

Lecture 21: Special relativity

Outline of philosophical issues

1. presentism versus eternalism (Putnam's argument)
2. the twin paradox
3. Lorentz contraction and four-dimensional objects
4. surprise issue

Intuition pumps

1. Constancy of the speed of light in all reference frames
 - (a) One way speed (addition of velocities)
 - (b) Round trip speed
2. Relativity of simultaneity

The geometry of simultaneity

light cones \Leftrightarrow null tangent vector

inertial trajectory \Leftrightarrow timelike tangent vector

Minkowski metric and orthogonality

spacelike hypersurface \Leftrightarrow spacelike tangent vector

constancy of the speed of light $c = 1$

? hyperbolic angles

Putnam's argument for eternalism

1. Conclusion: "... contingent statements about future events already have a truth value" (p 247)

"... the notion of being 'real' turns out to be coextensive with the *tenseless* notion of existence"

2. Assumptions from common sense

- (a) I-now am real
- (b) Two people A and B can move past each other
- (c) There are no privileged observers (democracy of reference frames)

If A takes B to be real, and B takes X to be real, then A should take X to be real

If A takes B to be just as reliable as himself, and if B currently (in A's frame of reference) believes that "the event X has occurred", then A should believe that "the event X has occurred"

3. Putnam's construction

- (a) Let A and B be located at the same place, but have velocity vectors that are not parallel
- (b) There is an X such that:
 - i. B should take X to be real (since X lies in the simultaneity surface for B)
 - ii. X lies in the future of the simultaneity surface for A
- (c) So there is an X that is in the future for A, but that A should judge as real

4. Ways out from Putnam's conclusion

Treat all spacelike separated events as vaguely "now"

5. Modified version of Putnam's construction

Consider two observers A and B such that B lies on A's simultaneity surface, and such that the instantaneous velocity vectors of A and B are not parallel

In this case, there is an event X that lies on B's simultaneity surface, and such that X is in the causal future of A

6. Responses to Putnam

- (a) Neo-lorentzian

There is a preferred frame of reference

- (b) Howard Stein

- i. “Now” for me is my past lightcone
- ii. “Now” for me is a point

(c) Momentum and context

Statements are made in a context

Context includes state of motion

Points for discussion

- Are there (objective) facts about which events are simultaneous?
 - Can it be objectively true that X and Y are simultaneous relative to A?
- “...the problem of the reality and the determinateness of future events is now solved. Moreover, it is solved by physics and not by philosophy. We have learned that we live in a four-dimensional and not a three-dimensional world” (p 247)

More literature on this topic

- C.W. Rietdijk, “A rigorous proof of determinism derived from the special theory of relativity”
- H. Stein, “On Minkowski spacetime”
- H. Stein, “On relativity theory and the openness of the future”
- T. Sider, *Four Dimensionalism: An Ontology of Persistence and Time*
- M. Hinchliff, “A defense of presentism in a relativistic setting”
- S. Saunders, “How relativity contradicts presentism”
- C. Rovelli, “Neither presentism nor eternalism”
- H. Halvorson, “Momentum and context”
- A. Ney, *Metaphysics*