ES212 Jan 3:0

Fluid dynamics of planetary interiors

Instructor

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Teaching Assistant

Email:

Department: Centre for Earth Sciences

Course Time:

Lecture venue: Earth Sciences Seminar Hall

Detailed Course Page:

Announcements

Brief description of the course

This is a graduate-level course aimed at students who would like to specialise in advanced fluid dynamical modelling of planetary interiors and atmospheres. Students with a basic knowledge in vector algebra, partial differential equations and undergraduate fluid mechanics will benefit from this course. Several classical theories in the subject and new developments (theoretical, computational, experimental) will be discussed. Students will also read and present journal papers as part of this course.

Prerequisites

ES 205 (Mathematics for Geophysicists) or undergraduate courses in Mathematics and fluid mechanics.

Syllabus

Basic fluid dynamics - Navier-Stokes equation, vorticity equation, Kelvin's circulation theorem, energy and dissipation, helicity.

Rotation - Coriolis force, linear inertial waves, formation of Taylor columns, geostrophy, quasigeostrophic approximation.

Stratification - Gravity waves, effect of rotation, Braginsky's theory of stratified outer core of the Earth.

Magnetic fields - Magnetohydrodynamic (MHD) equations, Lorentz force, low and high magnetic Reynolds number, Alfven waves, Magnetic-Coriolis (MC) waves, Rayleigh Benard convection with magnetic field and rotation, MHD of planetary cores.

Turbulence - Richardson's cascade, overview of classical theories, 2D turbulence, turbulence under moderate and rapid rotation, MHD turbulence, different length scales in planetary core turbulence.

Course outcomes

Advanced fluid mechanics in stationary and rotating reference frames, principles of rotating convection, magnetohydrodynamics (MHD) of planets, applications of turbulence theories to planetary interiors and atmospheres.

Grading policy

30% for mid-term, 30% for project/paper presentation, 40% for final.

Assignments

Resources

Davidson, P.A., Turbulence in rotating, stratified and electrically conducting fluids, Cambridge University Press, 2013.

Acheson, D.J., Elementary fluid dynamics, by, Oxford University Press, 1990.

Journal papers