Astrophysical Fluid Dynamics

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The purpose of the course is to complete the fluid mechanics background needed in astrophysics.

Attendance of a substantial fraction of course lectures is obligatory.

Problem sets are mandatory and constitute about 25% of the final grade.

Written exam at the end of the term: April 10, 2014 (exam) May 8, 2014 (re-exam)
Bibliography

I. The lecture notes and handouts are the main source of material. However, there are a number of good books that the student can use to clarify some of the topics or for extra material.

II. Interesting Books:

- **Fluid Mechanics**, Landau and Lifshitz
  - Exceptional book but of somewhat higher level.
- **Gas Dynamics**: Vol. II, Physics of Astrophysics, F. Shu
  - Univ. Science Books, very good for astrophysical perspective.
- **An Introduction to Fluid Dynamics**, G. K. Batchelor
  - Historic classic, widely regarded as a "bible" for the subject.
  - Daunting at first sight, but lucid, thorough and reliable.
- **Astrophysica: Inleiding Gasdynamica**, Bram Achterberg (UU)
  - Very clear and complete treatment of astrophysical hydrodynamics
- **Album of Fluid Motion**, van Dyke
  - Beautiful photographs showing fluid in motion

Astrophysical Fluid Mechanics

Topics

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Fluid Picture Book

Waves: sea & ocean waves
Cosmic Sound Waves

Primordial Sound Ripples seen in WMAP Cosmic Microwave Background
Convection: Benard cells

Convection: Earth Atmosphere
Convective cells on solar surface

Vortex & Vorticity
Vortices in Shear Flow

Tornados: Atmospheric Vortices
Hurricanes: Atmospheric Vortices

Vortices and Eddies: Jupiter's turbulent atmosphere
Voriticity Flow around Jupiter’s Red Spot

May 15, 2008  June 28, 2008  July 8, 2008

Jupiter’s Red Spots
Hubble Space Telescope • WFPC2

NASA, ESA, and A. Simon-Miller (NASA Goddard Space Flight Center) • STScI-PRC08-27
Jupiter’s Great Red Spot

Rayleigh-Taylor Instability

2 fluids of different density
Rayleigh-Taylor Instability

2 fluids of different density

Rayleigh-Taylor Instability

fluids of different density
Cosmic Rayleigh-Taylor Instability

Crab Supernova Remnant

Kelvin-Helmholtz Instability

at the boundary of 2 shearing fluids
Kelvin-Helmholtz Instability

KH instability in cloud cover

Kelvin-Helmholtz Instability

KH instability in Saturn's atmosphere
Supersonic Motion & Shockwaves
Supersonic Motion & Shockwaves

Cosmic Shockwave:
Supernova remnant  CasA
Gas streams along magnetic field lines

Solar surface
TRACE