

PHILOSOPHY 425: PHILOSOPHY OF SCIENCE
Fall 2022
F 10:20–1:20, 106 Somerset St., 5th floor seminar room
J. North (j.north@rutgers.edu)

This class is a seminar in the philosophy of science, the area of philosophy that examines the nature of science, including its methodology, epistemology, and metaphysics. We will focus on a few intertwined topics: the nature and objectivity of science; scientific realism; explanation; theoretical equivalence. One overarching theme will be the interplay among philosophy of science (philosophy of physics in particular), metaphysics, and scientific realism.

PREREQUISITES

There is an official prerequisite of Philosophy 225 (Introduction to the Philosophy of Science), which I am happy to waive. No prior coursework is necessary, though it will be helpful to have taken at least one course in philosophy.

READINGS

All readings are available on the Canvas course site.

REQUIREMENTS AND GRADING

Attendance and participation; weekly reading; reading questions: 20% of final grade. Attendance is mandatory. You must do the readings before each class carefully, and come prepared with questions and ideas to discuss. Toward that end, you must email me (j.north@rutgers.edu) at least one question about the assigned reading by midnight the day before class. (Note that if you miss a class it is *your responsibility* to get notes and announcements from a classmate.)

Written work: 80% of final grade. Three options. (1) Two take-home exams, 8–10 pages, of short-essay questions (1–2-page answers each). (2) Two 8–10 page papers. (3) With my permission, you may write one 18–20 page seminar paper. You must meet with me to discuss your topic at least four weeks before the end of term. Midterm assignments will be handed out Oct. 14 and are due Oct. 28. Final assignments are due December 19.

ACADEMIC INTEGRITY

Each student in this course is expected to abide by the Rutgers University Principles of Academic Integrity. Any work submitted by a student in this course

for academic credit will be the student's own work. For this course, collaboration is allowed in discussing questions on exams or paper topics; submitted work must be written up entirely on your own. Exams and papers submitted for credit must be entirely your own work. If you quote or use an idea from another source, *you must cite it*. More information on Rutgers' Principles of Academic Integrity is here: <http://academicintegrity.rutgers.edu>

Course materials posted on the course website or handed out in hard copy are intellectual property belonging to the author. Students are not permitted to buy or sell any course materials without the express permission of the instructor. Such unauthorized behavior constitutes academic misconduct.

OFFICE HOURS

Tuesday 12:00-1:00pm or by appointment.

SCHEDULE

Readings are listed by the date they will be discussed in class. Details are subject to change during the semester.

Class 1, Sept. 9: INTRODUCTION AND BACKGROUND

Some background on the history of the philosophy of science. Logical positivism and metaphysics; realism and empiricism; the epistemology of science. Overview of the class.

Reading: Carnap, "The Elimination of Metaphysics Through Logical Analysis of Language"; Schlick, "Positivism and Realism"

Class 2, Sept. 16: WHAT IS SCIENCE?

Science and pseudoscience. Testability and confirmation. Verifiability; falsifiability; normal science and scientific revolutions; scientific research programs.

Reading: Popper, "Science: Conjectures and Refutations"; Kuhn "Logic of Discovery or Psychology of Research?"; Lakatos, "Science and Pseudoscience"

Class 3, Sept. 23: RATIONALITY, OBJECTIVITY, AND VALUES IN SCIENCE

To what extent do irrational or subjective factors in scientific theorizing and practice inhibit the objectivity and rationality of science? Theory change and the nature of scientific progress; contextual values and the contextualist analysis of evidence; science as a social practice. Empirical adequacy and other criteria of theory choice.

Reading: Kuhn, “The Nature and Necessity of Scientific Revolutions” and “Objectivity, Value Judgment, and Theory Choice”; Longino, “Values and Objectivity”

Optional: Hempel, “Criteria of Confirmation and Acceptability”; Okruhlik, “Gender and the Biological Sciences,” esp. sec. 1

Class 4, Sept. 30: SCIENTIFIC REALISM I

Traditional arguments concerning scientific realism. The ontological status of theoretical entities; the observable-theoretical distinction; inference to the best explanation. Constructive empiricism as an alternative to realism.

Reading: Maxwell, “The Ontological Status of Theoretical Entities”; van Fraassen, “Arguments Concerning Scientific Realism” (skip sec. 5)

Class 5, Oct. 7: HOLISM AND UNDERDETERMINATION

Underdetermination arguments against scientific realism. Holism, empiricism, and realism. Empirical adequacy and empirical equivalence.

Reading: Duhem, “Physical Theory and Experiment” secs. 1–3, 10; Quine, “Two Dogmas of Empiricism” secs. 5–6; van Fraassen, “To Save The Phenomena” secs. 1–5; Glymour, “To Save the Noumena”

Class 6, Oct. 14: UNDERDETERMINATION OF GEOMETRY

Midterm assignment banded out.

Can we know the geometry of physical space? An application of holism and underdetermination arguments. Geometry in curved spaces. Underdetermination, confirmation, and convention.

Reading: Reichenbach, excerpts from *The Philosophy of Space and Time*

Optional: Gowers, “Geometry” (ch. 6 of *Mathematics: A Very Short Introduction*)

Class 7, Oct. 21: SCIENTIFIC EXPLANATION

What is it to explain a phenomenon, over and above predicting it? Is there any significant difference? Laws of nature and accidental generalizations; models of scientific explanation; probabilistic and non-probabilistic explanation; unification. Does a theory’s explanatory power give us reason to believe it?

Reading: Carnap, “The Value of Laws: Explanation and Prediction”; Hempel, “Two Models of Scientific Explanation” and “The Thesis of Structural Identity”; Kitcher, “Explanatory Unification”

Oct. 28: Class cancelled. *Midterm assignment due.*

Class 8, Nov. 4: REALISM: LAWS AND FORCES

Are the laws of physics true? Do Newtonian forces exist? Idealizations and approximations in physics. Forces and component forces; energy; capacities. Unobservable entities and theoretical posits. Fundamental and nonfundamental theories and ontology.

Reading: Cartwright, “Do the Laws of Physics State the Facts?” (skip sec. 3); Wilson, “Newtonian Forces” (skip sections 2.3 and 5)

Optional: Cartwright, “Fundamentalism vs. the Patchwork of Laws”

NOV. 11: NO CLASS

Class 9, Nov. 18: REALISM: DIFFERENT FORMULATIONS

Do different mathematical formulations of a theory and/or different explanations of the phenomena pose a threat to scientific realism? Newtonian mechanics and other versions of classical mechanics. Interpretation and idealization in classical mechanics, quantum mechanics, general relativity. Ontological commitment and ontological ambiguity in physics. Metaphysical and mathematical differences between scientific theories.

Reading: Jones, “Realism about What?”; North, “Formulations of Classical Mechanics”

Class 10, Nov. 23: THEORETICAL EQUIVALENCE

This class meeting will be held on Zoom; information on Canvas.

When are two scientific theories equivalent? The equivalence of physical theories; different senses of equivalence; underdetermination; explanation.

Reading: North, “On the Equivalence of Physical Theories”; Sklar, “Saving the Noumena”

Optional: Coffey, “Theoretical Equivalence as Interpretative Equivalence”

Class 11, Dec. 2: SCIENTIFIC REALISM II

Contemporary and traditional arguments concerning scientific realism. Structural realism; epistemic and ontic structural realism; approximate truth; objects, properties, relations, structure; fundamentality; physics and metaphysics.

Reading: Worrall, “Structural Realism: The Best of Both Worlds?”

Optional (it is recommended that you at least skim some of these, but feel free to choose which ones are most to your interest): Greaves, “In Search of

(Spacetime) Structuralism”; Ladyman, “What Is Structural Realism?”; McKenzie, “Ontic Structural Realism”; Ladyman, “Structural Realism,” available at:
<https://plato.stanford.edu/entries/structural-realism/>

Class 12, Dec. 9: REALISM: QUANTUM MECHANICS

Final assignment handed out; due December 19.

Arguments concerning realism in the context of quantum physics. Interpreting a physical theory; partially interpreted theories; underdetermination of interpretation by theory; fundamental vs. effective theories; ambiguity as a theoretical virtue. Theoretical equivalence and “deep metaphysics.”

Reading: Ruetsche, “Getting Real about Quantum Mechanics” (skip sec. 3.E); Saatsi, “Scientific Realism meets Metaphysics of Quantum Mechanics”

Optional: Ruetsche, “Exegesis Saves: Interpreting Physical Theories” secs. 1–5; Saatsi, “Truth vs. Progress Realism about Spin”

Further optional: Albert, *Quantum Mechanics and Experience*; Barrett, *The Conceptual Foundations of Quantum Mechanics*; Ismael, “Quantum Mechanics,” at: <https://plato.stanford.edu/entries/qm/>