ASTROPHYSICAL PROCESSES: NEBULAE TO STARS [PHAS2112]

Abbreviated Syllabus

Term: 2
Nominal Structure: 27 lectures, + discussion/problem classes
Prerequisites: Students should normally have attended (or be attending) introductory courses in Quantum Physics, and Thermodynamics.

Aims

The aim of this course is to introduce students to the most important astrophysical processes encountered in a range of nebular and stellar environments. Knowledge of these processes is an essential prerequisite for several more specialised 3rd- and 4th-year courses in astronomy and astrophysics.

The philosophy of the course is to start in low-density regimes where microscopic processes must be considered, then move through progressively higher-density environments – stellar atmospheres and stellar interiors.

Objectives

On completion of the course, students should be equipped with knowledge of the basic physical processes and astrophysical concepts that underlie subsequent advanced courses on the interstellar medium, stellar atmospheres, and stellar structure and evolution.

Methodology and Assessment

The nominal timetable is of 27 lectures, plus 3 lectures on non-examinable topics, and 3 problem classes. Assessment is based on results achieved in the final examination (90%) and the best 3 of 4 homeworks (10%).

Syllabus

Interstellar Clouds [7 lectures]

Physical conditions. Heating and cooling processes. Line broadening (natural, thermal, turbulent). Line transfer, curve of growth, abundances.

Photoionized Nebulae [7 lectures]

Physical conditions. Heating and cooling processes; collisional excitation of emission lines. Ionization equilibrium. Absorption & emission coefficients, and the source function. Free-free radio continuum, and radiative transfer.

Stellar Atmospheres [4 lectures]

Radiation transport. Moments of the radiation field. Saha-Boltzmann equation. Local Thermodynamic Equilibrium.

Stellar Interiors [4 lectures]

Equation of state. Hydrostatic equilibrium. Radiation pressure, Eddington limit. Virial theorem, stellar timescales.

Nuclear Processes [5 lectures]

PP chain. CNO cycle. 3-α processes and later stages of burning. Neutron capture, r and s processes. Supernovae.

Suggested Reading

This 'portmanteau' course is developed from a number of sources. For interstellar/nebular topics, *The Physics of the Interstellar Medium* (J.E. Dyson & D.A. Williams, IoP Publishing) is useful, while *Astrophysics – I: Stars* (R. Bowers & T. Deeming, Jones & Bartlett) is valuable for all aspects of stellar astrophysics.