

Philosophy of Modern Physics: the Quantum World

Lent Term, second half, Mondays 11am

Huw Price

The great revolutions of modern physics — relativity, quantum theory, and a new understanding of the direction of time — turn out to entangle physics with philosophy in fascinating ways. The connections go in both directions: physics throws new light on old philosophical issues, and philosophy turns out to have a role to play in trying to resolve some of the puzzles of the new physics. These four lectures provide a (very) non-technical introduction to the puzzles of quantum theory, and to the philosophical aspects of the unsolved question of the nature of the quantum world. The reading is mainly non-technical, and *the most important reading recommendations are starred below*.

[**Please note:** These lectures are cross-listed from the Faculty of Philosophy, where they comprise the **second half** of an 8 lecture series on Philosophy of Modern Physics. HPS students taking Paper 8 are welcome to attend the first 4 lectures, in Weeks 1–4 of Lent Term. Topics covered in those lectures include relativity and the direction of time.]

Lecture 1. The new quantum theory and the issue of completeness (15 February 2016)

Historical origins of quantum mechanics (QM), and its basic features in contrast to classical mechanics. Early issues of interpretation: the Copenhagen interpretation, and its links with philosophical instrumentalism. The importance of the issue of whether QM provides a complete description of reality.

- ♣ *Price, H., *Time's Arrow and Archimedes' Point* (Oxford: Oxford University Press, 1996), Chap 8. [eBook through LibrarySearch]
- ♣ Whitaker, A., *Einstein, Bohr and the Quantum Dilemma: From Quantum Theory to Quantum Information*. 2nd ed. (Cambridge: Cambridge University Press, 2006), Chap. 4.
- ♣ Kosso, P., *Appearance and Reality: An Introduction to the Philosophy of Physics* (Oxford: Oxford University Press, 1998). Chs 6 & 7.
- ♣ Cushing, J., *Philosophical Concepts in Physics* (CUP, 1998), Chaps 19–21. [eBook through LibrarySearch]

Lecture 2. The case against completeness (22 February 2016)

Arguments against *completeness* interpretations of QM. Schrödinger's cat, the measurement problem, and the original Einstein-Podolsky-Rosen (EPR) argument.

- ♣ Price, and Kosso (as above).
- ♣ *Cushing (as above), Chap 22. [eBook through LibrarySearch]
- ♣ Whitaker (as above), Chap 6.
- ♣ Albert, D.Z., *Quantum Mechanics and Experience* (Cambridge, MA: Harvard University Press, 1993). Chaps 4 & 5.

Lecture 3. The case for completeness (29 February 2016)

Arguments against *incompleteness* interpretations: the two-slit experiment, Bell's Theorem. Non-locality, entanglement, and the issue of tension between QM and special relativity.

- ♣ Price, and Kosso (as above).
- ♣ Cushing (as above), Chap 22. [eBook through LibrarySearch]
- ♣ Whitaker (as above), Chap 6.
- ♣ *Maudlin, T., *Quantum Non-Localities and Relativity*, 3rd edn. (Wiley Blackwell), Chap 1.

Lecture 4. Three possible paths (7 March 2016)

Three possible ways forward, in the puzzle of the nature of the quantum world: (i) the de Broglie-Bohm hidden variable theory; (ii) the Everett interpretation (“many worlds”); (iii) retrocausal hidden variable views.

- ♣ *Price, H. and Wharton, K., 'Dispelling the Quantum Spooks – a Clue that Einstein Missed?', online at [<http://arxiv.org/abs/1307.7744>].
- ♣ Albert, D.Z., *Quantum Mechanics and Experience* (Cambridge, MA: Harvard University Press, 1993), Chaps 6 & 7.
- ♣ *Handfield, T., *A Philosophical Guide to Chance* (CUP), Chap 10, 'Chance in branching worlds'. [eBook through LibrarySearch]