

## PHIL-UA 94/PHYS-UA 190 Course Syllabus (Spring 2016)

### PHILOSOPHY OF PHYSICS

#### CONCEPTUAL FOUNDATIONS OF SPACE AND TIME

Section 001: MW 9:30–10:45 PM (TISC LC9)

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**Office:** 19 WSN, Rm. 400  
**Office Hours:** Thursdays 1–3 PM

**OVERVIEW:** This course will examine the roles of space, time, and motion in physical theorizing, and various puzzles and questions associated with those concepts. Among the questions we'll investigate are: Do space and time (or spacetime) exist in the same sense as material objects? Are there objective facts about the geometry of physical space, or are they in some way conventional? Does time (unlike space) 'pass' or 'flow' in a particular direction, such that only the present moment is real? And is time travel possible, conceptually and physically? Indeed, how do the considerations relevant to addressing these questions change as we move from Newtonian physics to the modern spacetime frameworks of special and general relativity? No background in physics or philosophy is presupposed, but you should be prepared to engage with material from both disciplines.

**PREREQUISITE:** One introductory philosophy course.

**REQUIRED TEXTS:** The following texts have been ordered for the course:

Geroch, Robert. 1978. *General Relativity from A to B*. University of Chicago Press.  
(ISBN: 0-226-28864-1)

Huggett, Nick, ed. 1999. *Space from Zeno to Einstein*. MIT Press.  
(ISBN: 0-262-58169-8)

Maudlin, Tim. 2012. *Philosophy of Physics: Space and Time*. Princeton University Press  
(ISBN: 978-0-691-14309-5)

Sklar, Lawrence. 1974. *Space, Time, and Spacetime*. University of California Press.  
(ISBN: 0-520-02433-8)

Additional readings will be available online at the course site.

**COURSE REQUIREMENTS:** Requirements for the course are three medium-length papers (5–7pp.), a final exam, and regular participation and attendance in both lecture and recitation. Papers will be due in class on the following dates: 9 March, 18 April, and 9 May. Each component of the course (three papers, final exam, attendance and participation) will count for 20% of your final grade. *Please note that you must complete all assignments in order to pass the course.*

You must sign up for one of the following recitation times, which will be run by Dan Hoek: Fridays 11:00 AM – 12:15 PM and 12:30 PM – 1:45 PM.

**ACADEMIC HONESTY:** The NYU Honor Code is in effect for this class. I take plagiarism and other forms of academic dishonesty very seriously. Violations automatically result in a failing grade for the entire course (not simply the assignment) *and* a referral to the Committee on Student Discipline. It's your responsibility to familiarize yourself with the following University website (and links therein): <http://cas.nyu.edu/page/academicintegrity>. If questions arise as to what constitutes plagiarism, *please ask me*.

## OUTLINE OF SCHEDULE

*Specific readings will be assigned in class, and will include a subset or superset of this list.*

**27 Jan.: Introduction. What is the philosophy of spacetime physics?**

### SPACE, TIME, AND MOTION IN CLASSICAL PHYSICS

**1 Feb.: The Nature of Instantaneous Motion**

Central readings:

Huggett, pp. 31–37, 48–50 (selections from Plato, Simplicius, Aristotle)

Arntzenius 2000. “Are There Really Instantaneous Velocities?”, *The Monist*:  
pp.187–201.

**3 Feb., 8 Feb.: The (Apparent) Metaphysical and Geometrical Underpinnings of Newton’s Laws**

Central Readings:

Maudlin, pp.1–16, 24–34

Huggett, pp.107–126 (Newton)

Geroch, pp.3–36

**10 Feb., 15 Feb.: The Leibniz/Clarke Correspondence**

Central Readings:

Huggett, pp.143–159 (Leibniz, Clarke)

Sklar, pp.167–169, 173–181

Maudlin, pp.34–43

**(17 Feb.: no class – Presidents’ Day)**

**22 Feb.: Newton’s Bucket**

Central Readings:

Maudlin, pp.17–24

Sklar, pp.182–193

**24 Feb., 29 Feb., 2 March: Relationalism and Its Discontents**

Central Readings:

Huggett, pp.169–181 (Berkeley, Mach)

Sklar, pp.169–173, 194–202

Maudlin, pp.43–46

Butterfield 1984. “Relationalism and Possible Worlds”, *British Journal for the Philosophy of Science*: pp.101–113.

**7 March: Incongruent Counterparts**

Central Readings:

Huggett, pp.197–203 (Kant)

Brighouse 1999. “Incongruent Counterparts and Modal Relationalism”, *International Studies in the Philosophy of Science*: pp.53–68.

**9 March, 21 March: Neo-Newtonian Spacetime**

Central Readings:

Sklar, pp.202–206, 225–234

Maudlin, pp.47–66

Geroch, pp.37–52

Teller 1991, “Substance, Relations, and Arguments about the Nature of Space-Time”, *Philosophical Review*: pp.363–383.

**(14 March, 16 March: no class – Spring Break)**

**23 March, 28 March: The Epistemology of Physical Geometry**

Central Readings:

Huggett, pp.213–221, 235–241 (Kant, Poincaré)

Sklar, pp.13–27, 65–66, 79–146

Reichenbach 1958. *The Philosophy of Space and Time*. Dover. pp.1–19, 28–37.

## SPACETIME FOUNDATIONS OF SPECIAL RELATIVITY

### **30 March: The Geometry of Minkowski Spacetime**

Central Readings:

Maudlin, 67–76, 83–87

Sklar, pp.56–61

Geroch, pp. 67–112

### **4 April: Experimental Motivations, Simultaneity, Conventionality**

Central Readings:

Sklar, pp.244–272, 276–294

Geroch, pp.53–63, 113–158

Maudlin, pp.77–83, 87–105

### **6 April: Bell’s Puzzle**

Central Readings:

Maudlin, pp.106–125

Sklar, pp.294–296

### **11 April: Is Geometrical Structure Explanatory?**

Central Readings:

Pooley 2015. “Substantivalist and Relationist Approaches to Spacetime”, in *The Oxford Handbook of Philosophy of Physics* (Batterman, ed.), section 6.3.2.

Brown and Pooley 2006. “Minkowski Space-Time: A Glorious Non-Entity”, in *The Ontology of Spacetime* (Dieks, ed.), sections TBD.

Brown 2007. *Physical Relativity*, Oxford University Press, sections TBD.

Balashov and Janssen 2003. “Presentism and Relativity”, *British Journal for the Philosophy of Science*, sections TBD.

### **13 April: The Status of Energy and Mass in Special Relativity**

Central Readings:

Lange 2001, “The Most Famous Equation”, *Journal of Philosophy*: pp.219–238.

## **18 April, 20 April: What's 'Real' in a Relativistic World?**

### Central Readings:

Putnam 1967, "Time and Physical Geometry", *Journal of Philosophy*: pp.240–247.

Stein 1968, "On Einstein-Minkowski Space-Time", *Journal of Philosophy*: pp.5–23.

Weingard 1972, "Relativity and the Reality of Past and Future Events", *Journal of Philosophy*: pp.119–121.

## **SPACETIME FOUNDATIONS OF GENERAL RELATIVITY**

## **25 April, 27 April: Curved Spacetime, Black Holes, and Time Travel**

### Central Readings:

Maudlin, pp.126–146, 154–169

Sklar, pp.27–54, 62–64, 66–78

Geroch, pp. 159–185

## **2 May: The Nature of the Metric and Other Metaphysical Enigmas**

### Central Readings:

Weingard 1975, "On the Ontological Status of the Metric in General Relativity", *Journal of Philosophy*: pp.426–431.

Norton 2015, "What Can We Learn about the Ontology of Space and Time from the Theory of Relativity?", in *Physical Theory: Method and Interpretation* (Sklar, ed.), Oxford University Press, sections TBD.

Brown, *Physical Relativity*, Oxford University Press, sections TBD.

## **4 May, 9 May: The Hole Argument**

### Central Readings:

Maudlin, pp.146–151

Norton 2011, "The Hole Argument", *Stanford Encyclopedia of Philosophy*

Hofer 1996, "The Metaphysics of Space-Time Substantivalism", *Journal of Philosophy*: pp.5–27.