Title: Topics in Modeling Planetary Interiors

Course number: EART 290x Spring 2013

Instructor: Gary A Glatzmaier
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Lectures: Friday, 9:00am-noon, Earth and Marine Sciences Building, D236

Office Hours: By appointment.

Text: "Introduction to Modeling Convection in Planets and Stars" by G.A. Glatzmaier
(a pdf copy will be provided)

Course description:
This is an introduction to writing computer codes to simulate thermal convection and internal gravity waves in planetary interiors. The resulting codes could be used to study the fluid dynamics of the atmospheres, oceans, mantles and liquid cores of terrestrial planets, like the Earth, and the deep interiors of giant gaseous planets, like Jupiter. The codes could also be adapted to study the interiors
of stars. Students first learn how to write and run a basic computer code that simulates two-dimensional thermal convection using spectral and finite-difference
methods and an explicit time integration scheme. They also learn how to post-process
and analyze their simulated results using computer graphics, including movies. They then are shown how to improve the numerical method and physics of their codes.
The lectures for the first four weeks of the course will cover the following topics.

Week 1: Equations and numerical method for the basic convection model in a 2D box

Week 2: The thermal convection stability problem

Week 3: Nonlinear thermal convection and gravity wave simulations

Week 4: Post-processing, graphics, movies

The lectures for the following six weeks will cover some subset of the following topics, depending on the current group of students.

Numerical improvements:

- Higher-order and semi-implicit time integration schemes

- Different spatial discretization methods

- Different boundary conditions and curvilinear geometry

Spectral transform method for computing nonlinear terms

Parallel processing

More realistic physics:

Magnetic field

Density stratification

Planetary rotation

Required: basic computer programming experience in, for example, Fortran, C, IDL or Matlab. This course is designed for graduate students but is available
to qualified science majors. It may be repeated for credit.

Student Evaluations: based on the quality of the codes written.