### Course Outline

**Philosophy Faculty reading List and Course Outline 2018-2019**

**PART IB PAPER 06:**

**PHILOSOPHY OF SCIENCE**

#### Syllabus

- **Realism, for and against:** underdetermination of theory by data, the pessimistic induction, constructive empiricism, structural realism, incommensurability.
- **Confirmation:** the hypothetico-deductive model; the paradoxes of confirmation; Bayesianism; falsificationism.
- **Scientific explanation and laws:** what, if anything, distinguishes scientific explanation?; the deductive-nomological model of explanation and its rivals; 'best system' vs anti-reductionist views of laws.
- **Concepts of probability:** subjective probability; logical probability; frequency interpretation; propensity interpretation.
- **Introduction to philosophy of physics:** spacetime and relativity; time and thermodynamics; puzzles of quantum theory.

#### Course Outline

The Part IB course introduces five philosophical issues in scientific theory and practice.

(i) **Realism, for and against:** Are the entities postulated by scientific theories real? Or are theories no more than useful instruments for inferring from one set of observable circumstances to another?

(ii) **Confirmation:** What is it for a piece of evidence to support a hypothesis? And when should a scientific theory count as having been tested?

(iii) **Scientific explanation and laws:** What distinguishes scientific explanations? And what is a law of nature (as opposed to an accidental regularity)?

(iv) **Concepts of probability:** What does it mean to say that an event has a probability of 75%? Are there objective chances or is it just subjective confidence?

(v) **Introduction to philosophy of physics:** How is physics relevant to philosophy, and vice versa? What does modern physics tell us about time, and the nature of the quantum world – and why are such simple questions so hard to answer?

#### Prerequisites

It is not necessary to have background knowledge of any particular scientific theory. Some theories and historical episodes will be briefly touched on in lectures. Students should have a modest knowledge of formal logic.

### Objectives

Students taking this paper will be expected to:

1. Acquire an introductory overview of debates on method, the status of theories, the nature of explanation and laws, and concepts of probability.
2. Critically engage with texts by some key authors in analytical philosophy of science in the last half century.
3. Acquire a more detailed understanding of some particular debates within the listed areas.
4. Develop their ability to think independently about philosophical problems by critically assessing arguments in these areas.

### Preliminary Reading

- **BIRD, Alexander,** *The Philosophy of Science* (London: Routledge, 1998). Also available online at: [https://doi.org/10.4324/9780203133972](https://doi.org/10.4324/9780203133972).
- **CHALMERS, Alan F.,** *What is This Thing Called Science?* 2nd ed. (Milton Keynes: The Open University, 1982).

### Reading List

#### General Reading

The philosophy of science is an area particularly well supplied with readable and reliable introductions. The following are particularly recommended:

- **BIRD, Alexander,** *The Philosophy of Science* (London: Routledge, 1998). Also available online at: [https://doi.org/10.4324/9780203133972](https://doi.org/10.4324/9780203133972).
- **CHALMERS, Alan F.,** *What is This Thing Called Science?* 2nd ed. (Milton Keynes: The Open University, 1982).
- **LADYMAN, James,** *Understanding Philosophy of Science* (London: Routledge, 2002).

Lewen's is an excellent and accessible introduction, as is Bird's. Ladyman's book has a different emphasis: e.g. there's less on laws and more on Popper vs. Kuhn. Papineau's very clear essay deals primarily with issues about explanation, laws, confirmation etc., while Chalmers concentrates more on Popper's falsificationism, and the responses of Kuhn and Lakatos. Godfrey-Smith's book is longer and more comprehensive, but very lively, clear, and accessible.
Other introductions worth mentioning are:


Of these, Kosso’s book is the most introductory (useful perhaps for preliminary orientation or if you are transferring into philosophy). The Hempel volume is a short classic introduction. And Hacking’s book is particularly interesting giving a newer take on some old issues.

Earlier classics include the following:


This presents very clearly a developed version of some ‘traditional’ lines in the philosophy of science on laws, explanation, the observation and theory distinction, etc. It is very useful to read Nagel to get a sense of what quite a few of the later writers are reacting against.


Enormously influential and highly readable, this is the book that introduced the paradigm in philosophy of science.


Going even further than Kuhn, Feyerabend argues against the very idea of a scientific method (claiming that ‘anything goes’ is as good a methodological rule as anything suggested by mainstream philosophy of science). Controversial and again, highly readable.

**Useful Collections of Articles**

The following collections will be found particularly useful:


**Pre-amble on the Selected Readings**

Think of IB work on a topic as having two stages. (A) Getting a grounding in a problem area, writing a supervision essay, and getting feedback (to confirm that you have grasped the basics, and to suggest problems to think about, further lines to pursue etc.). (B) Additional reading and work on the topic (perhaps to be further discussed in Easter term additional supervisions, revision classes etc.). If you get stuck at stage (A) you won’t do particularly well in Tripos!

Some of these readings are divided into (A) and (B) lists below: some attempt is made to put material in the basic (A)-lists in a sensible reading order. (B)-lists are in alphabetical order, and for dipping into (no-one expects you to read everything).

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**REALISM, FOR AND AGAINST**

**General**

For an introductory survey of some of the issues about realism in the philosophy of science, see:


And for another survey, at a slightly more sophisticated level, try:


For a rather deflationary approach to issues about realism, much referred to, you should read:


For an excellent book-length treatment, see:

PSILLOS, Stathis, *Scientific Realism* (London: Routledge, 1999), ch. 8

‘Underdetermination undermined’. Also available online at: [www.dawsonera.com](http://www.dawsonera.com)
For an important critical perspective on the notion of objectivity sometimes associated with scientific realism, see:


For an earlier classic, still very much worth reading, see:


### Underdetermination of Theory by Data

Theory is underdetermined by data (i.e., in principle, different theories are compatible with the same data). Does that observation show that we shouldn’t take a realist attitude, even to our best theories?

(A)


LADYMAN, James, *Understanding Philosophy of Science* (London: Routledge, 2002), sect. 6.1. [Another introduction]


PSILLOS, Stathis, *Scientific Realism* (London: Routledge, 1999), ch. 8, ‘Underdetermination undermined’. Also available online at: www.dawsonera.com

(B)


### The Pessimistic Induction

In the history of science, time and again scientists have got things badly wrong. Should we pessimistically infer that our current best theories are also (probably) wrong, for all we know?

(A)


PSILLOS, Stathis, *Scientific Realism* (London: Routledge, 1999), chs. 5-7. Also available online at: www.dawsonera.com

(B)


Constructive Empiricism

The most influential non-realist theory of science in the last two decades and more is van Fraassen's constructive empiricism. For van Fraassen's own presentation and criticism see:

(A)


PSILLOS, Stathis, Scientific Realism (London: Routledge, 1999), ch. 9 'Constructive empiricism scrutinised'. Also available online at: www.dawsonera.com


Recent debate on constructive empiricism has focused upon the specific epistemological framework in which van Fraassen advances his empiricism, and upon the appropriate epistemological framework for the philosophy of science in general:

VAN FRAASSEN, Bas C., Laws and Symmetry (Oxford: Clarendon, 1989), Part II 'Belief as Rational But Lawless'. Also available online at: http://doi.org/10.1093/0198248601.001.0001

VAN FRAASSEN, Bas C., The Empirical Stance (New Haven, CT: Yale University Press, 2002), Lecture 2 'What is empiricism and what could it be?'. Also available online at: http://lib.myilibrary.com/browse/open.asp?id=172986

MONTON, Bradley, ed., Images of Empiricism (Oxford: Oxford University Press, 2007). Also available online at: http://doi.org/10.1093/acprof:oso/9780199218844.001.0001. [In particular, essays by Chakravartty, Ladyman, and Psillos, and van Fraassen's replies]

Structural Realism

A recently popular form of realism, advertised as avoiding some of the problems of older forms of scientific realism.

(A)


PSILLOS, Stathis, Scientific Realism (London: Routledge, 1999), ch. 7 'Worrall's structural realism'. Also available online at: www.dawsonera.com


(B)

CHAKRAVARTTY, Anjan, A Metaphysics for Scientific Realism (Cambridge: Cambridge University Press, 2007), chs. 2 & 3. Also available online at: http://doi.org/10.1017/CBO9780511487354


Ladyman's SEP article, above, provides a rich guide to the further literature for enthusiasts.

Incommensurability

A theme in Kuhn and Feyerabend is the supposed 'incommensurability' of (sufficiently different) rival theories. The idea is that observation-sentences embedded in sufficiently different theories can't be directly compared. For some background on observation/theory issues, you need to look at e.g.:

Two other useful background introductions are:

CHALMERS, Alan F., *What Is This Thing Called Science?*, 2nd ed. (Milton Keynes: The Open University Press, 1982), ch. 3 'Experiment'.


And for the debate about incommensurability, see:

(A)


KUHN, Thomas, *The Road since 'Structure'* (Chicago, IL: University of Chicago Press, 2000), ch. 2 'Commensurability, Comparability, Communicability'.

BIRD, Alexander, *Thomas Kuhn* (Chesham: Acumen, 2000), ch. 5 'Incommensurability and meaning'. Also available on Moodle.

(B)


CONFIRMATION

Hypothetico-Deductive Model, and Bayesian Responses

A classic view (a.k.a. ‘deductivism’, ‘the hypothetico-deductive model’) is that a scientific theory is a body of hypothesized laws from which observational consequences are deduced, and a theory is tested by checking how the observational consequences tally with reality, and is confirmed by positive outcomes. For some initial orientation, see:


Also useful is:


Hempel and Nagel give classic outlines in:


The H-D model of confirmation can seem so compelling that it is difficult to conceive of alternatives. So for a different sort of model, see:


Finally, to round out the Hájek/Joyce discussion of Bayesian views, see:

HOWSON, Colin, and Peter URBACH, *Scientific Reasoning: The Bayesian Approach* (La Salle, IL: Open Court, 1989), ch. 4 'Bayesian versus non-Bayesian approaches'.

The Paradoxes of Confirmation

i) The 'Ravens' Paradox

Since 'all ravens are black' is equivalent to 'all non-black things are non-ravens' does that mean that observing white shoes is a way of confirming that indeed all ravens are black?

(A)

BIRD, Alexander, *The Philosophy of Science* (London: Routledge, 1998), ch. 2 'Explanation'. Also available online at: https://doi.org/10.4324/9780203133972


HOWSON, Colin, and Peter URBACH, *Scientific Reasoning: The Bayesian Approach* (La Salle, IL: Open Court, 1989), ch. 4 'Bayesian versus non-Bayesian approaches'.


(B)


LIPTON, Peter, *Inference to the Best Explanation* (London: Routledge, 1991), chs. 5 & 6. Also available online at: http://lib.myilibrary.com/?id=11209


ii) The 'Grue' Paradox

Define 'Grue' to mean 'Either green and observed before midnight on 31.12.2010 or blue and not observed before midnight on 31.12.2010.' Then all observations to date equally well support e.g. 'all emeralds are green' and 'all emeralds are grue'. What's to choose?

(A)


(B)

BLACKBURN, Simon, *Spreading the Word* (Oxford: Clarendon Press, 1984), ch. 3 'How is meaning possible? (2)'.


The Stalker collection contains enough other papers to keep the most gruesomely enthusiastic satisfied!

Bayesianism


Falsificationism

(A)


Popper's classic *The Logic of Scientific Discovery* is highly readable; but for a briefer introduction to his views in their mature form see:


For initial discussion, see:

CHALMERS, Alan F., *What is This Thing Called Science?*. 2nd ed. (Milton Keynes: The Open University Press, 1982), chs. 4-7.


(B)


MILLER, David, *Critical Rationalism: A Restatement and Defence* (Chicago: Open Court, 1994). [Especially chs. 1-3]


Also available online at: [www.dawsonera.com](http://www.dawsonera.com)

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**SCIENTIFIC EXPLANATION AND LAWS**

**What, if Anything, Distinguishes Scientific Explanation?**

For a general introduction, see:


And for a longer treatment, see the excellent:

PSILLOS, Stathis, *Causation and Explanation* (Chesham: Acumen, 2002), parts 2 & 3. Also available online at: [www.dawsonera.com](http://www.dawsonera.com)

See also:


The Deductive-Nomological Model and Its Rivals

On the Deductive-Nomological Model, see:

(A)

BIRD, Alexander, The Philosophy of Science (London: Routledge, 1998), ch. 2 'Explanation'. Also available online at: https://doi.org/10.4324/9780203313972


NAGEL, Ernest, Structure of Science (London: Routledge & Kegan Paul, 1961), ch. 3 'The deductive pattern of explanation'.


PSILLOS, Stathis, Causation and Explanation (Chesham: Acumen, 2002), ch. 8 'Deductive–nomological explanation'. Also available online at: www.dawsonera.com

(B)


POPPER, Karl, Objective Knowledge (Oxford: Clarendon Press, 1972), ch. 5 'The Aim of Science'.

SALMON, Wesley, Causality and Explanation (Oxford: Oxford University Press, 1998), ch. 6 'A Third Dogma of Empiricism' and ch. 8 'Why Ask "Why"?'. Also available online at: http://doi.org/10.1093/0195106847.003.0009


The Causal Model

The causal model of explanation is argued, inter alia, to avoid the problems of the DN model. On the causal and related methods of explanation, see:

(A)


LIPTON, Peter, Inference to the Best Explanation (London: Routledge, 1991), chs. 2 & 3. Also available online at: http://lib.myilibrary.com/?id=11209


PSILLOS, Stathis, Causation and Explanation (Chesham: Acumen, 2002), ch. 8 'Deductive–nomological explanation'. Also available online at: www.dawsonera.com

(B)


SALMON, Wesley, *Causation and Explanation* (Oxford: Oxford University Press, 1998), ch. 19 'Scientific Explanation: How We Got From There To Here'. Also available online at: [http://doi.org/10.1093/0195108647.003.0020](http://doi.org/10.1093/0195108647.003.0020)


**Best System vs. Anti-Reductionist Views of Laws**

Are laws just universal generalizations with some special feature? What makes the difference between a law and a mere accidental generalization? Armstrong's review of 'Humean' views, preparatory to giving his own preferred account, is exemplary.

(A)


PSILLOS, Stathis, *Causation and Explanation* (Chesham: Acumen, 2002), Part 2. Also available online at: [www.dawsonera.com](http://www.dawsonera.com).

(B)


**CONCEPTS OF PROBABILITY**

**Background on the Probability Calculus**

A good introduction to the probability calculus for philosophers is still:

See also:

HOWSON, Colin, and Peter URBACH, *Scientific Reasoning: The Bayesian Approach* (La Salle, IL: Open Court, 1989), ch. 2 'The probability calculus'.


The Interpretations

(A)

For brief introductions, see:


See also:


It is worth looking at some of the historical sources:


(B)


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INTRODUCTION TO PHILOSOPHY OF PHYSICS

(A)

KOSSO, Peter, *Appearance and Reality: an Introduction to the Philosophy of Physics* (Oxford: Oxford University Press, 1998). [Good short introduction, covering most of the material that will be in the lectures, in all three sections]


PENROSE, Roger, *The Emperor’s New Mind* (Oxford: Oxford University Press, 1989), chs. 5, 6 and (especially) 7. [Highly readable introduction to the central philosophically significant parts of modern physics, relevant to all three sections]

PRICE, Huw, *Time’s Arrow and Archimedes’ Point* (Oxford: Oxford University Press, 1996), especially chs. 1-2 & 8-9. Also available online at: www.dawsonera.com [Relevant to the time and thermodynamics and puzzles of quantum theory sections]

(B)


SKLAR, Lawrence, *Space, Time and Spacetime* (Berkely, CA: University of California Press, 1974). [Classic and readable book on the spacetime and relativity material, in much more detail than we will deal with it]


We welcome your suggestions for further readings that will improve and diversify our reading lists, to reflect the best recent research, and important work by members of under-represented groups. Please email your suggestions to phillib@hermes.cam.ac.uk including the relevant part and paper number. For information on how we handle your personal data when you submit a suggestion please see https://www.information-compliance.admin.cam.ac.uk/data-protection/general-data.