Astrophysics

Lecturers
Daniel Mortlock (Blackett 1018a, d.mortlock@imperial.ac.uk)
Yvonne Unruh (Blackett 1114, y.unruh@imperial.ac.uk)

Lectures
The course consists of 26 lectures with an additional revision lecture early in the summer term. There are no classworks or tutorials, but there will be problem sheets (solutions posted online) as well as weekly office hours.

Assessment
Assessment is through a single 2-hour-long exam with a compulsory Section A, plus an additional 2 questions (out of 4) in Section B.

Course Aims
The astrophysics option complements Sun, Stars & Planets (2nd-year option) and Cosmology (4th-year option), though each course can be taken on its own. It takes up some themes that you will encounter in ‘Physics of the Universe’ (3rd-year core course) and explores them in more depth, though there is little direct overlap. There is no prerequisite for the astrophysics option. The idea is to apply physical concepts that you are already familiar with (mechanics / thermodynamics / basic quantum mechanics) to explain the formation, existence, and appearance of astronomical objects. Astrophysics provides us with laboratories where we can apply these theories on a wide range of scales and environments. For example, we will find out how gravity, the fundamental large-scale attractive force in the universe, forms structure on different scales through competition with various balancing sources of internal pressure (ideal gas, degenerate gas, magnetic fields, etc).

Course Syllabus

Compact Objects
- the equation of state for degenerate gases
- brown dwarfs and their formation
- end stages of stellar evolution: white dwarfs, neutron stars and black holes

Interstellar medium and gaseous nebulae
- dust
- hydrogen 21-cm observations
- diffuse interstellar clouds and the formation of absorption lines
- ionised nebulae and the formation of emission lines

Galaxies
- disk galaxies and rotation curves
- evidence for dark matter (or alternative gravity theories)
- observations of the Milky Way's rotation
- central super-massive black holes

Quasars
- accretion disks around black holes
- Eddington limit and efficiency

Gravitational Lensing
- Newtonian deflection calculation and relativistic correction
- lens equation and magnification
- multiple images, microlensing and arcs/rings
Textbooks

There is no prescribed textbook for the astrophysics option. We will provide handouts and lecture notes. There are quite a number of general astrophysics text books, though many of them concentrate on the more traditional aspects of astrophysics (solar system, stellar structure, galactic structure etc) and most of them are not cheap. Given that the course straddles several areas of astrophysics, you might find it easier to use some of the slimmer volumes dealing with the individual topic sections.

Two of the standard text books that cover most of the material are *Introductory Astronomy & Astrophysics* by Zeilik & Gregory (Saunders College Publishing, 4th edition), and *An Introduction to Modern Astrophysics*, by Carroll & Ostlie (Addison Wesley). The book by Carroll & Ostlie is more detailed, and you might consider it a worthwhile investment if you intend to pursue astronomy in the future. The book by Zeilik & Gregory is slimmer and perhaps somewhat superficial, though you might find it easier to navigate. Neither Carroll & Ostlie nor Zeilik & Gregory cover the section on Interstellar matter and diffuse nebulae very extensively. Gravitational lensing is also excluded from most of the general text books.

A book that does cover almost all of the material in the course is *The Tapestry of Modern Astrophysics* by Steven N. Shore (John Wiley & Sons). The level of this book is not for the faint-hearted, and probably tough going without an existing astrophysics background (it can miss out some of the basics). A very readable textbook that is unfortunately only available as a relatively ancient first edition is *The Physical Universe: An Introduction to Astronomy* by Frank H. Shu (University Science Books, 1982).