Introduction to Philosophy of Physics

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This course offers an introduction to the philosophy of physics, which deals with methodological, epistemological, and metaphysical issues in physics. It consists of seven modules offering a rich menu in philosophically deep questions arising in modern physics, concentrating on space and time in classical physics and in special and general relativity (and beyond), and quantum mechanics, the measurement problem and quantum non-locality.

The seven modules are as follows:

1. Organization and introduction: what is philosophy of physics, what are physical theories, and what is determinism?

2. Substantivalism vs relationalism: Newton, Leibniz, Kant, and time in Newtonian physics in general

3. Time in special relativity: relativity of simultaneity, Minkowksi spacetime, and implications for the metaphysics of time

4. Time in general relativity, cosmology, and beyond

5. Moving backward and forward in time: time travel in modern physics

6. Quantum mechanics: phenomena and theory

7. Quantum mechanics: the measurement problem and quantum non-locality

Accessibility and Prerequisites. This course will be self-contained and has no prerequisites. While some background in physics, mathematics, and philosophy will be helpful, I will not assume any specific knowledge beyond high school mathematics.

Recommended texts

- Nick Huggett. *Everywhere and Everywhen: Adventures in Physics and Philosophy.* Oxford University Press (2010).

- Most readings are available at icorsi at `https://www.icorsi.ch/course/view.php?id=15775`.

Course requirements and evaluation

The grade for this course will be determined by the points obtained from a single type of evaluation:

1. *Homework* (30 points): There will be **three sets of homework assignments** each worth 10 points due on the following dates:

   - Sunday, 5 March 2023
   - Sunday, 12 March 2023
   - Sunday, 26 March 2023

The solved homework must be uploaded (as PDF files) to iCorsi at `https://www.icorsi.ch/course/view.php?id=15775` before midnight on the due date.

Tentative schedule

Readings: for each session, the listed readings must be read in advance; the readings with an asterisk are background reading. Each of the modules will be covered in approximately 4 lessons.

1 Organization and introduction

- *Monday, 27 February 2023, 13:30-17:00*

Readings:

- Huggett, Ch. 1.

- *Christian Wüthrich. *An Invitation to Philosophy of Physics*, Ch. 1.

- *Christian Wüthrich. Can the world be shown to be indeterministic after all?. In Claus Beisbart and Stephan Hartmann (eds.), *Probabilities in Physics*, Oxford University Press (2011), 365-389.

2 Substantivalism vs relationalism

- *Tuesday, 28 February 2023, 09:30-13:00*

Readings:

- Huggett, Ch. 9 (and *Ch. 16 for Kant's argument).

- *Nick Huggett and Carl Hoefer. Absolute and relational theories of space and motion. *Stanford Encyclopedia of Philosophy* (Spring 2018 edition), Edward N. Zalta (ed.), `https://plato.stanford.edu/archives/spr2018/entries/spacetime-theories/`, particularly §4, §6.5.

3 Time in special relativity

- *Monday, 6 March 2023, 13:30-17:00*

Readings:

- Huggett, Chs. 14, 15.
- *Michel Janssen. Appendix: special relativity. In Michel Janssen and Christoph Lehner (eds.), *The Cambridge Companion to Einstein*. Cambridge (2014), pp. 455-506 (excerpts).

4 Time in general relativity, cosmology, and beyond

- *Tuesday, 7 March 2023, 09:30-13:00*

Readings:

- Tim Maudlin. *Philosophy of Physics. Space and Time*. Princeton University Press (2012), Ch. 6 (pp. 126-152).

5 Moving backward and forward in time

- *Monday, 13 March 2023, 13:30-17:00*

Readings:

- Huggett, Ch. 12 and 13.
- *David Lewis. The paradoxes of time travel. *American Philosophical Quarterly* **13** (1976): 145-152.
- *Frank Arntzenius and Tim Maudlin. Time travel and modern physics. *Royal Institute of Philosophy Supplement* **50** (2002): 169-200.

6 Quantum mechanics: phenomena and theory

- *Tuesday, 14 March 2023, 09:30-13:00*

Readings:

- Tim Maudlin. *Philosophy of Physics. Quantum Theory*. Princeton University Press (2019), Ch. 1 (pp. 6-29).
- *Jenann Ismael. Quantum mechanics. *Stanford Encyclopedia of Philosophy* (Spring 2015 edition), Edward N. Zalta (ed.), `https://plato.stanford.edu/archives/spr2015/entries/qm/`, particularly §3.
- *David Albert. *Quantum Mechanics and Experience*. Harvard University Press (1992), Ch. 1 and 2.

7 Quantum mechanics: the measurement problem and quantum non-locality

- *Monday, 27 March 2023, 13:30-17:00*

Readings:

- N David Mermin. Is the moon there when nobody looks? Reality and the quantum theory. *Physics Today*, April 1985, pp. 38-47.

- *Tim Maudlin. Three measurement problems. *Topoi* **14** (1995): 7-15.