

The concept of a frame of reference

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February 14, 2023

Presented to “Physics meets philosophy” group, University of Vienna

1. “Reference frame” is a concept that physicists learn to use effectively, often without asking themselves too many philosophical questions about what it means
Is “objective reality” just what is invariant across all reference frames? E.g. “The spacetime distance between x and y is λ ”
Are frame-relative descriptions ultimately reducible to the frame-independent facts? E.g. “The velocity of the rocket is v (relative to my frame of reference)”
Are frames of reference just “training wheels” that are to be thrown away when a theory becomes mature?
2. “Reference frame” is a concept that is unfamiliar to most philosophers
 - (a) However, it is analogous to concepts that have been of great importance in (analytic) philosophy for the past ca. fifty years
context, indexical, relativism, etc.
E.g. “The treasure chest is a kilometer due west from me.”
 - (b) Debate about how deep indexicality goes
 - i. Inessential indexicality (absolutism): there is a “book of the world” Γ that grounds all true indexical statements
 - ii. Essential indexicality (relativism):
3. How does the philosophical debate make a difference for physics?
 - (a) Is absolutism the motive behind the fight to “fix” quantum theory?
Einstein, John Bell, etc.
4. Do discoveries in physics & mathematics favor one or other philosophical position?
 - (a) In 1905, STR seems to push toward relativism

- (b) In 1908, Minkowski spacetime seems to push toward absolutism
- (c) Does the existence of an intrinsic/geometric formulation of a theory provide support for absolutism?

5. Open questions

- (a) Would it be helpful to think of “reference frame” as basically the same idea as “context” in semantics?
- (b) Does the concept of a reference frame generalize naturally to the concept of an “experimental context”? More generally, how does recent physics develop the concept of reference frame?
E.g. Bolted down vs free-floating slit apparatus
- (c) Is “reference frame” a mechanical or semantic concept? Does changing reference frame mean changing a physical state of affairs, or changing our descriptive apparatus?
 - i. E.g. Bohr’s response to EPR
“Of course there is no question of a mechanical disturbance of the system under investigation during the last critical stage of the measuring procedure. But even at this stage there is essentially the question of *an influence on the very conditions which define the possible types of predictions regarding the future behavior of the system.* Since these conditions constitute an inherent element of the description of any phenomenon to which the term ‘physical reality’ can be properly attached, we see that the argumentation of the mentioned authors does not justify their conclusion that quantum-mechanical description is essentially incomplete.”
 - ii. E.g. Unruh effect: particles in the vacuum
Does an accelerated observer create particles in the vacuum, or is it just that “there are particles” is true relative to an accelerated frame of reference?
- (d) Practically speaking, how do we manage reference frames so as to achieve effective (*eindeutig*, objective) communication?