Prospects for Possibilism

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Overview

Putnam and Stein

The debate refers to two papers published by Putnam and Stein, respectively, in 1967 and 1968. In his paper, Putnam uses a geometric construction and a philosophical principle to conclude that in Special Relativity:

1. Future things are real even if they do not exist yet.
2. Contingent statements about future events already have a truth value (i.e., indeterminism is wrong).

Stein denies that these conclusions can follow from Putnam's *geometric construction* in support of his argument. He has a serious flaw in his deductive methodology because his philosophical assumptions are in the wrong domain of discourse.

Putnam's Geometry

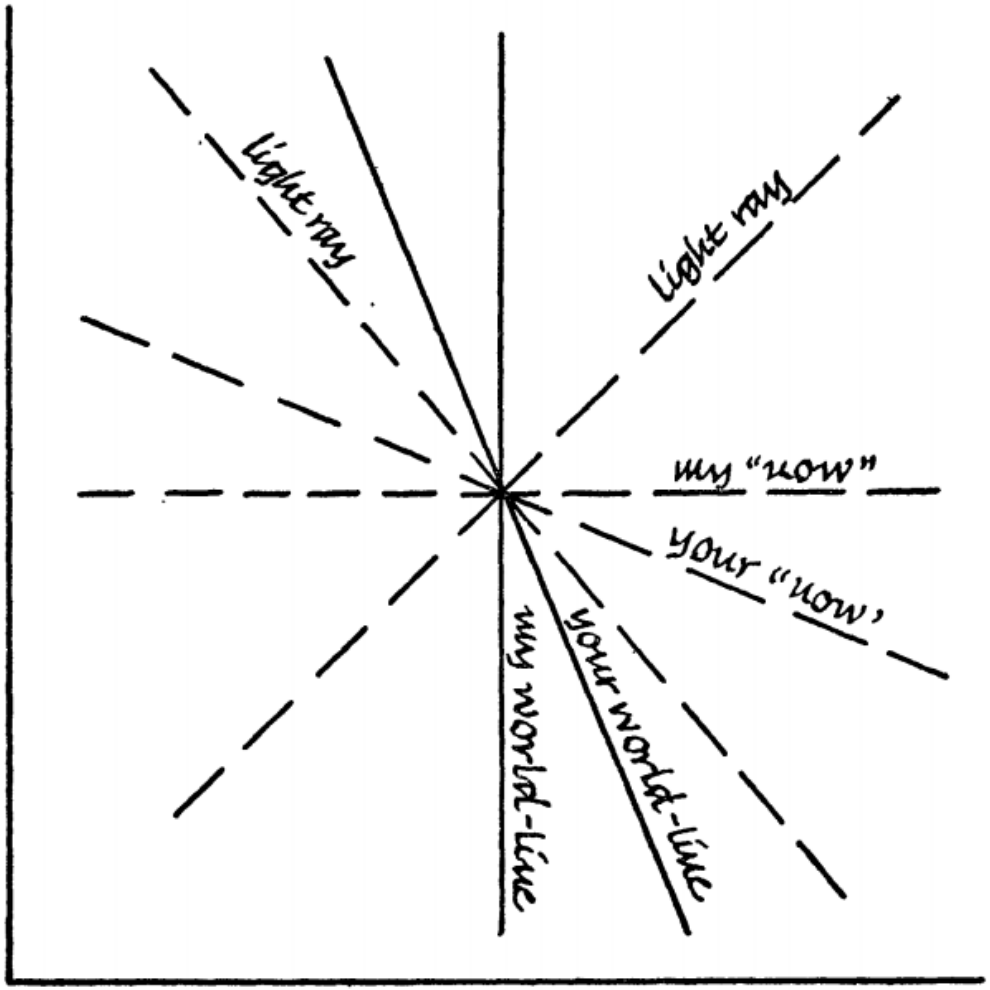

FIGURE 1

Presentism and Eternalism

Putnam's argument is pertinent to two competing metaphysics of time: presentism and eternalism:

Presentism.

All (and only) things that exist *now* are real:

$$P(e) \rightarrow \exists t_0 P_e(t_0) \wedge \exists t_1 \neg P_e(t_1), t_0 \neq t_1 \quad (1)$$

□

We can interpret this in terms of McTaggart's A-series.

Eternalism

All past, present, and future things that exist are real:

$$E(e) \rightarrow \forall e \exists t E_e(t) \quad (2)$$

We can interpret this in terms of McTaggart's B-series.

Putnam's Assumptions

If Putnam and Stein both deny presentism, then what's the problem? Well, look at Putnam's assumptions:

Assumption I

I-now am real. (Of course this assumption changes each time I announce I am making it, since 'I-now' refers to a different instantaneous 'me.')

Assumption II

At least one other observer is real, and it is possible for this other observer to be in motion relative to me.

The first two assumptions are uncontroversial. The third is the locus of Stein's criticism.

Putnam's Assumptions

Putnam calls his third assumption the *Principle that There Are No Privileged Observers* (PNPOs).

Assumption III

If it is the case that all and only the things that stand in a certain relation R to me-now are real, and you-now are also real, then it is also the case that all and only the things that stand in the relation R to you-now are real.

Putnam appeals to it explicitly to derive his conclusions. Stein identifies this as the source of his error.

Putnam's Assumptions in FOL

For the sake of analysis, we'll write Putnam's assumptions symbolically. Assumption I becomes

$$\exists m(mN) \tag{3}$$

where the predicate N denotes the predicate 'is real *now*.' Assumption II becomes

$$\exists y(yN) \wedge yVm \tag{4}$$

where the relation V denotes the relation 'in relative motion to.' So far so good.

Putnam's PNPOs in FOL

Putnam's PNPOs is more challenging to symbolize:

Assumption III

If it is the case that all and only the things that stand in a certain relation R to me-now are real, and you-now are also real, then it is also the case that all and only the things that stand in the relation R to you-now are real.

Hard to parse due to ambiguity about 'reality' of things and observers.

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How should we represent the reality of all and only the things symbolically? Some kind of quantification?

Stein's interpretation

Stein proposes to read the relation R as follows:

Stein

Let R be the relation that a is real to b such that if things are real to me, then things are real to you.

Then,

$$aRb \wedge bRc \rightarrow aRc \tag{5}$$

and we can verify that we have a relation that is

- symmetric
- reflexive
- transitive

i.e., an equivalence relation.

Equivalence Relations in Special Relativity

But, as we already saw in Judit's talk, we have the following theorem in Special Relativity:

Theorem (RS)

No non-trivial equivalence relation can be defined in RS.

Or, as Stein frames it,

Theorem (Stein)

In Einstein-Minkowski space-time there are no intrinsic geometrical partitions into equivalence classes at all, besides the two trivial ones: that into just one class (all of space-time), and that into classes each consisting of a single point.

Since the relation R is transitive, we see right away why it is inadmissible in Special Relativity.

PNPOs again

The problem with all of this is that this choice of definition of R is *disingenuous* to Putnam's original intent. Specifically, he lays the following three requirements for R:

1. R is to be identified with the relation of *simultaneity*.
2. The relata of R have to be understood in *tenseless* language (barring the indexicals me-now and you-now).
3. R must be restricted to physical relations that are independent of the choce of coordinate system.

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Our main focus is the first desideratum.

PNPOs in FOL – my way

I will represent the phrase all and only the things and being being real by the universal quantifier (i.e., existence implies reality). Then,

$$\forall\theta(\theta Rm \wedge yN \rightarrow \theta Ry). \tag{6}$$

We can rephrase this as a transitive relation:

$$\forall\theta(\theta Rm \wedge mRy \rightarrow \theta Ry) \tag{7}$$

provided that we can establish the conditions under which

$$yN \leftrightarrow mRy \tag{8}$$

is satisfied.

Upshot

Since we can read R as the relation of simultaneity in (6), (7), and (8), my symbolization of Putnam's PNPOs is more faithful to Putnam's original intent. That is, we can read

$$\theta R y \vDash Sim(< \theta_1, \ldots, \theta_n >, y) \tag{9}$$

for a collection of objects θ_i
Moreover, the upshot of this analysis is that we've recast the debate of whether the PNPOs is an admissible philosophical principle to refute presentism within the domain of discourse of Special Relativity to the question of whether (8) is admissible in something like RS or SpecRel. Let's compare how (8) fares in the geometry of pre-relativistic physics and in Einstein-Minkowski space-time.

Nowness in pre-relativistic physics

Following Stein, let's adopt the following definition

Definition (Chronological Ordering)

Let C be the relation capturing the fact that, for two events a and b, a is in the past of b if and only if b is in the future of a.

From here we have that

$$\neg aCb \wedge \neg bCa \rightarrow a \equiv b \tag{10}$$

Note that C is

- anti-symmetric
- reflexive
- transitive

i.e., it defines a partially ordered set. Label it $\langle N_t, \leq \rangle$.

Simultaneity in pre-relativistic physics

Given $\langle N_t, \leq \rangle$,

$$yN \leftrightarrow mRy \tag{11}$$

is immediately satisfied because there is *only one* possible foliation of space-time. In other words, the relation of simultaneity is transitive in pre-relativistic physics.

However, following Stein, we recognize that in special relativity there is *no unique* foliation of space-time into time slices. To see this, recall the classification of events in terms of the space-time interval $ds^2 = \eta_{\mu\nu} dx^\mu dx^\nu$:

- $ds^2 < 0$: time-like (τ)
- $ds^2 = 0$: light-like (λ)
- $ds^2 > 0$: space-like (σ)

Putnam's Confusion

Now then, we cannot take the relation of simultaneity-in-my-coordinate-system to be R without violating the way in which the principle that There Are No Privileged Observers is intended to be understood. Rather, we have to take R to be the relation of simultaneity-in-the-observer's-coordinate-system. Then, if I assume that all and only those things which stand in this relation R to me-now are real, I find that you-now are also real (since I-now and you-now are simultaneous-at-a-point and, hence, simultaneous in every coordinate system).

Putnam's Confusion

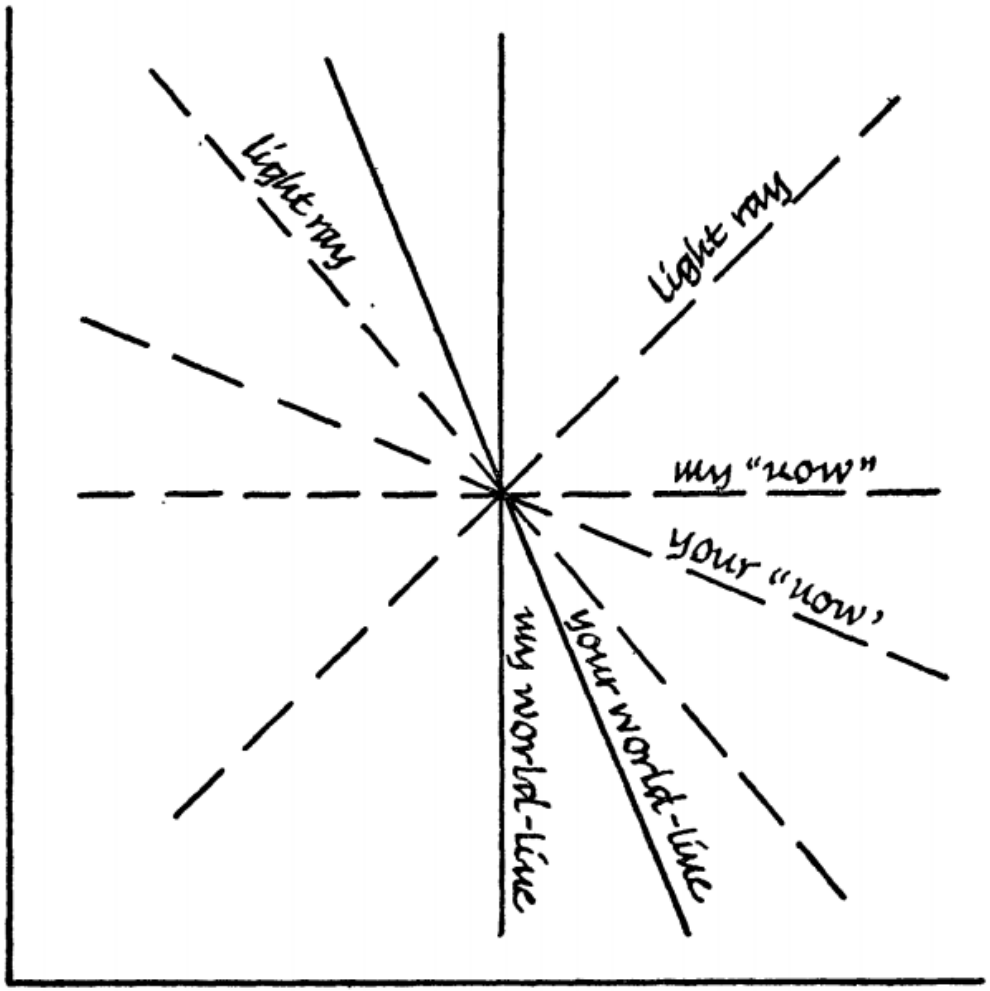

FIGURE 1

Simultaneity in Special Relativity

However, in Special Relativity *all* the physical meaning of the theory is contained in the space-time interval and *none* of it depends on the coordinates. This is what we mean when we say that the theory is covariant. So, at best,

$$mRy \leftrightarrow \eta_{\mu\nu}(x^{\mu}(m), x^{\nu}(y)) > 0. \tag{12}$$

But even this is all too tenuous. Besides, it's not formulated within FOL.

Simultaneity Slices

As a way forward, consider Saunders' treatment of the issue:

Saunders

Let $\{M_t\}$ be any time-like partition of the Einstein-Minkowski manifold (e.g., Cauchy Surfaces given within the ADM formalism). Then, we may recast the relation R in Putnam's PNPOs as

$$R = \{\langle a, b\rangle | a \in M_t \wedge b \in M_t\} \tag{13}$$

Let me-now be located at the event a and you-now be located at the event b. Then, the following observation applies:

$$\forall a \forall b \exists c (aRc \wedge \neg bRc) \tag{14}$$

PNPOs refuted

Observation (14) has the following implications:

- We can *always* find a point c that is space-like separated from a but *is not* space-like separated from b.
- There are *infinitely* many ways in which space-like surfaces can be defined relative to a point.
- Whenever two observers have a relative velocity, their time-axes are oriented differently such that their space-like surfaces fail to be identical.

Putting all of this together, we conclude that in Special Relativity,

$$yN \nleftrightarrow mRy. \tag{15}$$

Thus, the PNPOs is inconsistent with Special Relativity.

If not Presentism then Eternalism?

Despite the failure of PNPOs, we can still accept Putnam's first conclusion that future (and past) things are real. Then Special Relativity does contradict presentism. Should we adopt eternalism?

Benefits

- Earlier and later relations on same footing as here and there relations.
- Cashes out on conservation of energy by Noether's theorem.
- Captures time-reversibility in physics.

Challenges

- The Second Law of Thermodynamics: $dS = \frac{\delta Q}{T} \geq 0$.
- Manifest time predicates such as fate, synchronicity, predetermination, etc. unexplained.
- Has to explain why some the truth-value of some future events are indeterminate.

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Motivating Possibilism

Focusing only on whether the truth-value of predicates is determined in Einstein-Minkowski space-time, we already encounter a considerable challenge for the eternalist:

Challenge to the eternalist

Why can't we remember the future?

But to make this more tractable, consider the classical example

S. There will be a space-fight tomorrow.

Can we determine the truth-value of S *tenselessly*? If we answer no, we become indeterminists along with Aristotle.

Possibilism

Noting that only present and past events have determinate truth-values, Saunders gives the following definition for possibilism:

Definition (Possibilism - Saunders)

Possibilism is the thesis that only the present and the past is real.

But, by the preceding, this is immediately incompatible with Special Relativity! We shouldn't confuse the determinateness of truth-values for events with their reality!
Then, possibilism becomes an epistemic viewpoint about the nature of time. In pre-relativistic physics, all events become determinate at each N_t. But this notion is unavailable in Special Relativity. The key problem, Stein notes, hinges on the notion of *becoming* determinate.

Stein on Determinateness

In Special Relativity, the notion of 'becoming' may be epitomized as follows:

Definition

For an event–a man considering, for example–at a space-time point a those events, and only those, have already become (real or determinate), which occur at points in the topological closure of the past of a.

From here, we see that the predicate of having a determinate truth value at time t is not relativistically invariant. We have to replace it with the predicate of having a determinate truth value for me-now. But then this starts to sound solipsistic.

Stein on Contemporaneity

We can avoid this solipsism by recognizing that in Special Relativity we still have signalling theory. Or, as Stein calls it, 'contemporaneity':

Definition

Two such processes may be said to be said to be contemporaneous if part of each is past to part of the other–in other words, if mutual influence ('communication') is possible between them.

That is, multiple observers can share a commonly-determined past.

Possibilism - A tentative Definition

But this is not *all* their past. In Special Relativity, past events with a determinate truth value may occur for one observer but not the other.

Definition (Possibilism - epistemic)

Possibilism is the thesis that, predicates have determinate truth-values only for events that are present to observers or contemporaneous to their shared past.

Either way, possibilism as an epistemic view about events is not something we can determine solely within Special Relativity. For a collection of predicates $< P_1, \ldots, P_n >$ I propose the following *sketch*:

$$\Box(\varphi(P_i) = T \vee \varphi(P_i) = F) \leftrightarrow \{P_i(t) : t \leq M_t\} \tag{16}$$

$$\Diamond\{P_i(t) : t > M_t\} \rightarrow \neg(\varphi(P_i) = T \vee \varphi(P_i) = F) \tag{17}$$

I leave this as open question of to modal logic.

Thank you for your attention!

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