Philosophy of Physics, Fall 2024

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Today we will talk logistics, and then engage in an uninformed free-for-all about the topics of the seminar. The goal of the latter is to set a baseline for improvements in our views throughout the semester.

Logistics

- Website at hanshalvorson.dk/courses/phi538_f2024

- Eight sessions with HH, then Carlo Rovelli leads four
- Each session is 1hr math and 1.5hrs discussion
  - Math part based on Malament's *Foundations of General Relativity*
  - Discussion part based on Earman's *World Enough and Spacetime* and selected additional papers
  - Focus topic is substantivalism vs relationalism about spacetime. We will also make brief forays into causality, the direction of time, and foundations of quantum mechanics.
- PhD students can earn a formal methods unit by doing weekly problems
- PhD students can earn a unit by doing a presentation and paper
- UG students can earn course credit by doing three short "projects"

Discussion

"What has physics to do with philosophy?" and other meta-philosophical questions

- Generalized empiricism: our data includes the theories and practice of physics
- In an old-fashioned (circa 1989) view, the job of the philosopher of physics is to *interpret* the theories of physics: to say what the world must be like in order that these theories could be true. But that seems to be based on an analogy (with formal logic) that doesn't really apply to scientific theories.
- Possible worlds framework

  Many of the debates in philosophy of physics are carried out in the (vague) possible words framework that was so powerfully employed by Lewis et al.

  A common sort of question is how the models of a theory T are related to possible worlds. E.g. do isomorphic models necessarily represent the same possible world?

  HH: The pseudo-precision of this framework now brings about more confusion than clarification.
- Semantic disputes, or just how agnostic can one be without quitting philosophy?

  HH: The idea of a single, preferred formulation is absurd. One's metaphysical commitments are captured not just by the formulation one accepts, but by one's tolerance for re-formulation. Example: spacetime manifolds versus Einstein algebras.
- A lot of philosophy of physics is driven by some (ill-defined) commitment to the "grand naturalist project". E.g. mentaculus
- A lot of philosophy of physics is about the extent to which the deliverances of physics call for revisions of the manifest image.
- A lot of philosophy of physics is about how to understand relations between theories – especially equivalence and reduction.

Presentism versus eternalism

- Einstein's special theory of relativity (1905) has been taken by some to provide new, and rather decisive, evidence for eternalism.
- Why? Space and time put together into a four-dimensional manifold M. And there is no preferred way to divide M up into a sequence of successive "nows".
- Rovelli argues that neither presentism nor eternalism is right.

Substantivalism versus relationalism

- The classic debate is found in the Leibniz-Clarke correspondence, with Clarke defending Newton's view that space is eternal and unchangeable, and Leibniz arguing the space is a manifestation of relations between created objects.
- Logical positivists (Schlick, Reichenbach) argued that Einstein's general theory of relativity (1915) provides new, and rather decisive, evidence for relationalism.
- 1960s and 70s philosophers (Putnam, Earman, Nerlich, etc.): the positivists didn't understand how GTR works. It's actually much more friendly to substantivalism.
- 1980s Earman and Norton: substantivalism leads to absurdity.
- HH: GTR quantifies over spacetime points. But it doesn't name points, and treats them as interchangeable. Hence, the user isn't forced into anything like robust existential commitment.
  - In addition, I don't take quantifiers to indicate mandatory existential commitment, especially when there are alternative formulations that do not quantify over the same things.

The direction of time (and reductionism)

There's an apparent contradiction between the following three facts:

1. Thermodynamics is manifestly directed, e.g. entropy never decreases in the forward time direction
2. Fundamental physics is manifestly time reversal invariant
3. Thermodynamics is reducible to statistical mechanics

The most popular approach is to look for an *ontological* solution to this paradox — e.g. to deny #2, or to add a direction of time into the "best system" of local matters of fact.

HH: I prefer to question #3. What's more, I'm simply not bothered by the fact that there is a feature of our manifest experience that cannot be reduced to fundamental physics. We should try to understand how the description from physics coheres with what else we know about the world (possibly making updates on both sides of the equation), but no apriori reason to expect reducibility.

Causality (and reductionism)

Causality doesn't appear in Newtonian mechanics. This led some philosophers (e.g. Russell) to conclude that causality isn't part of the fabric of the world.

The argument here isn't quite as tight as for the direction of time, especially since Newtonian particle mechanics is no longer considered fundamental, having been replaced by quantum

field theory. However, causality is typically thought to be temporally asymmetric, whereas "non-problematic" fundamental physics is temporally symmetric.

This issue is complicated by the fact that there are dozens of competing philosophical analyses of causation, e.g. counterfactual, conserved quantity, interventionist.

Philosophy of quantum mechanics

According to many philosophers of physics, the quantum theory of undergraduate physics textbooks is *inconsistent*, and so cannot possibly be true. In fact, some go further and say that quantum theory is not even a physical theory in any reasonable sense of the word.

The basic issue is that textbooks say things like this:

> When we make a measurement, then the state of the system collapses instantaneously to a new state that has a sharp value for the measured quantity.

But they don't say what counts as a measurement, nor do they describe this collapsing process by the same laws it uses to describe other processes. Either the theory predicts something false (no collapse), or it is incoherent (collapse as ad hoc modification of the laws).

One cheap (non-philosophical) way out is to say: "don't worry about what quantum physics says about the world; it works just fine." That way out isn't available to those of us who aspire to be generalized empiricists.

Another cheap (non-scientific) way out is to say: "aha, this is where mind meets matter! The connection is, as Descartes pointed out, incomprehensible!"

Rovelli isn't as harsh as the philosophical critics, but neither does he take the easy way out. He thinks that QM has a profound metaphysical lesson: there are no absolute facts, but only facts about one object relative to another object.