SPACE PHYSICS: COURSE OUTLINE

Introduction

- The subject of Space Physics; the sun and the solar corona, the solar wind and the heliosphere; the Earth's ionosphere; planetary magnetospheres.

Physics of Solar System Plasmas

- Origins; quasi-neutrality; motion of charged particles in electric and magnetic fields; drift motion; plasma as an ion-electron gas; equations of conservation of mass, momentum and energy; the fluid description of a plasma; Maxwell's equations applied to a plasma; electromagnetic force on a plasma; magnetic tension and pressure; the magnetohydrodynamic (MHD) approximation and frozen-in flows;MHD wave modes; shock waves.

Physics of the solar corona and the solar wind

- Atmospheres in hydrostatic equilibrium; plasma and magnetic structures in the solar corona; the origin of the solar wind and Parker's isothermal solar wind solution; the solar cycle dependence of solar phenomena.

Physics of the heliosphere

- The solar wind and the heliospheric magnetic field; fast and slow solar wind streams; corotating and transient disturbances in the solar wind; solar cycle effects; the boundary of the heliosphere and the Local Interstellar Medium.

Physics of the Earth's ionosphere

- Formation of the ionosphere; photoionisation and the Chapman production function; ionisation by energetic particles; loss mechanisms; conductivity and current systems; ionosondes.

Physics of planetary magnetospheres

- The Chapman-Ferraro problem; the interaction of the solar wind with the magnetosphere; bow shock, magnetosheath, magnetopause, magnetosphere, magnetospheric tail; plasma flows due to corotation and solar-wind driven convection; radiation belts.

Solar-Terrestrial Physics and Space Weather

- Geophysical effects of solar phenomena; some practical effects of Space Weather phenomena; solar cycle dependence of geophysical effects; problems with forecasting Space Weather.

Contact details:

Dr. Michele Dougherty
Room 707 (Huxley)
Tel. 47757, email: m.dougherty@imperial.ac.uk
Web page: http://www.sp.ph.ic.ac.uk/~mkd/
Office hours: Tuesday 12-1pm, Thursday 12-1pm.

Recommended Books:

Basic Space Plasma Physics, W. Baumjohann and R. Treumann, Imperial College Press, 1997; £26.00 (paperback), £41.00 (hardback).
A very good book on space physics phenomena, emphasising magnetospheric physics. The descriptive sections provide a good overview of most aspects of space physics (but not the solar corona and the heliosphere). The mathematical treatment is at an intermediate to advanced level and needs some work to follow the details of the calculations. No problems are given.

Introduction to Space Physics, M. G. Kivelson and C. T. Russell (Editors), Cambridge University Press, 1995; £32.50 (paperback).
A collection of chapters written in most cases by world-class experts on the different aspects of space physics. This book provides a comprehensive coverage of the topics in space physics, but the level/difficulty (in concepts and mathematical treatment) of the chapters varies considerably. Similarly, the level of details given also varies, some of the chapters on magnetospheric physics go well beyond the scope of the course. The most useful chapters for the Space Physics course are chapters 1(a general introduction), 2 (basics of plasma physics), 3 (the Sun and the solar corona), 4 (the solar wind), 6 (basics of the Earth's magnetosphere), 7 (the ionosphere), 10 (detailed magnetospheric processes). There are problems at the end of each chapter, no solutions are given though and the difficulty of the problems is highly variable.

Physics of Solar System Plasmas, T. E. Cravens, Cambridge University Press, 1997; £64.00 (hardback)
A very good coverage of all aspects of Space Physics, with good descriptive detail of the different space environments. Much of the mathematical treatment is at an intermediate level, although occasionally the derivations become quite difficult. There are problems (unsolved) at the end of chapters.

Additional Books:

Physics of the Space Environment, T. I. Gombosi, Cambridge University Press, 1998, £44.00 (hardback)
A thorough coverage of all aspects of Space Physics, with full development of the mathematical treatment of space plasma phenomena. The level is in general closer to the advanced than intermediate level. There are unsolved problems at the end of chapters.

Plasma Dynamics, R. O Dendy, Oxford University Press, 1990(reprinted 1994); £16.00 (paperback)
Not a book on space physics, but an excellent book on most of the basic topics in plasma physics useful for the course. The mathematical treatment is, in general, at an intermediate level of difficulty. The most useful chapters are: 1. Basic plasma characteristics, 2. Motion of an electron in a magnetic field, and 4. Magnetohydrodynamic description of plasma. There are a small number of useful problems at the end of the chapters with solutions at the end of the book.

Advanced Space Plasma Physics, R. Treumann and W. Baumjohann, Imperial College Press, 1996; £44.00
A very good book which addresses the more advanced aspects if space plasma phenomena in a thorough manner. Good physical approach, but the mathematics are at an advanced level. This book goes well beyond the treatment offered in the course, but is recommended for those who plan to pursue space plasma research.