Philosophy of Physics

Professor: Hans Halvorson (hhalvors)

There is a (non-local) AI for the course (Alex Meehan). He will give the lectures in the fourth week, but otherwise he act upon us from a distance of approximately 250 miles.

The course is split into two components of approximately eight and four weeks respectively. In the first component, we will ask why so many people find quantum theory to be worth philosophizing about. (Is there a problem with quantum theory? Does quantum theory demand a change in the way we think about the world? Does quantum theory demand a change in how we think about ourselves?) We'll focus on the measurement problem, entanglement, no hidden variable theorems, and the relationship between quantum nonlocality and relativistic causality. (We will mostly rely on handouts, but there is one required book: Richard Healey, *The Quantum Revolution in Philosophy*.) In the second component, we will have guest lectures from physicists and philosophers working at the cutting edge of building this new worldview of physics.

Assessment: There will be approximately five problem sets for the first component of the course. For the second component of the course, there will be one longer paper (due on Dean's date), and a few response exercises in conjunction with the guest lectures.

First component

Week 1: Overview, a little history, and a couple experiments

> For Wednesday's lecture, please read Weinberg, "The trouble with quantum mechanics" and Maudlin, selection from *Philosophy of Physics: Quantum Theory* (found in the Course Materials section of the Blackboard site)

Week 2: Experiments and superposition

Week 3: The measurement problem

Week 4: More experiments, tensor products and dynamics

Week 5: The uncertainty principle, Kochen-Specker theorem

Week 6: EPR and Bohr

Week 7: Bell, quantum nonlocality and relativity

Week 8: Interpretations

Second component

April 1: Juan Maldacena, IAS. String theory

April 6: Adam Becker. Author of *What is Real? The Unfinished Quest for the Meaning of Quantum Physics.*

April 8: Carlo Rovelli, Marseille. Quantum gravity. Author of *Seven Brief Lessons on Physics*

April 22: Sean Carroll, CalTech. Physicist, philosopher, and author of many books such as *Something Deeply Hidden, The Big Picture,* and *From Eternity to Here*

April 27: Jill North, Rutgers Philosophy

April 29: Sheldon Goldstein, Rutgers Math, Physics, and Philosophy. Alternatives to orthodox QM, especially Bohm

TBD: Herman Verlinde, Princeton Physics. Black holes, string theory