# Models of Giant Planets

## Supervisor: Prof. Chris Jones, Room 9.21k

Stars are held in equilibrium by the balance of gravitational force pulling inward and pressure force pushing outward. The pressure is determined by the gas law in terms of the temperature and density. The equations governing these processes allow a set of ordinary differential equations to be written down, which can be solved using simple numerical methods. These stellar structure equations are well-documented in textbooks. In this project, the same ideas will be used to construct models of the giant planets Jupiter and Saturn which satisfy the same basic equations, though in these planets there is no energy source from nuclear reactions: instead the planets are very slowly losing heat and contracting. In the first part of the project, the basic stellar structure equations will be considered, and in the second part, the equations will adapted to construct models of gaseous planets.

In the interior of the giant planets, the pressure is very high but the temperature is much lower than in stars. In consequence, the gas goes into a new state of matter known as metallic hydrogen, because it can conduct electricity like a metal. Equations of state for this metallic hydrogen phase are available, and the aim of the project will be to use these equations to describe the internal structure of these planets: their temperature, density and pressure distributions. A key question is at what distance below the surface does the usual molecular hydrogen/helium layer end and the metallic hydrogen state begin.

Some familiarity with MAPLE or MATLAB is essential, as the differential equations formulated will need to be solved using one of these packages, and graphs of the variation of temperature with distance from the centre, etc. will be plotted. No previous knowledge of astronomy or astrophysics is required.

**Books:**

*Planetary Interiors*, W. Hubbard, (Van Nostrand, 1984).

*Planetary Sciences*, I. de Pater and J. Lissauer, (Cambridge University Press, 2001).

*The Physics of Stars,* A. Phillips, (John Wiley and Sons, 1996).

*Jupiter: the Giant Planet,* R. Beebe, (Smithsonian Institution, 1997).