

The Time Flow Manifesto

Chapter 4. Metaphysical Time Flow.

DRAFT ONLY

Andrew Holster

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Chapter 4. Metaphysical Time Flow.

For clarity, I start by defining some terms I use to characterise beliefs and positions of various camps. These intended meanings are specified here to avoid confusion.

- The *bloc universe* or *block universe* view refers specifically to the metaphysical view that time flow or tense is unreal, and events have only *earlier-than* and *later-than* relations, not modalities of *past*, *present*, *future*. This reflects the *space-time manifold* philosophy (from relativity theory in physics).
- The *static theory of time* here refers to the broader conventional view that includes the *bloc universe metaphysics* and the theory that *physical time and laws of nature are intrinsically symmetric*.
- *Time flow* in its narrow sense here means the thesis that *change* is real, and implies that tenses are not reducible to mere temporal relations between events. This contradicts the *bloc universe* thesis. It requires that some events or states are *present*, and the class of present events *changes*.
- I extend this term to refer to the '*time flow theory*', as the broader theory that includes the views that physical processes are directional, and laws of nature are directional, and causation is directional, and there is a natural integration of 'physical time flow' with 'metaphysical time flow'.
- *Presentism* refers to a group of *time flow* philosophies, that hold that all there is is what exists in the present moment, or *Now*. I take the various statements of *presentism* to contain the central proposition of *time flow*, viz. the reality of a changing *Now*, but with different treatments of the status of the reality of past and future, and different treatments of tensed semantics. I mention some leading 'presentist' theories, but I do not try to evaluate them against the position advanced here.
- *Semantics* should tell us, among other things, what we compare propositions or terms of propositions against in 'reality', to evaluate their truth and reference. If there no such things as 'past events' existing in reality, then we have a problem with the truth and meaningfulness of past-tensed propositions, because they apparently have no reference.
- *Neo-positivism* is used here as the term for a general kind of philosophical position and program, which commonly underlies the 'conventional view' often espoused as 'scientific common sense', but really based on a coagulation of beliefs with various flavours of *positivist* or *anti-realist* semantics, *materialist* ontology, *reductionist* metaphysics, *empiricist* epistemology, *scientistic* social ideology, and generally, by extension, *atheism* and *nihilism* about value.
- *Realism* is used here with almost the opposite meaning to neo-positivism, and in the context of the *time flow* debate, it is used to mean a full-blooded belief in realism about time flow and directionality.
- *Semantic realism* means we take about time flow or other beliefs as *realistic claims*, that refer to aspects of reality, and subsequently consider the *truth* of such claims. Anti-realists dismiss these debate from the start, by employing *anti-realist semantic explanations*, i.e. by playing with words, telling us the concepts themselves are 'nonsense', it is all explained by grammar, and so on.

The Static and Time Flow Theories.

In the philosophy of time, the neo-positivist is focussed above all else on sustaining the view called *the static theory of time*, as the very foundation of their scientific metaphysics. This is *the* deeply held metaphysical conviction of almost all ‘modern philosophical-scientific’ writers on time. In fact it is hardly too much to say that the *entire official modern 20th Century philosophy of physics rests on the assumption that the static theory of space-time is the only concept of time we can use in physics*. The static theory of time prescribes the *representational space* for physics as being logically based on *space-time* – to the point physicists are incapable of conceiving a theory without space-time any longer, and mutter superstitiously among themselves if someone suggests such a thing. By extension, this *space-time* provides the representation of *all reality* for the modern scientific materialists, since they believe that everything ultimately reduces to physics. This agenda simultaneously requires discrediting the alternative concept of *time flow* and the associated traditional metaphysical concepts that it supports.

Yet the neo-positivist’s fallacies about *time flow* are as striking as their fallacies about *time symmetry* in physics - where we have seen they simply made basic mistakes analysing their equations. But it is not quite as simple to dismantle these fallacies, because it involves metaphysics, which is a pluralistic subject, entertaining multiple systems of inconsistent beliefs and methods, not a monolithic subject like physics. The neo-positivist arguments begin with deeply confused ideas about metaphysics itself, and give stunningly bad presentations of what time flow *means*. Indeed, the whole thrust of neo-positivism in modern physics has been to attack realist metaphysics or semantics itself, leaving professional scientists pitifully ignorant of real philosophy, childishy opposed to thinking about the interpretation of their own theories, concepts and methods, and antagonistic to philosophical scientists - including the original founders of modern physics like Einstein, Schrodinger, Bohr, Lorentz, Planck, and so on. In this respect, the rise and rise of neo-positivism has been the biggest unmitigated cultural disaster for modern science from the 1950’s to the present day.

To dismantle the neo-positivist fallacies, we have to start by defining the two main views of time clearly and accurately to begin with. They are *metaphysical theories about the nature of existence itself*.

The static theory of time holds that all physics must be represented as fixed events in a ‘static space-time manifold’. Time is *spatialised*, or *objectified*. Time becomes a concrete object, extended just like an extra spatial dimension. ‘What exists’, or ‘reality’, is a single static concrete object, a fixed network of events spread out across all *time and space*, like a cosmic wall-paper. The ‘laws of physics’ are just patterns found among events on the space-time manifold – as we find patterns on wall-paper. Everything that has ever happened and ever will happen exists eternally, as the facts of our world-history. Our normal belief that the world is *happening*, that it is open to change, or to our causal intervention, or to our choices or our acts of will, is really a delusion. Our normal belief that our conscious perceptions represent a changing present is a delusion. Every experience we have exists for all time, without any temporal status - nothing is really past, present or future. ‘The present’ has no special status – in fact it is indefinable on this view.

The time flow view takes the physical world to exist as a set of persisting physical entities in space, as we normally think. The physical world *exists in its present momentary state*, but the present state *changes*. Basic physical objects (like particles) or basic physical ‘stuff’ (like energy), as well as space itself, persists in existence through *change*. Time is not an *entity* like space. Instead time is a construction or representation of *the sequence of change*. The physical world has a continuous existence, but changes its state, *and the class of all the truths about the world changes*. The laws of physics are the rules governing physical change. The time parameter enters into the equations of physics primarily to define *rates of change*. Change does not just happen randomly: one state leads to another, and then another, according to *causal laws*. The causal laws are naturally future-directed, because the present state is always responsible for generating the next state. Causation does not imply determinism: change may be *intrinsically probabilistic*, at least in part. But fundamental physical objects (or fundamental

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stuff like energy) do not randomly appear and disappear through time – they are fundamental precisely because they persist in existence through changes of state.

These two views deeply condition our understanding of all kinds of metaphysical concepts – from scientific metaphysics of causation, explanation, determinism, laws of nature, symmetries, space and time, information, to general concepts like consciousness, experience, action, will, possibility and necessity, counterfactuals, value, purpose, personal identity, death, spirituality, existence, knowledge, meaning, semantics, properties, abstract objects, realism. On the neo-positivist's view, these are effectively closed subjects: metaphysics is purely and simply the metaphysics of the material world in the static ontology of space-time. On the time flow view, the whole world of metaphysical questions remains open and real, and current scientific explanations and reductionist metaphysics are not satisfactory.

Neo-Positivist and Realist Metaphysics.

The neo-positivists' static view of time is fundamentally allied to *materialist metaphysics*. It presents the world in its entirety as a transparent concrete object, with a simple construction from basic material parts and their relations. Science is a matter of examining this object, cataloguing its facts and recording its patterns, just as we would dismantle a clock or anatomise a physical organism on a laboratory bench. The world in its entirety is just a *big machine*. All real things are simply *parts found in this object*. The 'laws of nature', for example, are just representations of *patterns in the space-time object*. There is no mystery about their 'reality'. Likewise, all objects of traditional metaphysics – consciousness, personal identity, properties, knowledge, propositions, will, action, etc – are *prescribed to have reductionist materialist explanations*. Insofar as they have any reality at all, they must 'reduce' to fundamental material objects and processes in the static world. There is nothing else they could possibly be in this ontological vision. The physical world itself can have no deeper explanation – it simply exists as it is: a concrete object presented to us.

This view is closely allied to the scientific belief that modern science has *already solved* the fundamental puzzle of the world, and irrevocably identified its fundamental

composition and structure. Science still has many interesting details to fill in, but the fundamental framework or ontology is thought to be fixed in the form of relativistic space-time plus quantum particles. Of course, this was also the attitude at the end of the C19th, when classical physics was believed to have already fixed the foundational theory, and only the details were left to be worked out. In recent decades, eminent authorities of science confidently preach that the grand goal of modern physics is all but completed, and it is just a step away from finishing the ‘theory of everything’. Decade after decade now, this triumphant completion has been just ‘a few years away’, ‘achievable within a decade’, ‘just give us the cash to build the LHC super-collider and we’ll tell you in about 5 years...’, etc. In reality, physics has become increasingly fraught with paradoxes and anomalies and contradictions, there is a lot of fiddling with theories to ‘make them work’ (dark matter, dark energy, etc), but still no fundamental questioning of the foundational doctrines (static space-time and instrumentalist quantum mechanics) is permitted within the mainstream, any more than *classical space* could have been questioned in the C19th Classical paradigm.

However, there are some distinct challenges to the general neo-positivistic conformity in recent years. The biggest challenge to positivism from within physics itself so far, to my mind, has been from ‘many worlds’ interpretations of quantum mechanics. This is a radical departure from materialism, because the fundamental entity that defines reality is no longer *a single, definite, actual physical world that we appear to inhabit*. Reality is only encompassed by *a space of possible and actualised worlds*. In a ‘many worlds’ ontology, we no longer live in a single actual physical world!

To see this, we can draw a *possible world diagram*, a fundamental tool of modern metaphysics, routinely used to model *propositions, possibility and necessity, laws of nature*, etc.

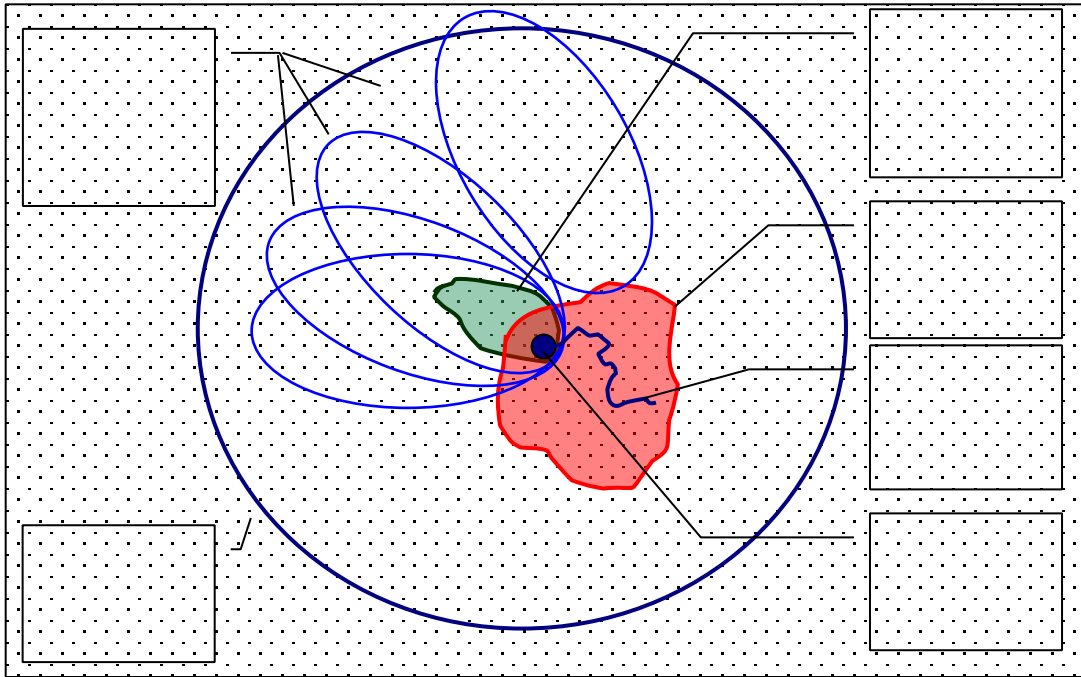


Figure zzz. A possible world diagram.

Points in this diagram represent *mechanical worlds in instantaneous states*, or instantaneous *world-states*. This is suited to representing a time flow ontology, since time flow requires a sequence of changing world-states. Possible world diagrams are often based alternatively on *complete world-histories*. A complete *world-history* would be represented in our diagram by a *one-dimensional path through the space of world-states (indexed with a time parameter)* – similar to a path through phase-space in physics.

Note that the neo-positivist metaphysics allows only *a single actual world-history* as the complete representation of reality. However, there are many elements, or pieces of information, represented in this possible world diagram that *cannot be represented within a single actual world-history*. This is the problem of metaphysics in a nutshell in a sense, similar to Parmenides: *the fact of a single concrete actual world is not enough to think about possibility, because there are non-actual possibilities*. I now indicate how *realists* interpret key concepts that remain opaque in neo-positivism.

A Possible World Realist Interpretation of Key Semantics.

Physical Laws. The class of worlds in the blue circle are *possible worlds that obey the actual laws of physics (nomic or nomological necessity)*. This is the boundary of ‘physical reality’. Possible worlds outside this circle can be conceived, but cannot be parts of anything physically real.

The Actual World/s. The blue circle in the centre represents *the actual mechanical world/s (in its instantaneous state Now)*. Classically we think this is a single world, but in a generalised metaphysics it might include many worlds. ‘The actual world’ might not be unique.

Possible Futures. The red area includes all the actually possible future worlds, given the present actual world/s. The actual world/s must follow a path through this space.

Particle States. Every particle in the actual world/s has a state which is consistent with a subset of worlds. These are illustrated by four blue ovals. Each of these must include the present actual world/s, but should normally include many other worlds too. An individual particle states does not normally represent complete information about the actual world/s: it is consistent with many possibilities.

Propositions. In intensional logic, any subset of worlds is a (*first-order*) *proposition*, but most propositions are never true or ‘physically realised’. The particle states are *physically realised or actually true first order propositions*.

True Propositions and the Actual World/s. The *intersection of all first-order particle propositions* must include the actual world/s. In a purely first-order ontology, this intersection must *determine the actual world/s* – because all information about the actual world is determined by the states of first-order particles within the world.

Higher-order propositions. But there could be also second-order propositions, as shown in green, which are stronger than first order propositions. These can be thought of as ‘binding’ first-order particle states together; they *connect* the intersection of the first-order particle propositions. However they might be stronger than the intersections alone, and determine a more powerful proposition, as shown here. Second order propositions could determine the path of the actual world/s more strongly than the set of single particles alone.

Non-physical entities. Second-order propositions do not appear as simple first-order material particles within the mechanical world. Instead they appear as ‘ghostly’, or ‘emergent’ non-material states. They contain real information which helps determine the world-proposition more strongly than the first-order states alone. They might be naturally interpreted as ‘entangled states’ in quantum mechanics. They are also the natural kind of entity to interpret as *conscious states*. There could equally be third, fourth, fifth,...etc, order states – which *connect* second, third, fourth, ...etc, order states in a similar way. Higher types of ‘conscious states’ or higher levels of ‘conscious connections’ may be interpreted as higher-order propositions.

The point here is not to try to justify this model in detail. Rather, it is to point out that there is a natural kind of metaphysical model for realistically representing (*i*) *the many*

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worlds interpretation of quantum mechanics in physics, (ii) the intensional theory of propositions in modern semantics, (iii) metaphysical objects like laws of nature, nomic necessity and future-directed causation in naturalistic metaphysics, (iv) mysterious entities of our experience like conscious identity and experience.

The fundamental point is that this *makes classes of possible but non-actual worlds necessary for the full representation of reality*. So does time flow, of course: the future is part of reality, but it is not *a mechanical part of the actual world*. But this kind of model is alien to neo-positivistic-materialist metaphysics. It contains *realist representations* of entities and structures that have no possible representation in the conventional static ontology. It raises all kinds of questions that cannot even be asked under the neo-positivistic model of physics – e.g. *if there are higher-order propositions or entities in reality, then what are their laws? Are they eternal objects, or are they created and destroyed? Where does such a hierarchy – the ‘chain of being’ – start and end?*

This is meant to illustrate the fact materialist metaphysics is not the only possible basis for the representation of physics. Quantum many worlds theory, as well as intentional semantics, are both respectable theories, but they have no realistic formulation within materialist metaphysics. The *logical space for a theory* – the space of its possible worlds – depends intimately on the construction of its possible worlds. We now turn specifically to the time flow and static ontologies, and their constructions of worlds.

The Time Flow and Static Ontologies.

The static view of time first appeared with the Einstein-Minkowski interpretation of the space-time manifold in special theory of relativity. The subsequent C20th neo-positivist philosophy of physics has been preoccupied above all else with enforcing the static theory as the foundational view of scientific metaphysics – prescribing a permanent framework for all future developments of fundamental physics.

- The *Special Theory of Relativity*, generalised to the *General Theory of Relativity*, is the first scientific foundation for this view.
- The *time symmetry of the fundamental laws of physics* is the second scientific foundation.
- A reductive interpretation of our ordinary metaphysical concepts of *time flow, change, causation, truth and existence* is the first metaphysical platform for this view.
- A destructive critique of our common-sense *time flow metaphysics* (dismissing this as logically paradoxical, incoherent, inexplicable, unobservable, etc) is the second metaphysical platform.

The positive strategy is to show how science can be explicated on the static theory of time. The negative strategy is to attack the main alternative view, *time flow*, and remove it as a credible option. The static view was inspired by the Special Theory of Relativity in the first instance, because this provided the first scientific model that makes the static view plausible. The extent to which the Special or General Theory of Relativity *compels* the static view is disputable, but in any case, the static view of time makes much more extensive metaphysical claims than relativity theory by itself.

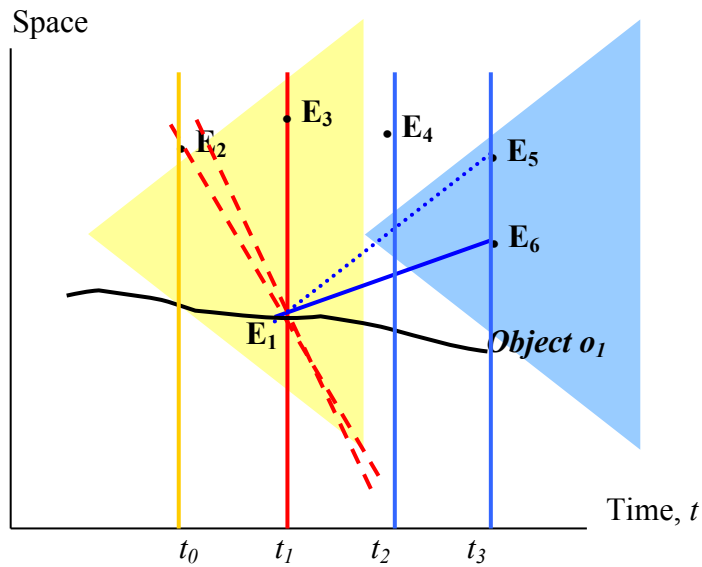


Figure zzz. The space-time manifold.

Instantaneous events $E_1, E_2, E_3, E_4, E_5, E_6$ are shown located in the manifold, with the backwards light-cone (yellow) and forwards light-cone (blue) from E_1 . E_1 is a point on the trajectory (world-line) of an object, o_1 . The red vertical line connecting E_1 and E_3 represents the *stationary reference frame* for the object, o_1 , at the coordinate-time labelled t_1 . In this frame, E_1 and E_3 both occur at t_1 (they appear to be ‘simultaneous’ in this frame). In this frame, E_2 occurs at t_0 and *appears to be earlier than E_1* , while E_2 occurs at t_2 and *appears to be later than E_1* . E_5 is connected to E_1 by a light-beam, and is *definitely later than E_1* in every valid frame. E_6 is in the *forward light-cone*, and is *definitely later than E_1* in every valid frame.

The features of three key ontologies (time flow, static relativistic and static classical) are explained in terms of this space-time diagram. In summary, the static ontology has only ‘bare events’ with space-time relations. The time flow ontology adds a *present*, a relation of absolute *simultaneity*, a distinction of *past* and *future*, and an intrinsic *temporal direction* of causation. Perhaps the most important thing to realise is that relativity theory still requires that *the causal laws apply to a complete momentary state (in an inertial frame) as the maximal boundary condition*. The peculiarity of the special theory of relativity is simply that the symmetries of the theory makes it possible to ‘tilt’ the spatial axis to a different angle in space-time, to give alternative

simultaneity relations, or alternative maximal momentary boundary conditions. This cannot be done in classical physics, where the simultaneity relation is uniquely defined. Relativity theory still depends on the notion that a *momentary state (or time-slice) can be defined*, however. This is implicit in the requirement that there is at least one valid frame of reference in STR. Although relativity theory makes time like a dimension of space, in fact *time is still treated as a completely different kind of entity to space in the scientific theory and imagination*. It is only in the static *metaphysical interpretation*, or in the mathematical formalism, that time and space are claimed to be the same kind of thing.

- ***The Basic Time Flow Ontology.***

- a. **Past, present, future.** There is a *present moment*, a set of *past events* and a set of *future events*. In the space-time diagram, the *present moment* (Now) is defined as all the events in space at a specific point of time, e.g. all the events defined at t_1 above. (A slice of space-time). Time is not an entity (like space), but a construct from the sequence of change.
- b. **Temporal relations.** Events at the same present moment are absolutely simultaneous. Events at a later moment are *future events*. Events at an earlier moment are *past events*.
- c. **Truth and representation of facts.** Any spatial representation (like a space-time diagram with the present moment marked on it) can be actually true only for an instant – as the present moment moves forward into the future, the representation of the present moment becomes outdated, representing something that *was true in the past*.
- d. **Universal Laws.** The fundamental or universal laws of nature have *time translation symmetry*, i.e. they remain constant as time changes, but have an intrinsic *time direction*, reflecting the sequence of change. This is reflected by the fact that in a valid coordinate frame, the laws appear invariable w.r.t. time translation. In any such frame, we can universally quantify time over the laws.
- e. **Valid coordinate frames.** There is always at least one such valid coordinate frame for time, viz. where coordinate time t coincides with *simultaneity*, and where the metric for t coincides with *the universal rate of time flow* in which the laws of nature appear to have a constant form. It is an empirical question

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whether this is defined as an inertial frame or not. There may be more than one valid frame, depending on the symmetries of the laws of nature.

- f. **Causation.** Causation is future directed from the present state. The complete present state of the universe is the maximal causal condition (boundary condition) that the laws of nature apply to, to determine the future states. This includes dynamic properties (like velocities), as instantaneous limiting properties ($dr/dt = \lim_{dt \rightarrow 0} (r(t) - r(t-dt))/dt$).
 - g. **Determinism.** Future states need not be uniquely determined by the present state combined with the causal laws – they may be intrinsically probabilistic. Past states are only determined indirectly, by the requirement of consistency with the present state and the future directed causal laws – with probabilistic causal laws this will normally require epistemic probabilities.
- ***The Static Ontology with the Special Relativity Space-Time Metric.***
 - a. **Past, present, future.** There is no present moment, no past, and no future. Time is an entity, just like space. It is a one-dimensional continuum of moments.
 - b. **Temporal relations.** There is no absolute relation of simultaneity, only a relation relative to a valid choice of reference frame. There are only *space-time relations (distances or intervals) between event pairs*. Two events are absolutely *earlier-than (later-than)* than each other only if they lie in each others' light cones.
 - c. **Truth and representation.** A complete space-time diagram (a purely static representation) represents the maximal class of truths about the universe. Nothing outside this class can add to the representation of truth.
 - d. **Universal Laws.** The laws of physics have both *time translation symmetry*, i.e. they are the same at every moment, and *time reversal symmetry*, i.e. they are invariant under the transformation: $t \rightarrow -t$. *There is no intrinsic direction of time reflected in the laws of nature.*
 - e. **Valid coordinate frames.** Valid coordinate frames are defined as inertial frames of objects. In any valid coordinate frame, the laws appear invariable w.r.t. both time translation and time reversal. In any such valid frame, we can universally quantify time in the laws of physics. There is always at least one

such valid coordinate frame for space-time. Valid frames are connected by the Lorentz transformation, which preserve the interval: $c^2 d\tau^2 = c^2 dt^2 - dr^2$.

- f. **Causation.** There is no intrinsic directionality of causation. The complete state of the universe at any time t in any frame is the maximal type of causal condition (maximal boundary condition) that the laws of nature apply to, to determine earlier and later states alike. No causal effect can propagate faster than light, i.e. space-like separated events cannot provide causal boundary conditions for each other.
- g. **Determinism.** All truths at all times are uniquely determined by the world alone. The causal laws may be intrinsically probabilistic. If they are probabilistic in the later-than direction of time, then they must be symmetrically probabilistic in the earlier-than direction of time.
- ***The Static Ontology with Classical Space and Time.*** This is almost the same as in special relativity, except that there is no limit to the speed of causal propagation, there is an absolute relation of simultaneity, there is an absolute relation of *earlier-than* (*later-than*) between all pairs of events, and valid frames are connected by the Galilean transformations, which preserve the intervals: $dr^2 = dx^2 + dy^2 + dz^2$ and $d\tau^2 = \text{constant}$.

The third example is to emphasise that although the neo-positivist theory of time was inspired by the Special Theory of Relativity, it is retrospectively applied to classical physics as well. It is not constrained to relativistic theories, nor compelled by relativity theory. The arguments of its adherents would mean that it is the only concept of time that makes sense *for any theory of physics*.

Relativity theory does not force the static view, or rule out time flow by itself, for multiple reasons. First, the special theory of relativity does not *contradict* time flow directly. It only claims that a unique frame of simultaneity in physics is unobservable, and concludes that *the present moment* cannot be operationally defined within physics. Whether this premise is true or not, the argument is bad: *observability is not the criterion for reality*. My pain (a kind of mental anguish) at *still* having to make this point, at this stage in scientific history, in 2014, is unobservable to you; but I

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assure you it is real. Second, the special theory of relativity it is not a complete theory of nature without being combined with additional theories like quantum mechanics and cosmology – what if a further theory turns out to require time flow after all? (In fact, the isotropic micro-wave background radiation, discovered about 50 years ago, provides exactly what we need to determine a *unique physical frame of simultaneity* for the universe globally – so the premise of the first argument is wrong too.) Third, a *general theory* like the Special Theory of Relativity may not be strictly true (in fact it isn't) – what if future theories alter its consequences (in fact they have)? Fourth, our primary evidence for time flow is undoubtedly our conscious experience – we observe the world as if we exist in a changing present – and this may provide a perfectly good reason outside of physics to embrace time flow, and add it as an extra metaphysical postulate. After all, science itself is based on our prior interpretation of *experience itself*, the assumption that experience reflects a real physical world with real change, etc. Experience seems to transcend scientific theory, in the sense that a scientific theory that denies common elements of experience is not convincing.

The neo-positivists reject this idea of metaphysical knowledge that transcends science. This is taken to extreme lengths sometimes, e.g. in the positivist-behaviourist account of consciousness. Their theory that *consciousness does not exist and it all reduces to behaviour* probably appears absurd to most philosophers now, I hope so anyway, but how many *millions* of person-years of earnest conferences and graduate studies and research grants and academic careers did this bizarre metaphysical speculation generate – to fizzle out in the end with nothing at all!? The theory that *time flow does not exist* seems equally absurd to many philosophers. This is why a negative strategy of attacking the concept of time flow is so important to the neo-positivists. To make the case against time flow, they put up a raft of additional negative arguments, as reflected in the claims 9* - 11*. These are all fallacies, which we now consider.

The Four Neo-Positivist Fallacies about Time Flow.

Claim 9*. The first argument is that “time flow is meaningless in physics because physical time is symmetric. No direction can be identified by the laws of nature as the ‘past’ and ‘future’ directions of time.” We have seen this is wrong. Quantum mechanics is *time asymmetric*. It has *probabilistic causal laws, and these only hold in the future direction of time*. On a realist view of quantum probabilities, there is no truth about the outcome of future probabilistic events until they happen. We cannot even make sense of this unless we can understand the concept of ‘the future’. There is nothing here to support the neo-positivist argument at all – despite the central place this claim takes in their accounts. Their ‘scientific evidence’ turns out to be an error. The best current scientific theories support asymmetric physical time, asymmetric causation, and consequently they support time flow. This is a critical failure in the static theory of time, which requires that causation is intrinsically symmetric in time. If causation really works as a process that takes a *present momentary state and develops it into a later state* then it is very difficult to see how the static view can survive.

There is also a circular ideology at work. Static theorists are convinced that time *must be intrinsically symmetric*, because this is central to their metaphysical vision. They then *try to prove time is symmetric* to support this. Instead of evaluating the evidence for the time symmetry independently, and subsequently evaluating the static theory, they do the reverse: they assume the static theory as given, and try to force the evidence into their metaphysical theory. This is why so many researchers, who have staked their reputations on the static theory, are incapable of evaluating the scientific evidence for time *symmetry* objectively either.

Claim 10*. “Time flow is meaningless in physics because physicists never refer to time flow in their textbooks or theories.” This oft-repeated claim is simply delusionary. Physicists constantly refer to tenses - past, present and future - in describing experimental set-ups and physical systems that their theoretical equations refer to. Physicists constantly assume that causation is future-directed. *E.g.*

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“The interference pattern appears only after many particles have passed through the slits, but each particle retains its discrete individuality and goes its own way, being finally deposited somewhere on the screen. Note that the appearance of the interference effects does not require that a whole beam of particles go through the slits. In fact, particles can actually be accelerated and observed singly, and the interference pattern can be produced over a length of time, a particle hitting the screen now here, now there in a seemingly random fashion. When many particles have come through, a regular interference pattern will be seen to have formed.” (Merzbacher, 1970, p. 9-10).

This is laden with tensed propositions, that depend on the reader’s ability to distinguish between the past and future directions of time. Theories of physics do not consist of purely formal mathematical equations. They consist of *interpreted equations*. The *interpretations* relate the equations to the physical world, and these are laden with references to past, present and future, and they assume the normal grasp of time flow that everyone else uses. They also assume a grasp of *counterfactual reasoning* as well, and this is based on the assumption of causal laws as directional, our ability to control initial conditions from before an experiment, but not final conditions from after an experiment, and so on.

The neo-positivists will reply that what they *really mean* (of course – they are just over-emphasising their claims a little ...) is that *they could ‘in principle’ (whatever that means?) rewrite physics textbooks* in an ‘idealised logical language’, without using any terms that refer to ‘past’ or ‘future’. A few years earlier the logical positivists thought they could rewrite the whole of science in an idealised language, using only terms for ‘observables’. This program also turned out to be a philosopher’s hallucination. It is a common fantasy – and anyway, if they can do it, why don’t they and prove their point? The fact is, the Positivists tried and repeatedly failed to make any kind of reductionist language like this. In any case, the fact that quantum mechanical probability laws *only apply one way in time – towards the future* – shows that their new claim to be able to remove tenses from the language of physics is doomed to fail before it starts.

In real life, physicists constantly and unavoidably assume that their time coordinates *are aligned to the future* – their equations do not work if they are reversed in time.

But in any case, the general notion that we could or should *reform language* to remove reference to ‘metaphysical’ concepts like time flow, consciousness, goodness, value, beauty, and so on is one of the widespread delusions of neo-positivism. The delusion is based on a deep-seated fallacy, that since (in their view) all reality reduces to a network of physical events, we can therefore (‘in principle’, whatever that means) reduce all language about the real world to some simple referential language about these physical events. This is an utterly misguided idea of semantics, and the source of a lot of anti-realist C20th philosophy that seeks to resolve philosophical questions about the nature of reality by playing games with language.

When we do specify the tensed semantics realistically, what we find, of course, is what we have already seen above: *the block universe does not have the extra tensed facts that the time flow universe has*, e.g. the specification of the time *Now*. This is the whole issue isn’t it? The neo-positivists who then go on to claim that *the meanings of the tensed propositions can be semantically reduced to a tenseless language in the block universe* show their confusion. If this was true, there wouldn’t be any distinction between the *time flow universe* and *the block universe* in the first place. They would be *isomorphic* models, there would only be one possible view. The fact is, they are not isomorphic, and *time flow is an ontologically simpler but logically richer concept than the static model*.

I make one final point: in modern cosmology, with an expanding universe, we *do need a reference to where we are ‘Now’ in cosmological time and we see this in many physics diagrams and notations nowadays!* Part of the reasoning in certain problems involves precisely imagining what happens *when a large amount of time passes, and the Now becomes later* – how do we compare between our two *Nows*? In fact we see reference to the *Now* appears on large-scale cosmological diagrams, marking our present point in the large-scale development of the universe. And it may be of great concern to us - exactly as the point we are at *Now* in relation to our own personal lives is of concern to us.

Claim 11*. “Time flow is a meaningless or paradoxical metaphysical concept, because it cannot be reduced to more basic physical concepts, it can only be explained by an infinite regress, etc.” Attempts to prove that the concept of *change* is self-contradictory go back to Parmenides and Zeno and the Eleatic school at the very beginning of Western philosophy, and the issue was famously revived by McTaggart in the early C20th. Parmenides raised critical questions for philosophy; but most modern attempts to logically disprove time flow are based on basic fallacies of analysis.

The most common is the complaint that ‘change’ cannot be reduced to more fundamental concepts – it cannot be defined without referring to change somewhere in the definition. Well of course it can’t. Any realist conceptual scheme ends up with *irreducible concepts*. The concept of *change* is the irreducible concept in the theory of time flow. We may just as well ask physicists to define space without referring to space in their definition.

Modern critics of time flow generally begin by implicitly assuming that all reality can be represented in their static space-time picture. By assumption, anything real must be reducible to something already in their picture. They then observe that there is no representation of ‘real change’ in this picture - it contains no absolute distinct of ‘past’, ‘present’ and ‘future’. So they conclude that ‘change’ is consequently a meaningless concept. This is a purely circular argument. All it proves is that the static ontology without change does not include change.

The main strategy however is to smuggle the static time assumption in through a *static theory of truth*. If it is assumed that *there is a single unchanging class of all truths about the world*, then of course this will contradict time flow: the time *Now* could not change to start with. On this assumption, that *the class of all truths is fixed and static*, we have a *reductio ad absurdum* argument against time flow, since it assumes that *the class of truths changes*. E.g. *assume time flow; then truth about what the time is Now changes; but this contradicts the assumption that the class of truths is unchanging; reductio*. The elaborate arguments of McTaggart and his modern followers, about ‘A’ series and ‘B’ series and so on, are simply convoluted versions of this simple observation. But what they rally need to demonstrate of course is their

initial assumption that *there is a single unchanging class of all truths*. If this is taken to be a fundamental axiom, then it is just speculative metaphysics about ‘truth’. In any case, it is *exactly the same as the original question about time flow*, just slightly restated in terms of ‘truth’. Consequently, playing with semantic theories about *truth* is not going to change the question, or solve it. Comparing with reality is required.

Ultimately when philosophers simply insist that they cannot understand the ordinary meaning of change, or the concepts of past, present and future, we know they are pretending, because they understand the concepts perfectly well in their ordinary lives! They understand them well enough to present expert arguments against them. It is an intrinsic part of conscious experience that *we experience existence in the present*, and we experience *our present existence or consciousness changing*. What they really mean is that they cannot explicate the concept of change in their chosen static ontology, they think our experience of it is an illusion, they think a correct scientific account of the world has no real facts about change. But these are arguments about whether change is *real*, not arguments about whether the concept of change makes sense.

If they really think there is a strong scientific case against the reality of change, then they should not need to add all these bogus ‘conceptual paradoxes’. All that these long-winded philosophical arguments achieve is an impoverishment of our conceptual language and imagination, removing our ability recognise the real difference between the intuitive ‘time flow’ metaphysics we adopt in ordinary life and the ‘static’ metaphysics they want us to adopt as a ‘logical metaphysics’.

Claim 12. “Relativity theory shows that that time is just another space-like dimension, in which events exist, without any objective quality of being ‘past’, ‘present’ or ‘future’, and with no intrinsic directionality. Time flow is scientifically meaningless because no rate of time flow can be specified. Time flow is scientifically proved irrelevant to modern physics.”

We have seen that the main ‘scientific arguments’ referred to are fraught with mistakes. The known laws of physics are *time asymmetric*. Time flow cannot really be *irrelevant* if physicists constantly and unavoidably refer to it in their textbooks

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whenever they explain any theory of physics. The argument from relativity theory is the only substantial argument in my view, and it is interesting and important. I will show that the proposal to add time flow to the relativistic ontology of space-time reveals critical choices for real, empirical theory development.

There are two main points made in the two following sections. The first is exposed by simply *adding time flow* as an extra assumption to relativity theory, and considering the kind of model development it entails. The usual development in physics takes the *space-time manifold as the fundamental object*, and seeks to develop mathematical equations in a tensor framework. This incorporates the interpretative assumption that *tensorial invariants are the only real physical objects*. In a time flow ontology, we are forced instead to look for underlying models of space and matter to support the relativistic metric – and to consider the choice between the standard modelling assumption that assumes *space-time has intrinsic curvature* and an alternative realist modelling that assumes that *space has extrinsic curvature*. This is explained in the following section.

The second point relates to the complaint that ‘no rate of time flow can be specified’, which is a popular one-line reason for rejecting it. The idea is that if it is a *flow* then it must have a *rate of flow*. (Don’t all physical flows have rates?) If we cannot specify a rate of flow it is therefore a bogus physical concept.

In one respect, this is a disingenuous linguistic argument: the term ‘time flow’ itself is a metaphorical construction, and it doesn’t have to mean a ‘flow’ taken literally like a flow of water at all. It refers to the concept that *what exists (or the set of facts about reality) changes. There is a sequence of change. We refer to this sequence as time – but time is not an object in the world like space, it is the sequence of existence itself. And we refer to the passage of the present moment through the sequence of moments of time as ‘the flow of time’*. There is no necessity to interpret this as a traditional concept of a physical flow – i.e. as a flow of some measurable quantity like mass.

However, that is not the end of the story, for there is a critical respect in which time flow can be positively said to have a rate, and we can specify it. Universal time flows at a *constant or uniform rate*, as Newton observed! For in physics, we must put a

metric on time, and this metric must correctly match something physical. But the static and time flow views differ on what this is.

The static theory assumes the time metric must be defined instrumentally or operationally, which means we must take time intervals to be measured against natural physical *processes*. In the special theory of relativity, these are defined by natural processes in inertial frames – i.e. if we travel with a physical system in inertial motion, without being subject to any forces or accelerations, then time must be measured by natural processes of the system (e.g. physical clocks). This reflects a positivist-instrumentalist dogma that *all meaning is anchored directly in physical observation or measurement*.

But the time flow theory claims something quite different: to capture the uniform flow of universal time, the time metric must *correctly render the laws of nature time translation invariant*. It is the *laws of nature* that must be constant with time, not specific processes. There is an extremely pertinent example of this. In the expanding cosmology, we must wonder (as Dirac did) whether the universal physical constants could be changing with the expansion of the universe, and consequently, whether physical processes might change their intrinsic rates over cosmological time. If we just simplistically *define the time metric operationally through physical processes*, then the laws of nature in the form we define them *now* will not remain time translation invariant. The same lesson applies to all our *fundamental quantities: time, space, mass, and electric charge*. When we consider the question of the evolution of fundamental constants (c , G , h , ε and μ), *we must simultaneously consider whether the fundamental physical variables (t , r , m , q) as we currently measure them need to be transformed to a new set of true variables* – universal variables in which the laws of nature are truly constant.

The Conventional Interpretation of the STR Metric.

The conventional interpretation of STR postulates the relativistic metric:

$$\text{STR-Metric} \quad cd\tau = \sqrt{(c^2dt^2 - dr^2)}$$

$$\text{Or equivalently} \quad c^2d\tau^2 = c^2dt^2 - dr^2$$

On the left hand side we find an *invariant physical quantity*, viz. proper time, $d\tau$. This is measured by physical clocks – by *counting events*, such as revolutions of wheels, or cyclic atomic processes, etc. The count of such events between two points on the world-line of a physical system is invariant w.r.t. measurements of space, time or mass, by its operational definition. It is independent of any choice of coordinate system, or ‘frame of reference’. This quantity is therefore regarded as *physically real and fundamental*. It is certainly real: but the question we will ask is whether it is *fundamental*, or whether it should be modelled by a deeper construction.

On the right hand side we have a quantity measured via a frame of reference, by placing a metric, or system of numerical coordinates, on the measurement of *time intervals (durations)* and *spatial intervals (distances)*. The heart of the Special Theory of Relativity is therefore this idea that the quantity: $c^2dt^2 - dr^2$ must be the same *in any valid inertial frame*, for any valid coordinate system for space and time.

There are different choices of *space and time* coordinate systems that preserve this *proper-time interval*. In the first place, if we keep the time coordinates the same, we can use translated, rotated or reflected spatial coordinates, without affecting the quantity dr^2 , so $c^2dt^2 - dr^2$ is invariant. The chief interest however lies in transformations that affect *time and space together*. By placing a coordinate system in uniform relative motion w.r.t. another, we can make the separate time and space components - dt^2 and dr^2 – larger or smaller. But when they are combined as: $c^2dt^2 - dr^2$ they must always give the same quantity. I.e. $c^2dt^2 - dr^2 = c^2dt'^2 - dr'^2$, where (t,r) and (t',r') are alternative valid coordinates. The class of valid transformation between coordinate frames (the Lorentz transformations) is defined by this requirement.

The intervals dt and dr taken separately then *do not seem to be objectively real to the physicist* – since they change according to a ‘conventional’ choice of coordinate frame. According to the theory, there is no way to observe a uniquely correct choice between (t,r) and (t',r') . The central principle of relativity holds (the meta-physical law) that *the fundamental laws of physics (although we don't know what they are yet, in 1905 ... or 2005 ...) are equally valid when viewed in moving frames of reference*, so either choice of coordinate systems, suited to the two different frames, is adequate to express the laws of physics. This leads to the famous conclusion that there is no unique correct choice of time coordinates that uniquely defines simultaneity relations within the Special Theory of Relativity.

We now consider the *semantic interpretation* of the metric equation. What *quantities* do its terms refer to? On the left hand side is a measurable quantity, $d\tau$, *converted into a spatial distance* by multiplying by c . So this is a *construction* that results in a *distance in space*. What does the right hand side refer to? It is also a spatial distance, but a distance formed by combining a spatial interval dr , with a temporal interval dt , multiplied by c to turn it into a spatial interval so they can be combined. It is essential in physics of course that *we can only add quantities of the same physical kind together*.

Minkowski famously interpreted the right hand side as an *interval in the space-time manifold*. This is a four-dimensional manifold, with the ‘time’ dimension added orthogonally to the usual space dimensions. The interval defines an invariant distance along *time-like world lines*, which are trajectories of physical particles. However, if we are to be precise, the metric equation does not really add *time* to space: it adds *time-converted-to-space-by-multiplying-by-c* to space. That is: it adds *space* to more *space*. Time is ontologically a different kind of thing to space, its apples and oranges, and they cannot be literally added together, any more than energy and mass can be added together. We can only add quantities of the same physical kind together. We cannot take: $dt^2 - dr^2$. That doesn't make sense, it has no logical interpretation as a physical quantity. We must convert time, dt , to space by taking: cdt .

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The *space-time manifold* (which is really a *space+space manifold* if we identify its ontology properly) is taken as the fundamental physical entity that the metric equation describes. This is extended in ‘time’, converted to a spatial representation. The metric equation is taken to describe a fundamental property of the manifold: its *distance function*. The Lorentz symmetry of the metric is taken to reflect the defining physical property of the manifold. As such, we cannot even represent physical processes in the space-time manifold that contradict its metric property.

The Time Flow Interpretation of the STR Metric.

Let us now consider interpreting this in the time flow ontology. We still have exactly the same equation, but we want to hold that *there is a single unique physical frame of reference for time*, defining absolute simultaneity relations. Ignoring the question of whether this is detectable, the simple fact that we want to maintain that it is *real* compels us to reinterpret the metric equation. In the time flow ontology, *time is not an object like space*, it is the parameter of change, and we cannot sensibly combine it in the same manifold as space. We need to look at *time-slices of the world*, i.e. momentary spatial states, and interpret what kind of object this is – because *this is the world!* So let us first rearrange the equation, putting time on one side, and everything else on the other side:

$$cdt = \sqrt{(c^2d\tau^2 + dr^2)}$$

On the right hand side, we still have a *spatial quantity* – this is now a distance in a ‘*proper-time + space*’ manifold. This is also now just a simple Euclidean spatial metric. But still, we have the same kind of ontological problem that confronted Einstein and Minkowski: how can we combine *proper time* (amount of physical process) with *space*? We multiply it by *c* as a formal operation and that turns it into a *distance* – but what does this distance refer to?

The first natural and direct interpretation is simply to propose that the *proper time interval is a part of a real motion through a spatial manifold*. But this motion cannot be just in the ordinary three-dimensional space manifold, because that is measured by

r already. Let us assume instead that it is a fourth dimension of space, added (orthogonally) to ordinary space. We therefore *reinterpret proper time as motion through an extra dimension/s of space, in a new dimension, called W* , and write:

$$dw = cd\tau$$

The fundamental equation then becomes:

$$cdt = \sqrt{(dw^2 + dr^2)}$$

On the time flow view, time enters into the equations primarily to define *rates of change*, and dt , although presented like a ‘line-metric’, is really a differential operator on the $r(t)$ function. If we define *total distance travelled* by: $du = \sqrt{(dw^2 + dr^2)}$, then the *STR metric equation* really represents a very simple speed law:

$$du/dt = c$$

This means that *the total speed of all particles in the (4-dimensional) spatial manifold equals c* . This applies equally to light or matter – for light, $dw = 0$, for matter at rest, $dr = 0$. What remains is then to interpret the extra dimension/s of space, W . We can begin to reason thusly. W is an extra dimension/s of space in particles are free to move; but it must have a very small extension, since we do not perceive motion in W , and particles do not appear to disperse in W . Motion in W must be periodic. The simplest natural choice is to add either a two or three dimensional curled-up sub-space – a ‘pipe’ or a ‘ball’ or a ‘torus’ – orthogonal to ordinary three-dimensional space. In fact the best model appears to be a torus, and from this simple model, we can actually derive a range of properties that correspond exactly to properties of quantum particles – including intrinsic angular momentum, de Broglie wave length, up to the Klein-Gordon equation (relativistic version of the Schrodinger equation).

We see already that we have found the entrance to a new theory! This theory is developed in more detail elsewhere, as it represents a separate and speculative development of a new unified theory of physics, not to be confused with the central points being made here about the philosophy of time. The importance of this however is that *it shows that adopting time flow leads to a new theory development*.

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The development of this type of theory is not possible to *imagine* on the neo-positivist theory of static time. Of course, the resulting theory may be wrong. But it is not wrong because of anything the neo-positivists have said, or because of any reasons or arguments anyone has put forward against time flow, or on any evidence yet understood. It is not wrong because the current orthodox theories have been shown to be any better. It conforms to known physics very closely, and has substantial flexibility, in terms of possible combinations of dimensions and topology of the space, to keep adapting for a while if it ends up on a slippery slope of being modified to keep working - like the current orthodox theories. It is really a new class of models, and its ultimate success may or may not be easy to settle (ironically in this case, it is easier to settle if it is true, and may be harder to settle if it is wrong). But if it is wrong, it is because *it does not match reality empirically*. It is not wrong *a priori*, or because it is 'nonsense', or because it incorporates the concept of time flow, or because it postulates that there are absolute relations of simultaneity. No one will know if it is wrong or not if no one is allowed to develop theories of this kind, and no one is interested in examining them.

This question is really of importance in physics, because the neo-positivist doctrines about time represent an attempt to *severely limit the representational space for describing physics (and metaphysics)*. Built into their metaphysical theory are very strong assumptions about what kinds of physical theories it is possible to develop. In the first place, they want to *prescribe time symmetric theories* as the only possibility – unaware that their favourite theory, quantum mechanics, has been time asymmetric all along! Even more dogmatically however, they want to *prescribe relativity theory in its current form and interpretation as the only possible theory of space-time*. It has become impossible to propose any alternative to relativity theory in mainstream physics. Yet a whole class of possible alternative theories lie just under the surface of relativity theory if we allow ourselves to use a slightly larger representational space – the *time flow representation*. I demonstrate this in more detail elsewhere by developing this as a novel, realistic alternative unified theory. Without the freedom to think outside the neo-positivist dogmas it is not possible to conceive such a theory.