Problem Set #6

Due Friday, April 25 by 5pm to Dickinson 104

Unless otherwise indicated, all problems come from "The Cosmic Perspective," 8e

1. Problem 5.56 *Doppler Calculations*
2. Problem 13.51 *Identical Planets?*
3. Problem 13.52 *Finding Orbit Sizes*
4. (*Adapted from Problem 13.53 in your book)* It's possible to make a rough estimate of how often planetary systems form by making some basic assumptions. For example, if you assume that the stars we see have been born at random times over the last 10 billion years, then the rate of star formation is simply the number of stars we see divided by 10 billion years. The fraction of stars with extrasolar planets is at least 50%, so this factor can be multiplied in to find the approximate rate of formation of planetary systems.
    a. Using these assumptions, estimate how often (e.g. "once a month," "once a year", "once every hundred years", etc.) a planetary system forms in our galaxy (Our galaxy contains at least 100 billion stars).
    b. How often does a planetary system form somewhere in the *observable universe*, which contains at least 100 billion galaxies?
    c. Write a few sentences describing your reaction to your results. Do you think the calculations are realistic? Are the rates larger or smaller than you expected?
5. The Automated Planet Finder (APF) is a telescope that "enable[s] a Doppler precision of 1 m/s" and, therefore, can detect stellar velocities induced by planets of 1 m/s ("equivalent to human walking speed") or greater.
    a. How big a wavelength shift in green light can this instrument detect?
    b. Suppose you observe a Sun-like star with a planet in an Earth-like orbit. How massive does the planet have to be for it to be detected by the Automated Planet finder?
    c. What is the maximum orbital period and semi-major axis of an Earth-like planet around a Sun-like star that could be detected by the Automated Planet Finder?
6. The detection of extrasolar planets came much sooner than most astronomers expected. Was this a result of planets being different than expected or of technology improving faster? Explain.
7. Arguments that there are likely to be many instances of life ("as we know it") throughout the Universe tend to depend on the premise that there are lots of Earth-like planets in Earth-like orbits around Sun-like stars for such life to evolve on. To what extent are arguments of this kind strengthened or weakened by the discovery of Hot Jupiters?