

# **RADIATIVE AND DYNAMICAL PROCESSES**

This model syllabus defines the core material for Radiative and Dynamical Processes. Instructors should use their discretion in deciding the ordering of topics, the depth to which each is covered, and additional material to include. It is anticipated that instructors will draw upon a range of examples from astrophysics and planetary science to illustrate the core material.

## **TRANSPORT PHENOMENA**

*Microscopic description of transport processes for particles*

Random walks and relation to diffusion  
Mean-free path, collision time  
Langevin, Fokker-Planck and Boltzmann equations

## **RADIATION PROCESSES**

*Macroscopic treatment of radiation and its interaction with matter, primarily at the level needed to deal with grey atmospheres*

Defining the radiation field (specific intensity, moments, fluxes)  
Equation of radiative transfer  
Emission, absorption, definition of the source function, formal solutions  
Approximations for optically thin and thick media: diffusion and two-stream limits  
Local thermodynamic equilibrium  
Grey atmospheres: applications and limitations  
Mean opacities: definition and qualitative discussion of opacity as a function of wavelength.

## **MAGNETOHYDRODYNAMICS**

*Derivation, application, and understanding the limits of the MHD approximation. There is overlap with Fluids in the derivation of the MHD equations – instructors might consider an independent derivation of the basic fluid equations starting from the Boltzmann equation.*

Basic assumptions for a magnetized fluid  
Derivation of the ideal MHD equations  
Diffusivity and non-ideal MHD: magnetic Reynolds number and Prandtl number  
Hydromagnetic equilibria  
Force-free approximation  
Alfvén and magnetoacoustic waves  
Limits to the MHD approximation (e.g. when is additional physics such as ambipolar diffusion important, and when is a full plasma treatment needed)

## **DYNAMICAL PROCESSES**

*General introduction to dynamics with application to both planetary and stellar dynamical problems*

Orbits in Keplerian potentials

Dynamics in perturbed potentials

Simple examples of resonant dynamics (pendulum, planetary orbits)

Concepts of stellar dynamics, scattering, relaxation time, dynamical friction

Dynamics of clusters: Fokker-Planck and N-body approaches

Stability of N-body systems (e.g. restricted 3-body problem, disk stability)