



# Philosophy of Physics PHIL 146

## Puzzles of Dynamics

Fall 2018, TuTh 3:30  
HSS 1128A

**Prof Craig Callender**

This quarter the course will focus on the philosophical foundations of dynamics. We'll begin with classical mechanics and some puzzles about determinism, action-by-contact, and locality. Then we'll introduce probability and dive into thermodynamics, statistical mechanics and the problem of the direction of time. We'll then investigate the strange quantum world, looking first at the notorious quantum measurement problem (the Schrodinger's Cat problem) and then one of the oddest phenomena in the world, Bell nonlocality.

These topics are deep ones that have attracted some of the all-time greatest thinkers in the history of science and philosophy, e.g., Laplace, Boltzmann, Maxwell, Russell, Einstein and Bell.

There is no prerequisite for the course. A tolerance for math is important, however, as we'll dive into physics. Every effort will be made to present the physics as cleanly and accessibly as possible. Students without technical backgrounds can and do thrive in this course, so long as math anxiety is left behind.



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**Final Exam** Take home exam, due 12/10/2018, 3pm

**Reading** *Free* journal articles, chapters, etc on triton.ed.  
David Albert, *Quantum Mechanics and Experience*, e-textbook,  
\$17.60

**Attendance** I guarantee that every single lecture will contain material not found in the reading—indeed, typically there will be a lot of such material. Given all the quizzes, anything short of regular attendance will severely damage your grade.

**Grade** 6 short assignments/quizzes (6x5=30%), participation (5%), a midterm (30%) and a take-home final examination (35%).

**Fine Print** In your assignments, all sources, must be appropriately acknowledged. All answers given must be in your own wording. Closely paraphrasing or simply copying the work of others (such as authors of books or articles, or classmates, or Wikipedia) is not allowed. Plagiarism, the stealing of an idea or actual text, and other forms of academic dishonesty will be immediately reported to the Academic Integrity Office. Students agree that by taking this course all required papers, quizzes and homework may be subject to submission for textual similarity review to Turnitin.com for the detection of plagiarism. Use of the Turnitin.com service is subject to the terms of use agreement posted on the Turnitin.com site. The University's Policy on Integrity of Scholarship at [www.senate.ucsd.edu/manual/appendices/app2.htm](http://www.senate.ucsd.edu/manual/appendices/app2.htm). Students who wish to take a make-up exam or hand in material late must inform me (by phone or email) well ahead of time. In order to qualify for a make-up exam, appropriate evidence of the most severe circumstances must be produced by the student. I will determine, in consultation with the student, what qualifies as appropriate evidence. Finally, texting, emailing, facebook, etc., during lecture is not allowed.



<b>Week 1</b>	Zeno's Paradoxes
<b>Week 2</b>	Physical Determinism
<b>Week 3</b>	Locality and Action by Contact
<b>Week 4</b>	Newtonian Physics, Thermodynamics and Statistical Mechanics
<b>Week 5</b>	The Problem of the Direction of Time
<b>Week 6</b>	Quantum Phenomena and Math
<b>Week 7</b>	Bell's Theorem
<b>Week 8</b>	The Measurement Problem
<b>Week 9</b>	EPR and Hidden Variables
<b>Week 10</b>	Some Interpretations: Bohr, Bohm, Everett, Ghirardi

Each week I will type up a handout detailing the reading for the next week or set of topics. The readings will be on TED. You are expected to do the relevant readings prior to the relevant class meeting.



You might want another book to help guide you through the course—or you might have further interest in a topic. Unfortunately, no one book covers everything we will. Here are a bunch of good books that connect to parts of what we’ll do (for readings targeting relativity and spacetime, see last year’s syllabus on [craigcallender.com](http://craigcallender.com)).

- Lange, M. *An Introduction to the Philosophy of Physics*
- Earman, A *Primer on Determinism*
- Sklar, L. *Philosophy of Physics*
- Rickles, D. *The Philosophy of Physics*
- Maudlin, T. *Quantum Nonlocality and Relativity*
- Lewis, P. *Quantum Ontology*
- Norsen, T. *Foundations of Quantum Mechanics*
- Bricmont, J. *Making Sense of Quantum Mechanics*
- Albert, D. *Quantum Mechanics and Experience*
- Becker, A. *What is Real?*
- Callender, C. *What Makes Time Special?*
- Price, H. *Time’s Arrow and Archimedes Point*
- Bell, J.S. *Speakable and Unspeakable in Quantum Mechanics*
- Arntzenius, F. *Space, Time and Stuff*

Please don’t hesitate to ask me for further recommendations.

Here are a few related events this term.

October 12  
Barry Loewer (Rutgers University)  
"What Breathes Fire into the Equations?"  
HSS 7077, 4pm, UC San Diego

October 20  
Craig Callender  
"TARDIS"  
Fleet Science Center

December 3  
Craig Callender  
"Flowing Time or Flowing Self?"  
SDSU