# AS5002 - Magnetofluids and Space Plasmas

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| **Credits:** | 15.0 | **Semester:** | 1 |
| **Number of Lectures:** | 27 | **Lecturer:** | Dr Christiane Helling |
| **Academic Year:** | 2018-19 | | |

## Overview
The interaction of a magnetic field with an ionised gas (or plasma) is fundamental to many problems in astrophysics. Star formation in particular is heavily influenced by the magnetic fields of molecular clouds, and once stars form they can, if they posses a convective region, generate their own magnetic fields by dynamo activity. The behaviour of this magnetic field is at the heart of many of the most interesting observations of young stars and their accretion disks.
This module is suitable for physics students as well as astronomers. PH4031 Fluids or MT4509 Fluid Dynamics are recommended as prior study.

## Aims & Objectives
To present an account of the theory and observations of magnetic activity in solar-like stars, including an introduction to magnetohydrodynamics, the physics of heating stellar coronae to temperatures of 10^6K, the generation of stellar magnetic fields by dynamo action, the role of magnetic fields in star formation, the physics of accretion disks, stellar spin down by accretion disks and stellar winds.

## Learning Outcomes
By the end of the module students should have an understanding of the physics of stellar magnetic fields as presented in the lectures and should be able to

- Describe the main observational signatures of magnetic activity
- Use the magnetohydrodynamic equations describe the behaviour of simple magnetic field configurations
- Give an account of the heating of stellar coronae and derive the scaling relations for pressure, temperature and length of magnetic loops
- Describe the main observational features of solar and stellar dynamos and calculate the characteristics of a simple kinematic solution
- Use the Virial theorem to explain the characteristics of magnetic support of molecular clouds and the onset of cloud collapse
- Demonstrate the role of viscosity in accretion disks and determine the temperature profile of such a disk
- Use torque balance in an accretion disk to explain stellar spin-down by star-disk coupling
- Use conservation of mass and momentum to derive Parker's wind solution and describe the role of magnetic channelling in a rotating star
- Determine the angular momentum loss rate for simple examples

## Synopsis
Review of observations of stellar magnetic activity. Equations of magnetohydrodynamics (MHD) Heating of stellar coronae. Reconnection. Energetics of coronal loops and the role of rotation MHD waves and propagation of information. Solar and stellar dynamos (mean field models). Star formation: properties of magnetic cloud cores, magnetic support and the Virial theorem. Accretion disks: transport of mass and angular momentum, role of viscosity. Temperature profiles. Stellar spin down by magnetic star-disk coupling. Rotation distributions of young solar-type stars. Magnetic braking by stellar winds.

## Pre-requisites
(PH3007 or MT4510 or MT4553) AND (AS3013 or PH4030 or PH3080 or MT3802 or MT4112). PH4031 fluids or MT4509 Fluid Dynamics strongly recommended.

## Anti-requisites
None

## Assessment
2 Hour Examination = 100%

**Recommended Books**
Please view University online record:
http://resourcelists.st-andrews.ac.uk/modules/as5002.html

**General Information**
Please also read the general information in the School's honours handbook.