both these deflationary points.

In chapters six and seven Meyer develops the ersatz time series, a construction modelled on that of ersatz possible worlds in modal logic. A possible present is a maximal consistent set of sentences of his favoured tense logic Z. A choice of a possible present determines a whole history because each possible present contains statements (many statements!) with nested tense operators P (in the past) and F (in the future). Each such history (leaving aside refinements) is an ersatz time series, with one ersatz series representing the actual times. Not all possible presents are times. The tense operators P and F are, in Meyer's way of construing tense logic, primitive. Tense primitivism and temporal ersatzism are the two central pillars of his enterprise.

I would like to note that, according to Meyer, temporal ersatzers can admit 'the possibility of *freezes*, which are extended periods during which no object undergoes change' (p. 68). For instance, the possible present {Ka, PKa, PPKa, PPPKa, ...} determines an ersatz time series that yields four instants (at least) in which 'Ka' is true, 'even if no other sentences change their truth values during this period' (p. 68). If this is so, then one ersatz instant contains 'Ka' but not 'PKa' or 'PPKa' or 'PPPKa', while another (the next, in fact) contains 'Ka' and 'PKa' but not 'PPKa' or 'PPPKa', etc. If this is correct, then an ersatz time series that accommodates freezes cannot be dense (see p. 46). It also seems plausible that an ersatz time series that is dense cannot accommodate freezes, limiting the freedom of construction of the linguistic temporal ersatz in a perhaps unwelcome way.

Chapter eight adds quantifiers to the logical system Z, paving the way for the discussion in chapter nine of presentism, the view that only present objects exist. Meyer's official line is that presentism is either trivially true, if 'exist' is a present tense verb, or obviously false, if 'exist' means *exists temporally*. No third option has ever been clearly stated.

If eternalism is the view that all temporal objects (past, present, or future) exist, then it would seem that this view is either trivially true, if 'exist' means *exists temporally*, or obviously false, if 'exist' is a present tense verb. But Meyer actually takes eternalism to be the view that 'all times are metaphysically on the same footing' (p. 87). Since times (that is, *ersatz* times) are 'presently existing, abstract sets of sentences' (p. 98), Meyer comes down on the side of eternalism, as, he claims, we all do (p. 87).

Certainly anyone who wishes to look at time through the lens of tense logic must think about the domain of objects that the quantifiers range over. Meyer has a technical reason for preferring an untensed quantifier, in

which case the domain of quantification, D , is all temporal objects. (The technical reason is that this style of quantification can handle an example suggested by David Lewis, ‘There were three kings named Charles’, see ‘Tensed Quantifiers’, *Oxford Studies in Metaphysics Volume One*, edited by Dean W. Zimmerman, Oxford: Oxford University Press, 2004, pp. 3–14.) This style of formalization requires the introduction of an existence predicate in order to make time-relative existence claims.

Alternatively one can introduce time-relative quantifiers, quantifiers that range over sets of objects that exist at a given time, t . Call these domains D_t . The union of these D_t , where t is a time, is just the domain D of the untensed quantifier. There are interesting questions about the expressive powers of these two styles of quantification, but not interesting questions of ontology.

Chapter ten tackles the (alleged) flow of time. Meyer elegantly dissects the most popular accounts of this ‘flow’, the moving NOW view and the supposition of pure becoming. All that is left standing after his critique is what he calls the ‘trivial’ view (I prefer to call it the ‘deflationary’ view) that the passage of time is just the occurrence of change. He rightly captures the anti-metaphysical strain in this view:

The point of the trivial theory is to pose a challenge to those who believe that there is something metaphysically interesting about the passage of time. The challenge is to explain what the flow of time consists in, if it is not mere change, and to spell out what reasons there are for believing that there is such a flow, given that the trivial theory already accounts for the observational data. (p. 103)

As I have said, Meyer argues that no current metaphysical account of the ‘flow’ of time meets this challenge.

The remaining two chapters are needed to fulfill one of Meyer’s desiderata for an account of time — that it mesh with our best accepted physical theory. Chapter eleven introduces some basic concepts, including the concept of space–time, and results of the special theory of relativity. In chapter twelve Meyer introduces the concept of space–time curvature and so extends the argument, as he must, to the general theory of relativity. While the general theory of relativity is typically taken to highlight the fundamental importance of space–time as a single entity, Meyer argues that the independence of space and time in certain extreme examples of curved space–time show that the general theory leaves room for different treatments of the two. That is, the general theory still leaves room for denying what he calls *the inseparability thesis*, the thesis that only full four-dimensional space–time substantivalism or relationism are possible ontological views. Since neither view accommodates his modal view of times, he wishes to open up conceptual space for a third kind of view, a hybrid view, which postulates substantival spatial points along with either a relational or, as he prefers, an ersatz account of times.

He first argues that hybrid views can be rendered consistent with principles like the relativity — that is, the frame-dependence — of simultaneity. Then, in

a paragraph that seems to pull together all the themes of *NT*, Meyer continues:

We can use this insight to reconcile tense primitivism with the theory of relativity. Given a choice of reference frame, we construct an ersatz time series in the usual way, as discussed in chapter six. The Cartesian product of the spatial manifold *M* with this ersatz time series yields a frame-relative spacetime that we can populate with events that are constructed out of times, places, material objects, and properties. There are as many such frame-relative spacetimes as there are reference frames, and no presumption that any one of them is privileged over the others. As in the relationist case, we then construct coordinate-free spacetimes by taking equivalence classes of points in frame-relative spacetimes. This account offers a way of reconciling the best metaphysics of time (i.e. tense primitivism) with our best physical theory of motion. Neither spacetime nor events would count as fundamental entities, but we recover both at a higher level of abstraction. So there is no need for physicists to give up their familiar spacetime talk. What is being proposed is a way of making metaphysical sense of spacetime, not a philosophically-inspired reform project for physics. (p. 130)

But *does* this program make metaphysical sense of space–time? First, let me observe that it is a striking feature of the general theory of relativity that the curvature of space–time determines the motion of matter not acted on by other (that is, non-gravitational) forces. Newton, recall, argued that motion with respect to (absolute) space gave rise to inertial forces. The absence of any analogous argument in respect to time allowed Meyer to suppose that one might have a substantival view of space while holding a different view of time. But the relation between space–time curvature and geodesic motion now includes both space and time in the relation between what one might broadly call four-dimensional geometry and the motion of matter. This in itself does not show that hybrid theories are either false or incoherent, but I think it does undercut one motivation for them.

Second, the construction of space–time starts with a reference frame and then constructs, as in chapter six, an ersatz time series. Consider the construction of an inertial frame in the special theory, which is what I think Meyer has in mind here. One uses ideal clocks and rods to construct, in a conventional way, a lattice of points assigned both spatial and temporal coordinates. One has from the very beginning, then, a time series constructed directly from basic measurements. What need is there to superimpose an ersatz time series on it?

Finally, the ersatz time series seems to me metaphysically more puzzling than enlightening, for on this view one of the dimensions of space–time consists of abstract entities. ‘The time series would form a logical space that is occupied by sentences or propositions, rather than a geometric space that is populated by material objects or events’ (p. 3). It may be difficult to understand metaphysically how substantival space–time (say) can tell matter how to move, but I think it is even more difficult to comprehend how three-dimensional spatial points plus a set of abstract entities can

manage the same feat. If the abstract entities are removed from the picture by the time of the final stage of the construction of space–time, then it looks as if we have taken a detour when moving from the physical time series in the reference frame to physical space–time points at the end of the process by way of these abstract entities for no evident end.

I doubt that such a detour is needed in order to apply temporal logic to the metaphysics of time in the sophisticated and illuminating way that Meyer does in the first ten chapters of *NT*. What I do not doubt is that there is room for much more discussion of these topics and that *NT* will (or, at least, should) set the agenda for philosophy of time for years to come.

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