Astro 205. Problem set 4. October 8 2003, due October 15, 2003

1. Consider a planet in a circular orbit around a star of mass 1 $M_\odot$ (2×10^{33} gm). Suppose we observe the system edge-on, and that the accuracy with which we measure the reflex velocity of the star is 3 meters/second, i.e. we cannot detect motions smaller than this. Assume that you can observe for arbitrarily long times so can measure long periods. If a planet of given mass is close to the star, the reflex velocity is larger. For planets further from the star, the reflex velocity is smaller, until for large distances it's too small to detect. If a planet has a small mass, it produces a smaller reflex velocity than does a high-mass planet. Thus for a planet of a particular mass, there's a range of distances from the star over which it can be detected. Draw a graph of planet mass (in Jupiter masses, 0.001 times that of the Sun) versus distance from the star (in A.U.) and shade in the region on this diagram in which you could detect a planet. You'll need a minimum radius too: use the solar radius, 7×10^{10} cm.

2. Suppose a planetary system has two planets of the same mass in circular orbits orbiting it in the same plane at the same distance, with the planets on opposite sides of the star (this configuration is a favorite of science fiction stories along the "shadow Earth" lines, in which the Earth has an unseen companion sharing our orbit). Would you be able to detect these planets by radial velocity wobble?