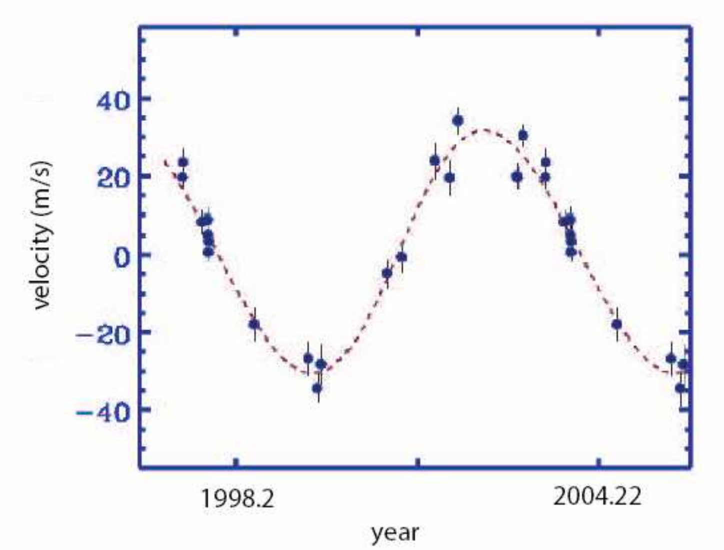
Astronomy 230 Fall 2006
Homework #4
Due in Class: Thursday, Sept. 28

The only homework assignment that requires some math, but on the plus side, it does not have to be typed.

Extrasolar Planets. We are in the midst of the pioneering days of discovering extrasolar planets. Consider a star of mass M_{star} with a planet of mass M_{planet} << M_{star}. Both the star and the planet orbit their common center of mass, and both have an orbital period P about the center of mass that is equal to the period P of the planet around the star. The planet is detected not by direct observation, but by the periodic change the "wobble" it causes in the star's velocity.

1. The figure below illustrates the Doppler velocity data from a nearby star. The wobble is caused by an extrasolar planet. Calculate the orbital period of the planet in years.



2. Kepler's Law is $P^2 = a^3$ where P is the period in years and a is the semi-major axis of the orbit in AU. Assume that Kepler's law is valid for this system (i.e. M ~ 1 $M_\odot$). Using this, calculate the distance that this planet orbits its star. Compare this result to Jupiter.

3. The velocity of the star along our line of sight (v) is the shown in the Doppler data in the figure. The peak, or maximum, velocity can be related to the planet-star mass ratio as

$$v_{peak} = \frac{M_{planet}}{M_{star}} \frac{2\pi a}{P}$$

   Estimate the peak line-of-sight velocity from the Figure, and assuming $M_{star} = 1\ M_\odot$, compute the mass of the planet in Jupiter masses. **Be very careful** of the units in this equation, i.e. the units for a/P must be the same as v_{peak}, and the masses must be in the same units.

4. Using the same formula, calculate the peak line-of-sight velocity for our Sun, using only the effect of Jupiter. Comment on this value compared to the star in the figure. Do you expect to see Jupiter–sized fluctuations?