PX420-7.5 Solar Magnetohydrodynamics

20/21

Department
Physics
Level
Undergraduate Level 4
Module leader
Valery Nakariakov
Credit value
7.5
Module duration
5 weeks
Assessment
100% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

Our knowledge of what is happening in the Sun is increasing rapidly, largely as a result of space-based instrumentation. The challenge is to understand it. The basic process is simple: Heat moves outwards from its source at the centre (nuclear fusion). However, on its way out, this energy drives processes on many different length scales many of which are not well understood. For example, there is still no convincing theory of how the Sun's magnetic field is generated and how the atmosphere is heated.

The module starts by stating the basic properties of the Sun as deduced from observation and general physical principles, and introduces a hydrodynamic model of the Sun. This treats the solar matter as a fluid. There are the usual gravitational and pressure gradient forces governing the fluid motion but, because the constituent particles of the fluid are charged, there are also electromagnetic forces. As a result, we need to worry about Maxwell's equations as well as Newton's laws. The module then discusses applications of this theory, called magnetohydrodynamics, to model and understand phenomena like sunspots, coronal loops, prominences, solar flares, coronal mass ejections and space weather.

Module web page

Module aims

To review the basic physics underlying the structure and the dynamics of the Sun, to provide a background in the description of physical processes in the Sun in terms of magnetohydrodynamics and to show the results of recent observations.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

1. An outline of observational properties ranging from the solar interior ot the Sun's outer atmosphere
2. Theoretical aspects of solar magnetohydrodynamics (MHD)
3. Magnetic equilibria. Stratification. Force-free magnetic fields. Magnetic arcades, prominences, suspots, intense flux tubes.
4. MHD Waves. Helioseismology.
5. Solar flares. Heating of the solar corona. Coronal mass ejections and space weather.

Learning outcomes

By the end of the module, students should be able to:

- Describe the structure of the Sun and the main features and phenomena observed on the solar surface and in the solar atmosphere
- Describe the physical processes at work in the sun
- Demonstrate understanding of the dynamic processes operating in the Sun, in terms of MHD

Indicative reading list

Priest E.R., Solar Magnetohydrodynamics; Reidel; 1982.
Golub L., and Pasachoff J.M., Nearest Star: the Surprising Science of our Sun; Harvard Uni. Press; 2001.

View reading list on Talis Aspire

Subject specific skills

Knowledge of mathematics and physics. Skills in modelling, reasoning, thinking.

Transferable skills

Analytical, communication, problem-solving, self-study

Study

Study time

Type	Required
Lectures	15 sessions of 1 hour (20%)
Private study	60 hours (80%)
Total	75 hours

Private study description

Working through lecture notes, solving problems, wider reading, discussing with others taking the module, revising for exam, practising on past exam papers

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group B1

Assessment component	Weighting	Study time	Eligible for self-certification
Online Examination Answer 2 questions from 3	100%		No

Reassessment component is the same

Feedback on assessment

Personal tutor, group feedback

Past exam papers for PX420

Availability

Courses

This module is Optional for:

- Year 4 of UPXA-F303 Undergraduate Physics (MPhys)

This module is Option list A for:

- Year 3 of UMAA-G100 Undergraduate Mathematics (BSc)
- Year 3 of UMAA-G103 Undergraduate Mathematics (MMath)
- Year 4 of UMAA-G101 Undergraduate Mathematics with Intercalated Year

This module is Option list B for:

- UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
    - Year 3 of G105 Mathematics (MMath) with Intercalated Year
    - Year 5 of G105 Mathematics (MMath) with Intercalated Year
- UMAA-G103 Undergraduate Mathematics (MMath)
    - Year 3 of G103 Mathematics (MMath)
    - Year 4 of G103 Mathematics (MMath)
- UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe
    - Year 3 of G106 Mathematics (MMath) with Study in Europe
    - Year 4 of G106 Mathematics (MMath) with Study in Europe
- Year 4 of UPXA-FG33 Undergraduate Mathematics and Physics (BSc MMathPhys)
- Year 4 of UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)