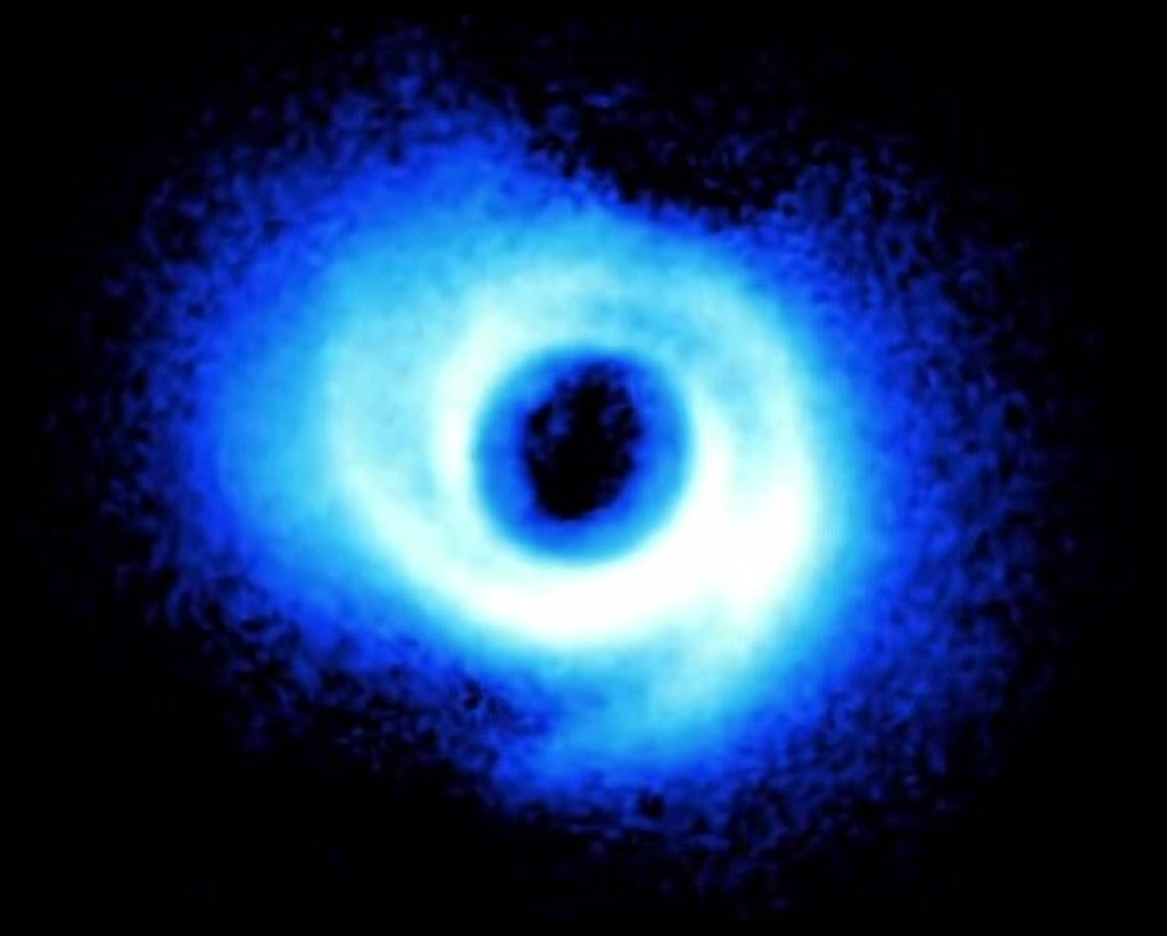
University of Glasgow | School of Physics & Astronomy



ASTRO4005

Heliophysics and Stellar Atmospheres

Course Information Guide

Course Details

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		Schedule:	HSAI - 11 lectures, semester 1 HSAII - 11 lectures, semester 2
Credits:	15	ECTS Credits:	7.5
Assessment:	2 hour exam (100%)	Exam Diet:	April/May
Level:	Honours	SCQF Level:	10
Year Cycle:	A (odd years)		

Course Aims

To provide students with an opportunity to develop knowledge and understanding of the key principles and applications of heliophysics and stellar atmospheres, and their relevance to current developments in astronomy.

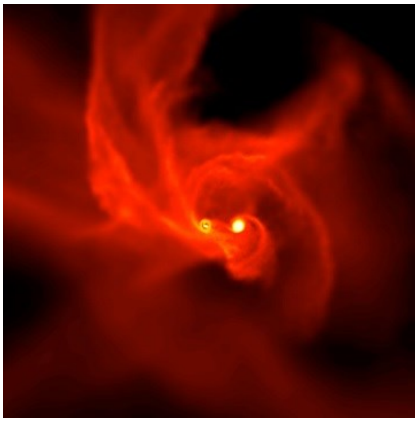
Intended Learning Outcomes

By the end of the course students should be able to:

- Demonstrate a knowledge and broad understanding of heliophysics and stellar atmospheres.
- Describe and analyse quantitatively processes, relationships and techniques relevant to the topics included in the course outline, applying these ideas and techniques to solve problems which may include straightforward unseen elements.
- Write down and, where appropriate, either prove or explain the underlying basis of astrophysical laws relevant to the course topics, discussing their applications and appreciating their relation to the topics of other courses taken.

Semester 1 Course Outline

- *Basic Concepts*: Specific intensity, proof that it is constant along a ray path. Definition of mean intensity, energy density, radiative flux, radiation pressure. Definitions of absorption and emission coefficients. Derivation of the equation of radiative transfer. Local thermodynamic equilibrium - thermodynamic temperature, statistical equilibrium and detailed balance. The case of a plane-stratified atmosphere, general results.
- *Equation of Radiative Transfer*: Examination of the equation of radiative transfer and its formal solution. Optical depth and the source function, scattering and non-scattering processes. Definitions of the Einstein coefficients and their interrelation.
- *Grey Atmosphere*: Optical depth in a grey atmosphere. The Eddington approximation and comparison with exact grey solution. Application to solar limb darkening. Application to the more general problem. Definition of the Rosseland opacity.
- *Line Formation*: Definition of the atomic absorption coefficient in terms of the Einstein coefficients, profile function, relation to oscillator strengths. Boltzmann and Saha



Radiative transfer model of star formation
Credit: **Matthew R. Bate 2009**

equation. Departure from local thermodynamic equilibrium. Line Profiles: equivalent width of a spectral line; line profiles under thermal Doppler, rotational, macroturbulence, microturbulence, natural and pressure broadening. Curve of growth and typical profiles of strong and weak spectral lines.

Semester 2 Course Outline

- *Solar Atmospheric Structure:* Photosphere, recap of optical depth. Isothermal atmospheres in hydrostatic equilibrium and scale height. Opacity and limb darkening. Chromosphere: chromospheric emission lines; the transition region and the corona. Coronal heating - acoustic and Alfvenic waves; radiative instability; width of the transition region and Spitzer conductivity.
- *Static and Dynamic Equilibrium*: Fluid equations. Conditions for a hydrostatic corona. Isothermal, static atmosphere. The Chapman model. Stellar wind theories - the solar wind as coronal expansion. Isothermal winds; the Parker wind model. Velocity profiles and the critical solution; stellar breeze solution; ram pressure; mass loss rate.
- *Radiatively Driven Winds*: Optically thin solutions. Eddington luminosity. Castor, Abbott, Klein velocity profiles. Accretion solutions; mass-loss rates; wind luminosity; effect of finite stellar size on radiation pressure. Line driven winds; P Cygni profiles - theory and interpretation; multiple scattering, conservation of energy and momentum; performance factor; pulsation and magnetically driven winds.
- *Magnetised Winds*: Magnetic fields and flux freezing. Magnetic pressure. Plasma beta. Stream structure and the ballerina model. The current sheet. Archemedian (Parker) spirals. Coronal holes. High and low speed streams; transients; the solar cycle; geomagnetic effects.

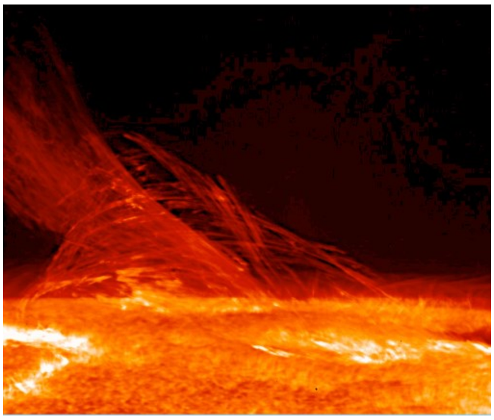


Image of the Sun's chromosphere
Credit: **JAXA/NASA**

Further Information

Consult the reading lists for Semester 1 and for Semester 2.

Course specifications - More details about the course in relation to other courses and degree paths on the course catalogue website.
Time and location of lectures - will be available during term time on the course website via Moodle.
Enrolment - Through MyCampus, details on the Astronomy 345 Moodle page.