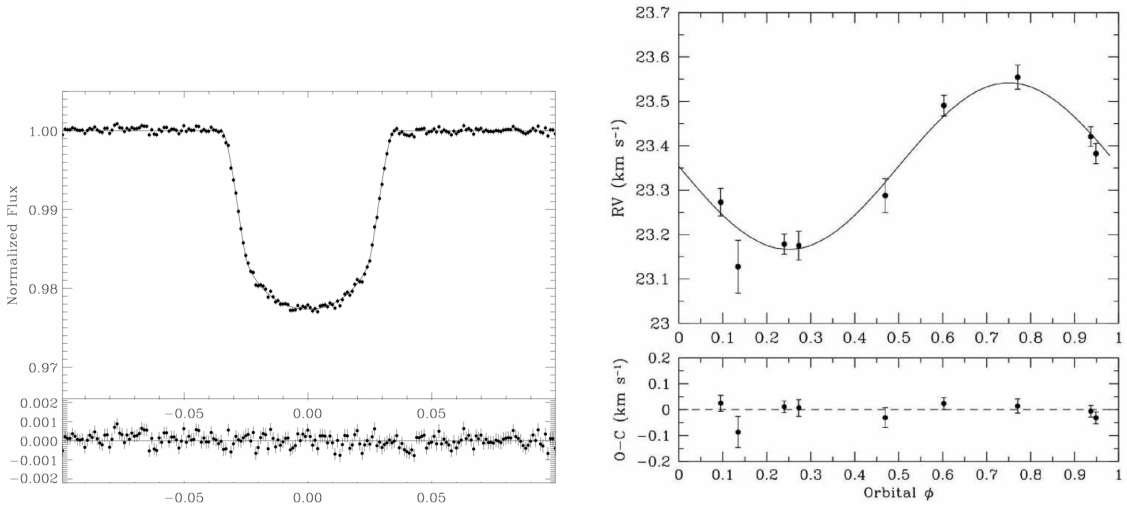
Astronomy 405 (Spring 2013)
Homework 7 (due on March 8)

Problem 1.



The transit of a planet can be studied with the light curve, as shown in the left panel of the figure above. The central star has a spectra type G0 V. The planet has a circular orbit and the orbital period is 1.5 days. The radial velocity curve of the central star is shown in the right panel of the figure above. The horizontal axis is the orbital phase.

(a) What is the mass and radius of the star? (See Appendix G of Carroll & Ostlie)
(b) What is the orbital radius of the planet?
(c) What is the orbital velocity of the star? (Use the radial velocity curve.)
(d) What is the mass of the planet?
(e) Draw a diagram of planet transit to explain the light curve (left panel).
(f) How long does the entire transit last (in hours)?
(g) How much distance does the planet travel during the transit?
(h) What is the radius of the planet?
(i) Compare this planet to Jupiter. Express its mass in Jupiter mass and radius in Jupiter radius.

Problem 2.

When the Sun was formed, it had an accretion disk. The accretion releases gravitational energy, which provides the heating of the accretion disk. The temperature in the accretion disk drops off as a function of radius r. Show that the temperature is proportional to $r^{-3/4}$.

Problem 3.

In this problem, you will compare the rotational angular momentum of the Sun to the orbital angular momenta of Jupiter and Saturn.

(a) Calculate the Sun's moment of inertia.
(b) Calculate the Sun's angular momentum.
(c) Calculate Jupiter's and Saturn's orbital angular momenta. Compare them to each other, and compare their sum to the Sun's rotational angular momentum.
(d) If the orbital angular momenta of Jupiter and Saturn are tied up in the Sun, what would be the rotational period of the Sun?
(e) What would be the equatorial velocity on the surface of the Sun?
(f) What is the escape velocity on the surface of the Sun? How does it compare to the equatorial velocity in (e)?

Problem 4.

Assuming that a spherical cloud experiences only the forces due to its self-gravity and its internal thermal pressure, what are the Jeans masses (in units of M_{sun})and Jeans lengths (in units of pc) of

(a) a 10 K H_2 molecular cloud with a density of 10^4 H_2-molecule cm^{-3} ?
(b) a 100 K HI atomic cloud with a density of 10 H-atom cm^{-3} ?
(c) a 10^8 K intergalactic medium with a density of 0.001 H-atom cm^{-3} ?
(d) Under which of the above conditions are stars formed?