

Astrophysical Hydrodynamics

- i Lecturer: Rien van de Weijgaert
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 - b Office hours: You are always welcome to come to my office for short questions. You can also make an appointment via email.
- ii Teaching assistant: Patrick Bos
 - a Office: 189, phone: 4053, email: pbos@astro.rug.nl
- iii The purpose of the course is to complete the fluid mechanics background needed in astrophysics.
- iv Attendance of a substantial fraction of course lectures is obligatory.
- v Problem sets are mandatory and constitute about 25% of the final grade
- vi Written exam at the end of the term

Bibliography

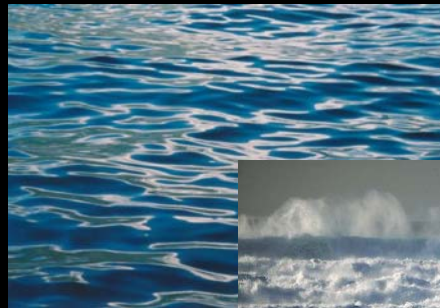
- I. The lecture notes and handouts are the main source of material. However, there are a number of good books that the student can use to clarify some of the topics or for extra material.
- II. Interesting Books:
 - **Astrophysical Flows**, J. Pringle and A. King, Cambridge University Press, nice concise introduction
 - **Fluid Mechanics**, Landau and Lifshitz exceptional book but of somewhat higher level.
 - **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.
 - **Gas Dynamics**; Vol. II, Physics of Astrophysics, F. Shu Univ. Science Books, very good for astrophysical perspective.
 - **Album of Fluid Motion**, van Dyke Beautiful photographs showing fluid in motion

Astrophysical Fluid Mechanics

Topics

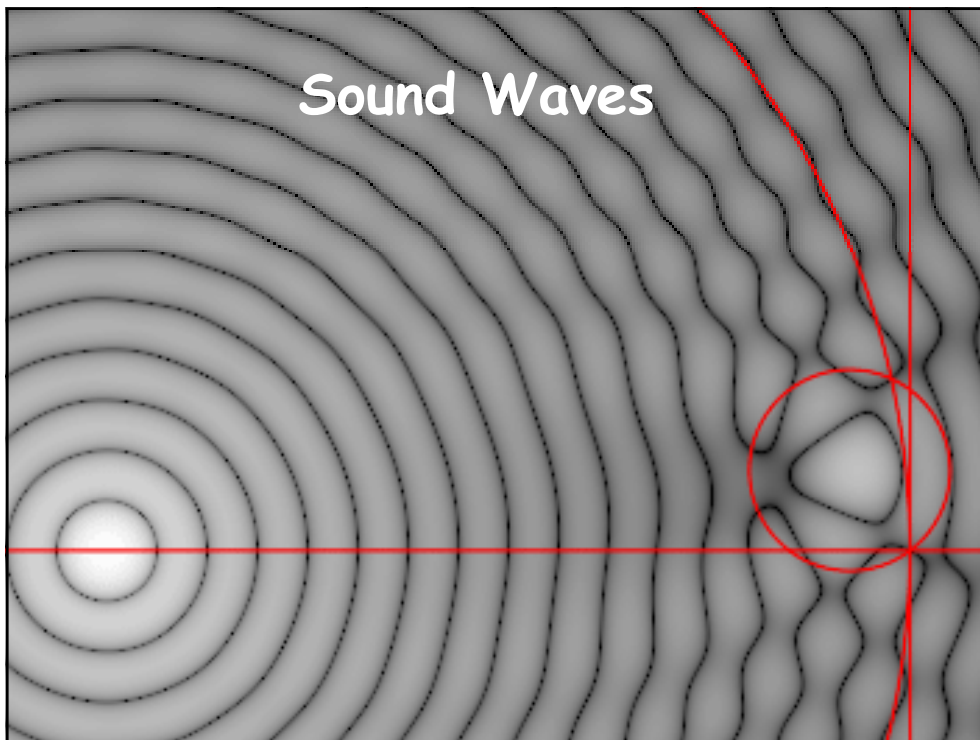
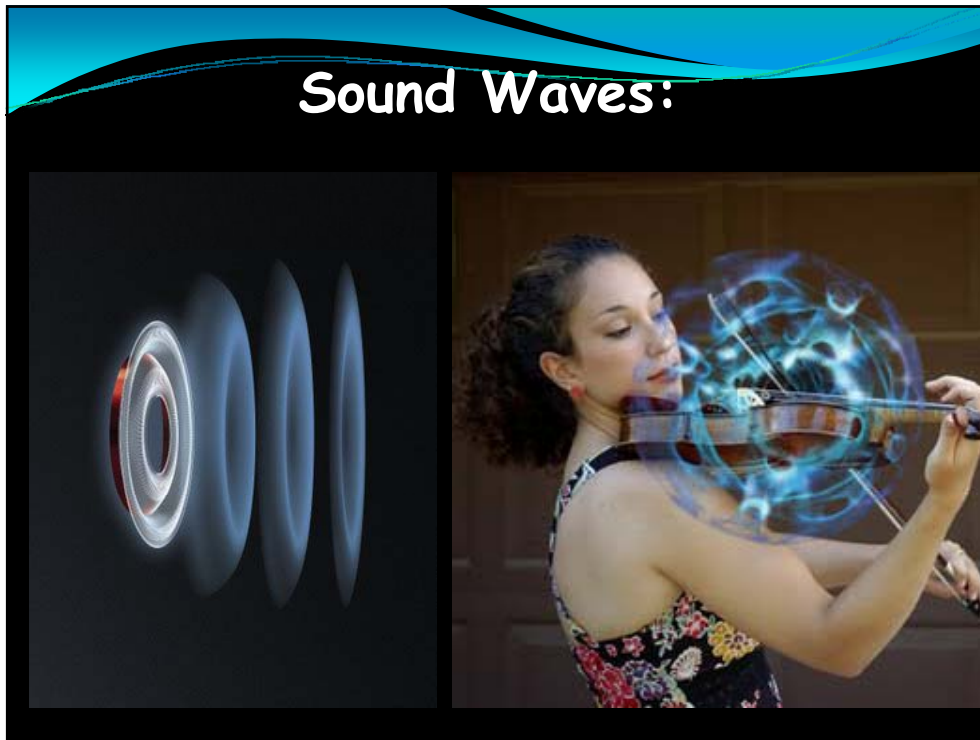
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|-------|---|--|--|
| I | Fluid Picture Book | | |
| II | Basic fluid equations of ideal fluids | | |
| III | Inviscid Barotropic Flows: Kelvin Circulation Theorem Bernoulli Theorem | | |
| IV | Incompressible Fluids | | |
| | Compressible fluids: | | |
| V | Waves | | |
| VI | Hydrodynamic Instabilities | | |
| VII | Shock Waves | | |
| VIII. | Viscous flows: Navier-Stokes Eqns. | | |
| IX. | Similarity solutions | | |
| X. | Turbulence | | |
| XI. | Magnetohydrodynamics | | |
| XII. | Numerical (astro)hydrodynamics | | |

Fluid Picture Book

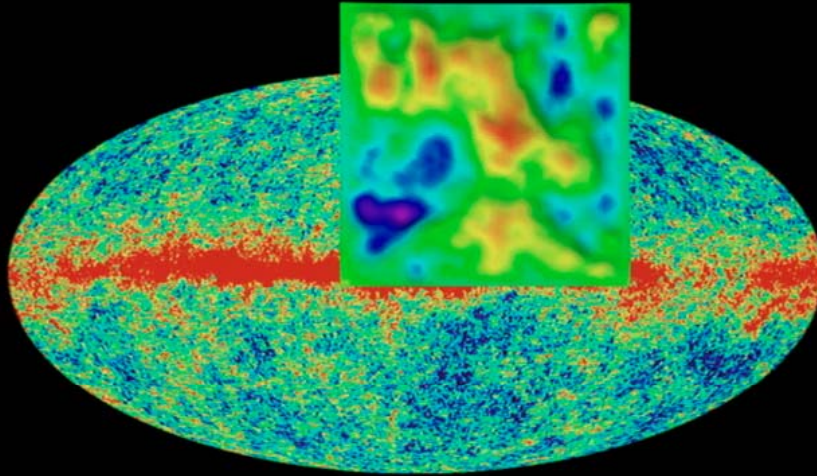


**Waves:
sea & ocean waves**





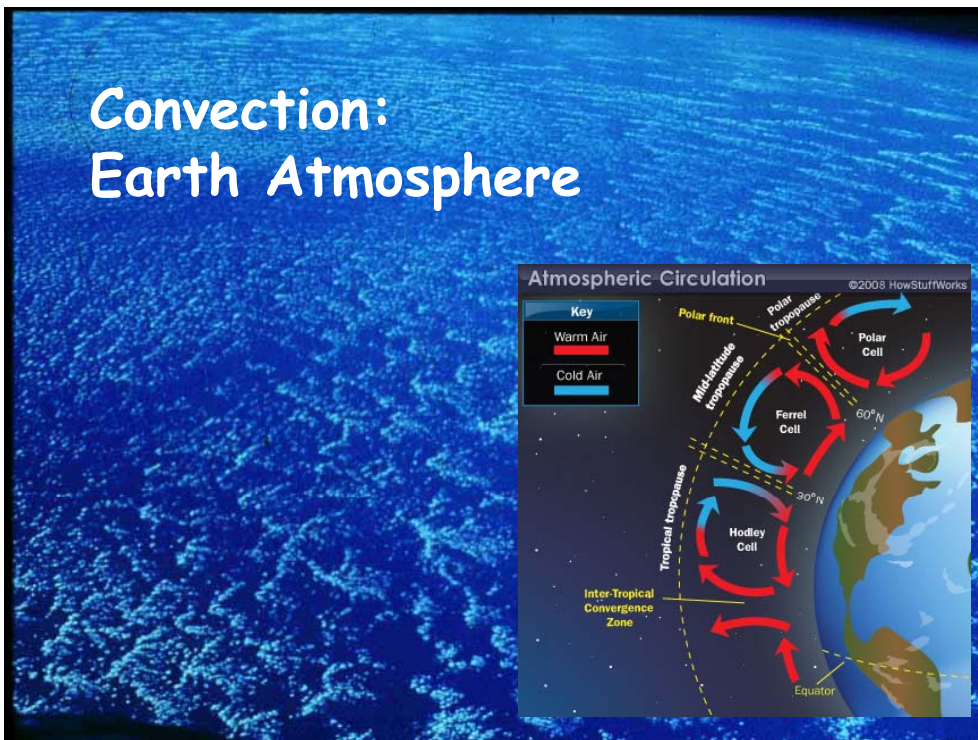
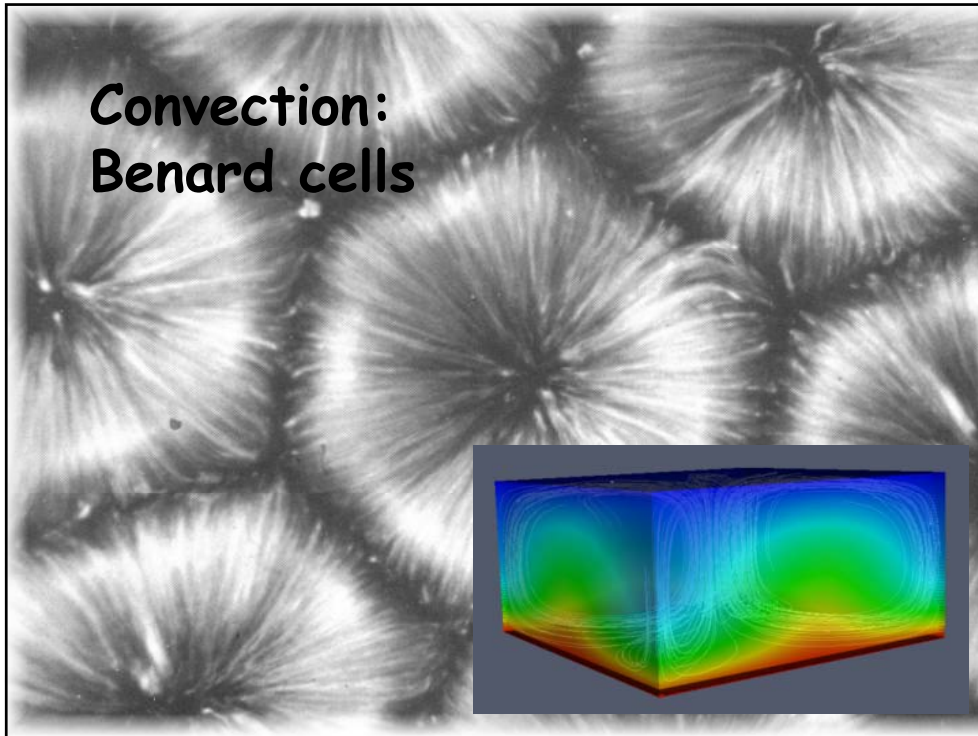
Cosmic Sound Waves

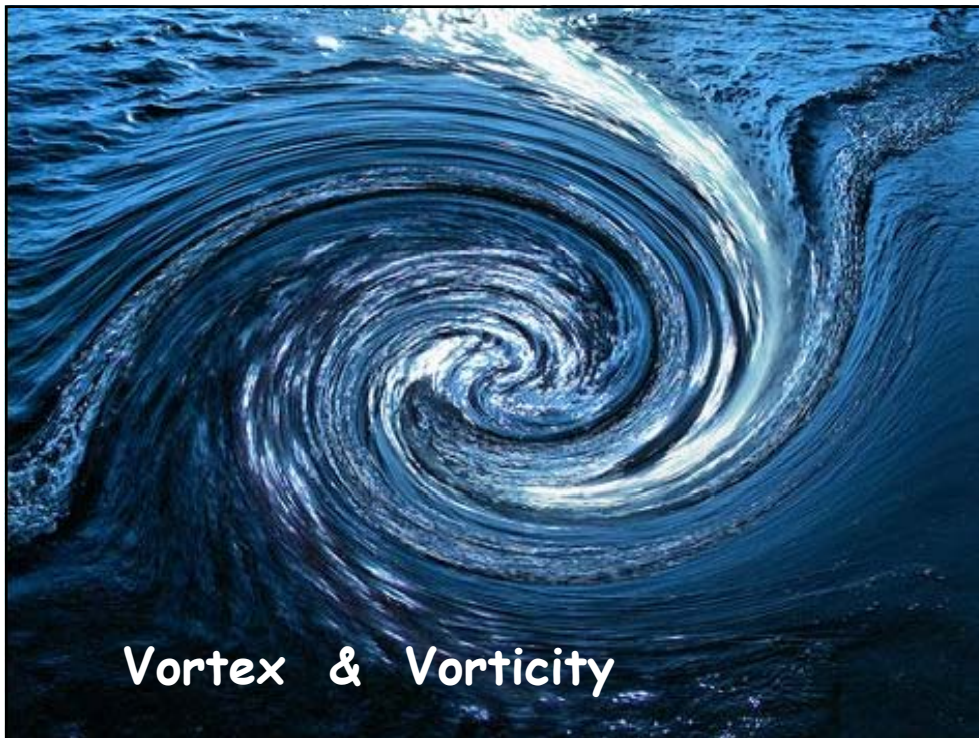
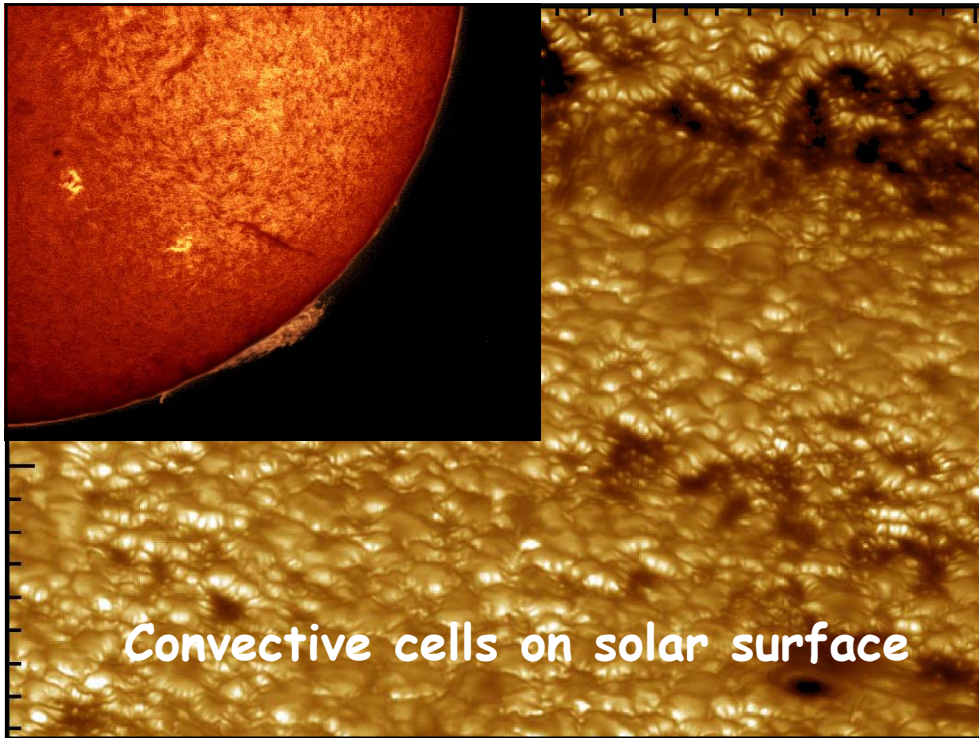


Primordial Sound Ripples seen in
WMAP Cosmic Microwave Background

Cosmic Sound Waves



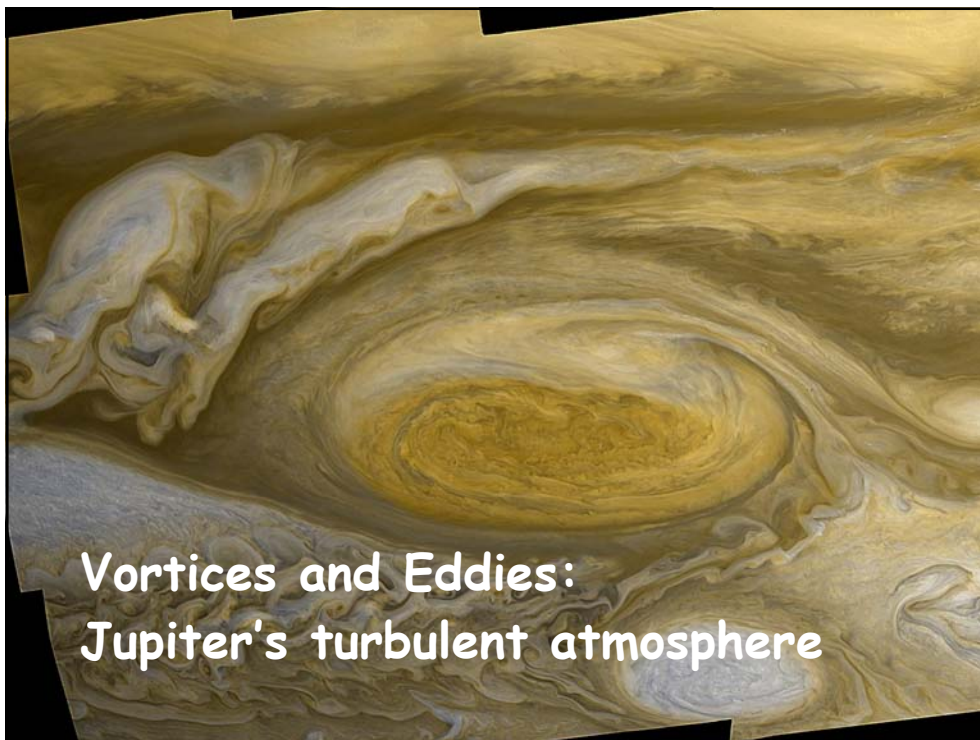
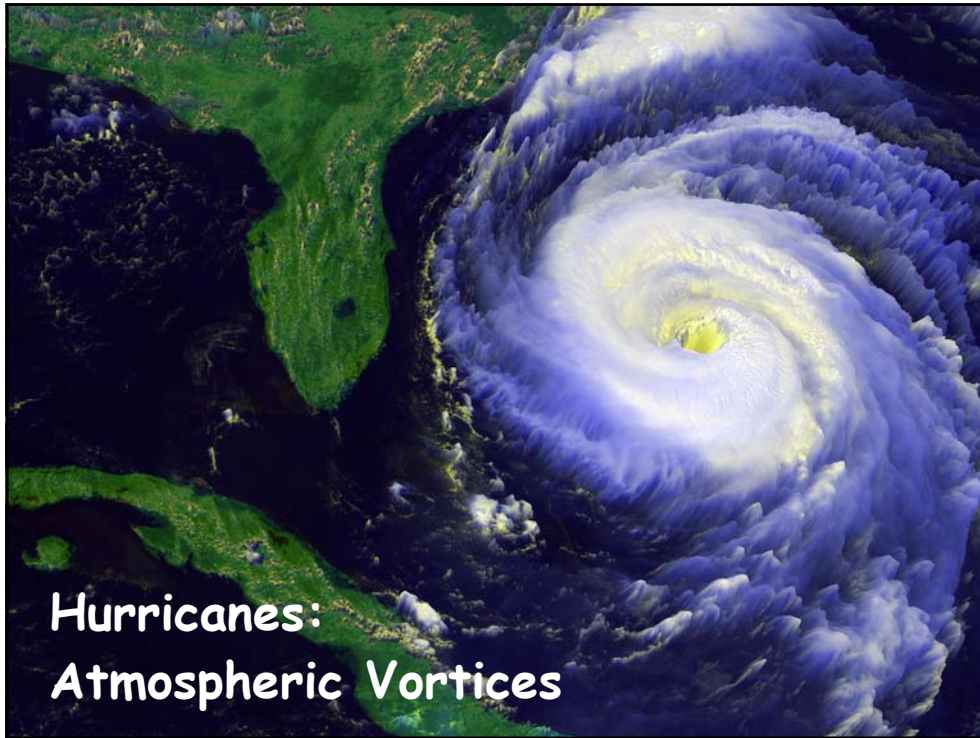


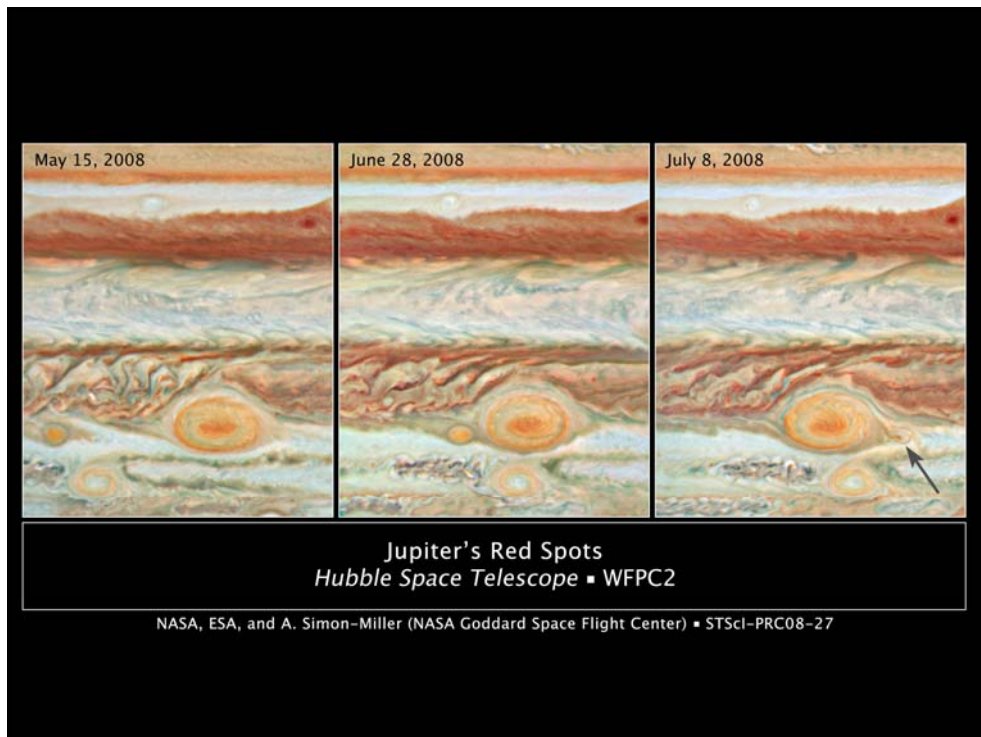
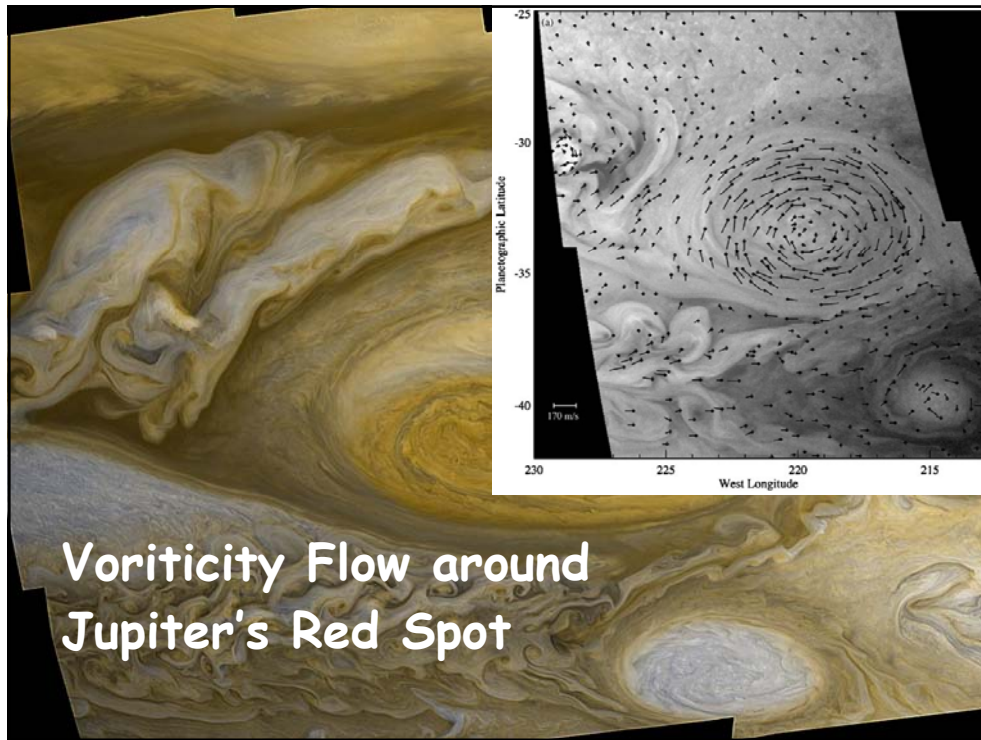


Vortices in Shear Flow



**Tornados:
Atmospheric Vortices**



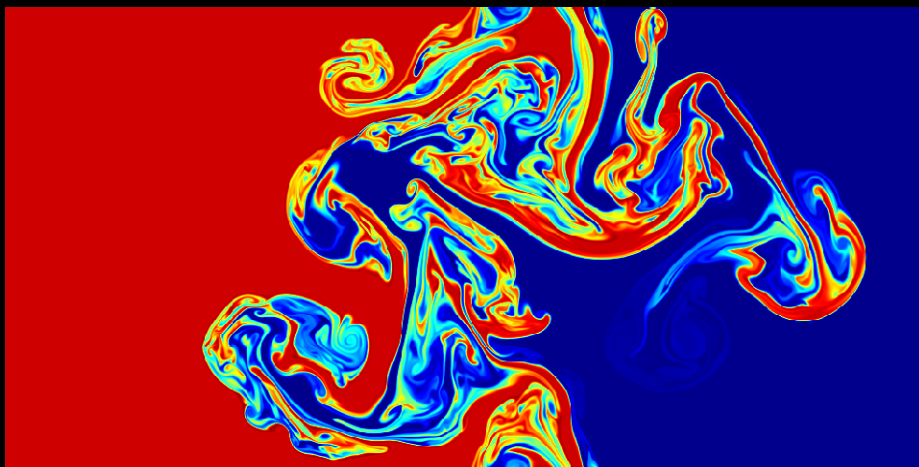


Rayleigh-Taylor Instability

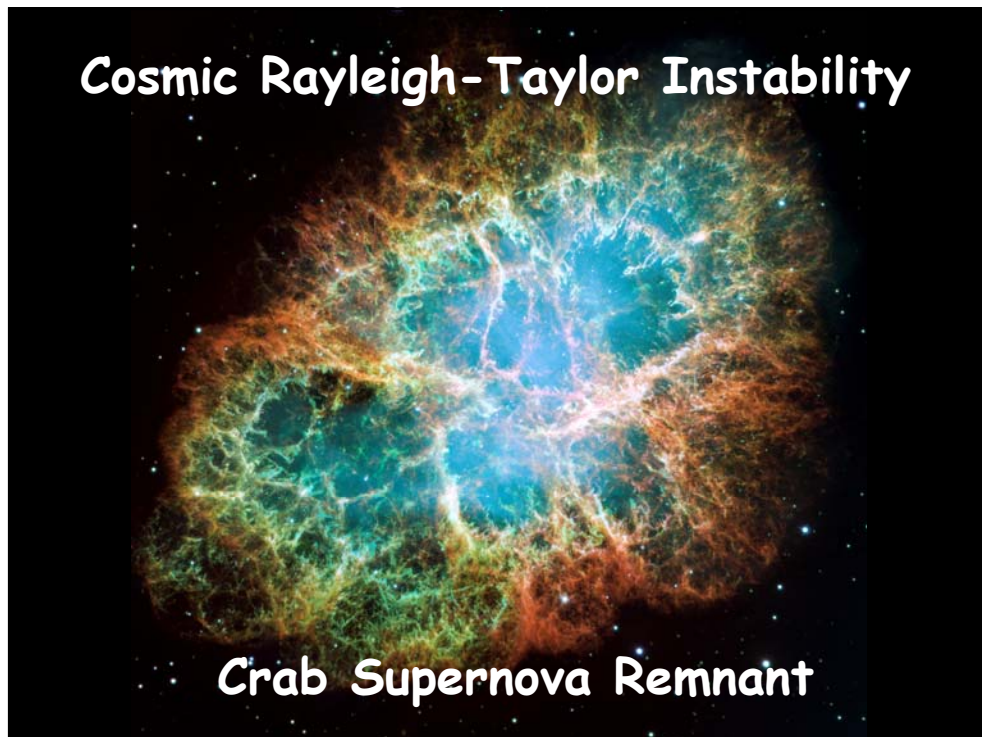
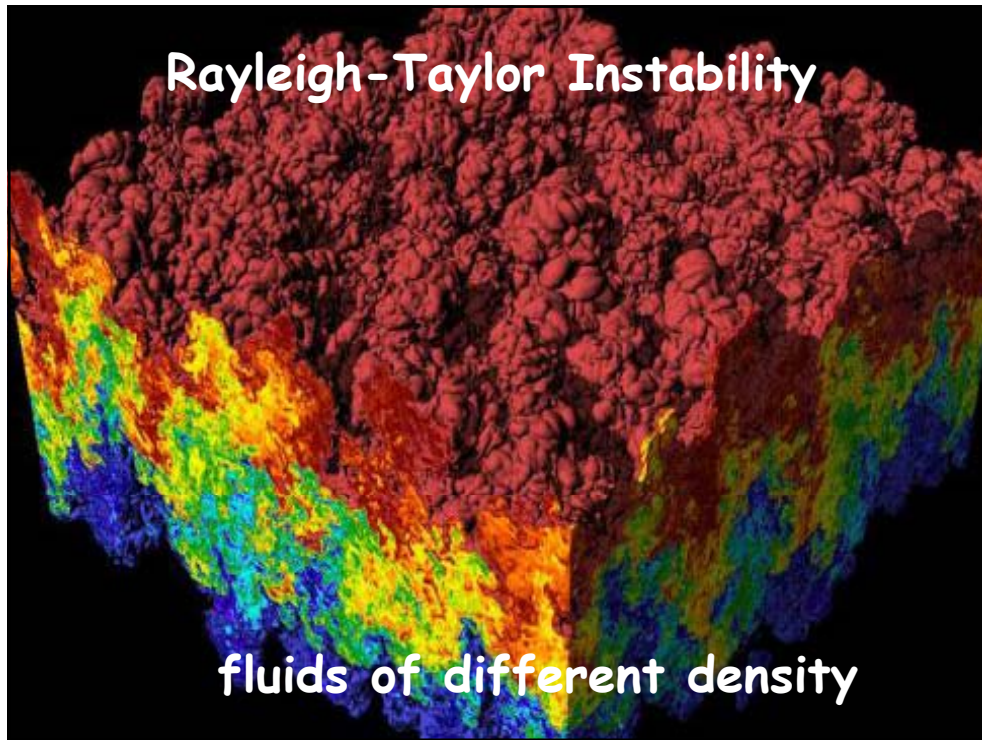


2 fluids of different density

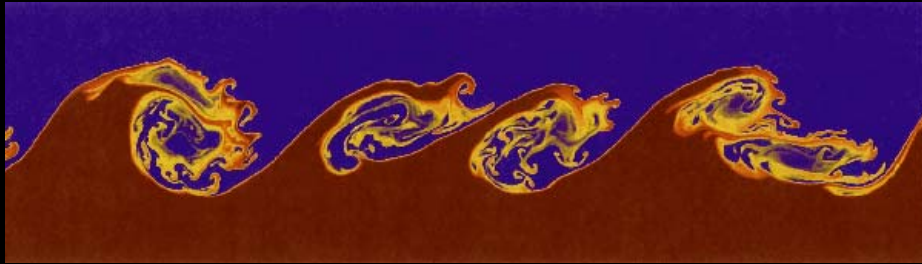
Rayleigh-Taylor Instability



2 fluids of different density



Kelvin-Helmholtz Instability



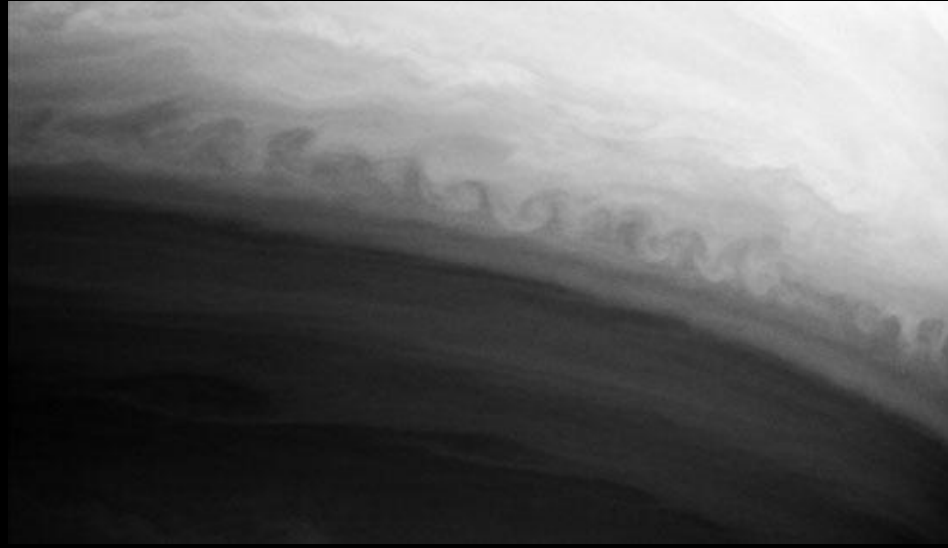
at the boundary of 2 shearing fluids

Kelvin-Helmholtz Instability



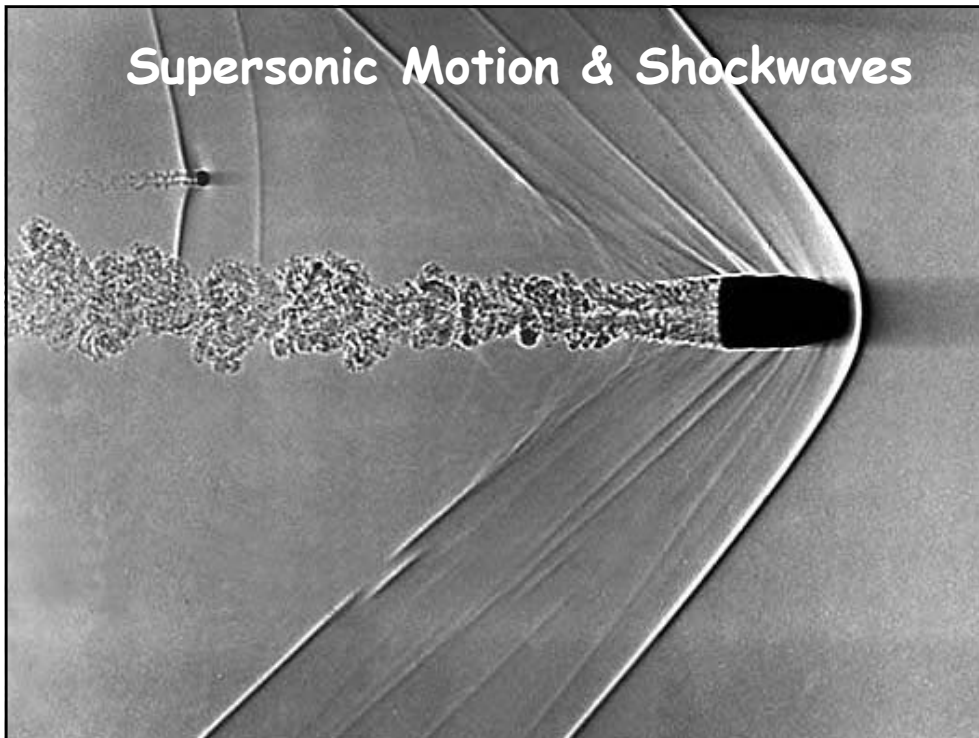
KH instability in cloud cover

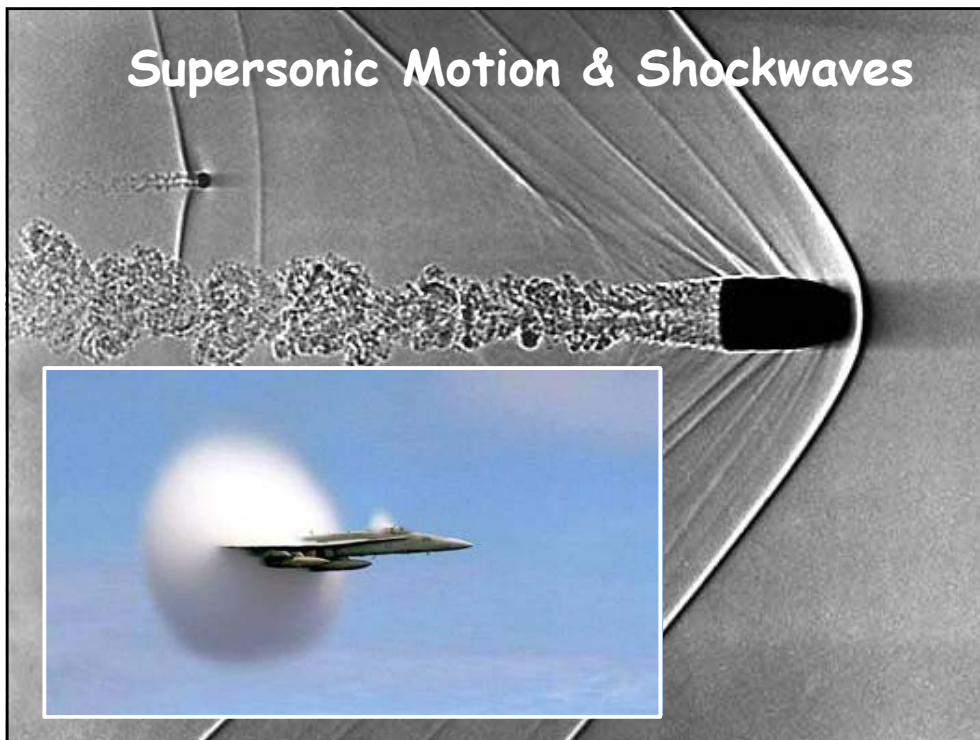
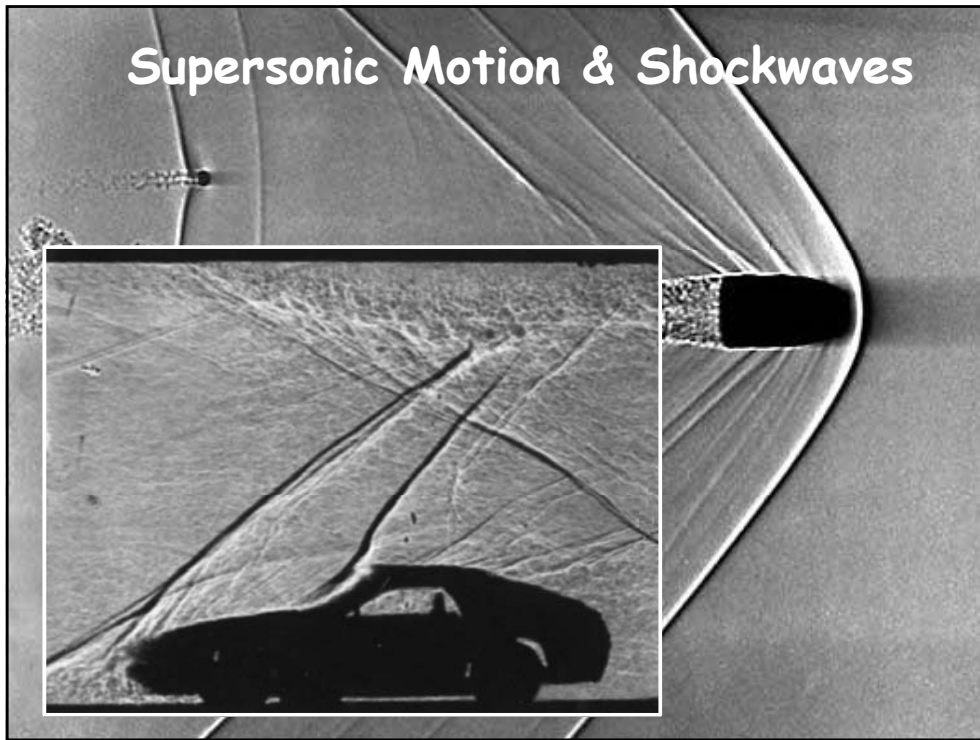
Kelvin-Helmholtz Instability



KH instability in Saturn's atmosphere

Supersonic Motion & Shockwaves





**Cosmic Shockwave:
Supernova remnant CasA**



**Gas streams
along magnetic field lines**

