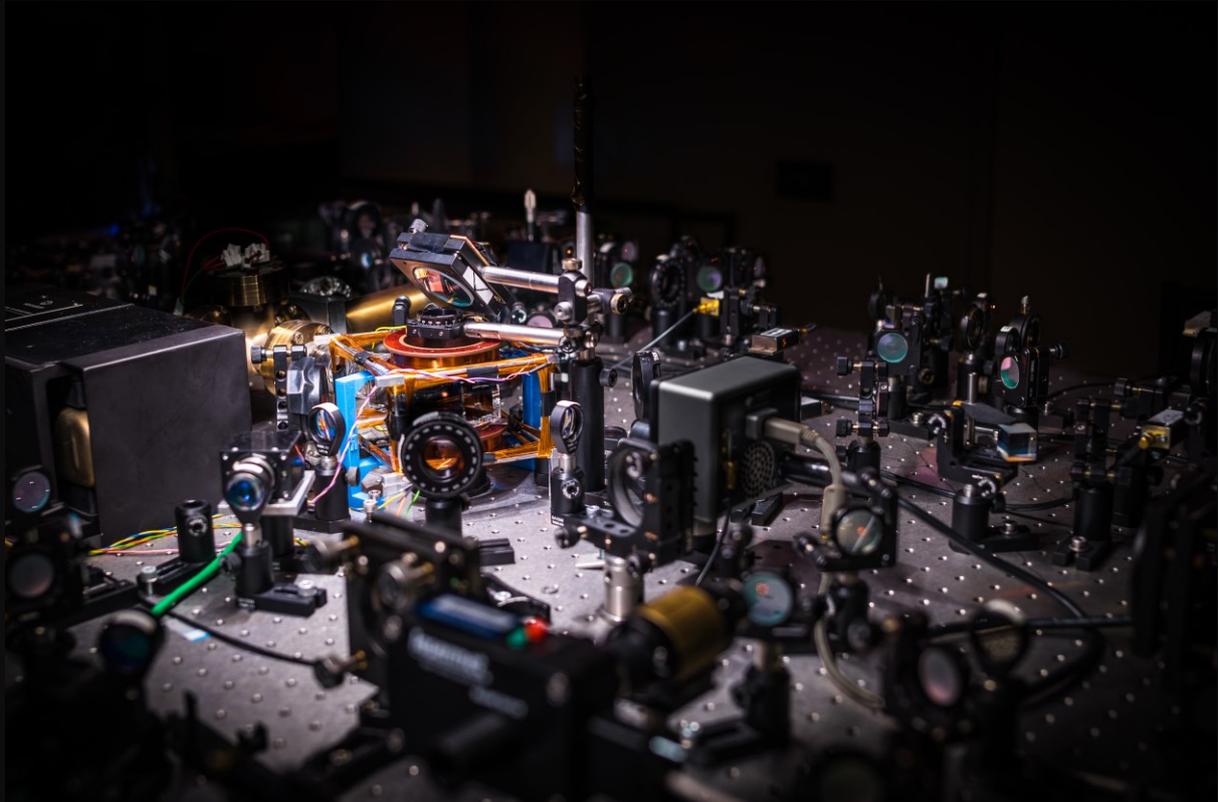




University
of Glasgow | School of Physics
& Astronomy



PHYS5002 Quantum and Atom Optics

Course Information Guide 2023-24

1 Course Details

PHYS5002 Quantum and Atom Optics is an elective level 5 Physics Masters course. It is composed of 18 lectures and 2 full class tutorials, all given in Semester 2.

Lecturer: Dr. Robert Bennett
Kelvin Building Room 539a
robert.bennett@glasgow.ac.uk

Time and place: see timetable

Recommended texts:

- Christopher J. Foot, *Atomic Physics*, 2005 (Oxford Master Series in Atomic, Optical and Laser Physics) <http://tinyurl.com/yxtz4o4y>
- Gilbert Grynberg, Alain Aspect, Claude Fabre, *Introduction to Quantum Optics: From the Semi-classical approach to Quantized Light*, 2010 (Cambridge University Press) <http://tinyurl.com/y242fnmc>
- Rodney Loudon, *The Quantum Theory of Light*, 2000 (Cambridge University Press) <http://tinyurl.com/y6mncdco>

Course notes and problem sheets will be made available on Moodle.

2 Assessment

This course will be assessed via a continuous assessment (25%) and a written exam in the April/May diet (75%). It provides 10 M-level credits.

3 Required Knowledge

Students are expected to have completed the Level 3 courses Quantum Mechanics and Electromagnetic Theory as well as Level 4 course Atomic Systems (or equivalents). It is recommended that students will also have taken courses Laser and Nonlinear Optics and Quantum Theory (or equivalents).

We will assume familiarity with the basic understanding of general concepts in optics, electromagnetism and atomic physics, as well as quantum mechanical operators and wavefunctions. Students should ideally be familiar with Dirac notation for quantum states and the use of these and of operators to extract probabilities and expectation values, as students will need to be ready to apply these techniques to solving problems.

4 Intended Learning Outcomes

By the end of the course students will be able to demonstrate a knowledge and broad understanding of Quantum and Atom Optics and show a critical awareness of the significance and importance of the topics, methods and techniques discussed in the lectures and their relationship to concepts presented in other courses. They should be able to describe and analyse quantitatively processes, relationships and techniques relevant to the topics included in the course outline, applying these ideas and techniques to analyse critically and solve advanced or complex problems which may include unseen elements. They should be able to write down and, where appropriate, either prove or explain the underlying basis of physical laws relevant to the course topics and discuss their applications.

5 Course Outline

Course syllabus for quantum optics:

- Characterisation of Quantum Optics in the development of physical theories
- Introduction to a quantisation of the electrodynamical field and quantum states of light
- Description of optical elements, such as beam splitters, acting on states of light
- Introduction to the concept of correlations, optical coherence and quasi-probability functions and non-classical light
- Introduction to the concept of zero-point energy
- Introduction into the quantum description of light-matter interactions

Course syllabus for atom optics:

- Introduction to atom optics and the mechanical forces that light can exert on atoms.
- Theoretical description of light-matter interaction based on classical and semiclassical models; introduction of Rabi oscillations, development and interpretation of optical Bloch equations, derivation of expressions for the scattering and dipole force.
- Introduction to experimental techniques and parameters relevant for atom cooling and trapping; Zeeman and chirp slowing, optical molasses, magneto-optical traps, dipole traps. Derivation of the recoil and Doppler temperature.
- Description of some applications in atom optics, including absorption spectroscopy, atomic memories and atomic clocks.

6 Further Information

Further information can be found on the course Moodle page and also using the links below:

- [Course specification](#)
- [Reading list](#)