

## Exoplanets Homework

due 12/1/14

Answer these questions on your own paper and attach to this sheet.

1. What are the relative strengths and limitations of the Doppler and transit techniques of detecting extrasolar planets? What kinds of planets are easiest to detect with each method? Are there certain planets that each method cannot detect, even if the planets are very large? Explain. What advantages are gained if a planet can be detected by both methods?
2. The planet TrES-1, orbiting a distant star, has been detected by both the transit and Doppler techniques, so we can calculate its density and get an idea of what kind of planet it is.
  - a. Calculate the radius of the transiting planet. The planetary transit blocks 2% of the star's light. The star TrES-1 has a radius of about 85% of our Sun's radius. (*Hint:* Look at Mathematical Insight 13.3 in your book.)
  - b. The mass of the planet is approximately 0.75 times the mass of Jupiter (which is  $1.9 \times 10^{27}$  kg). Calculate the average density of the planet. Compare this to the average densities of Saturn and Earth. Is the planet terrestrial or jovian in nature? (*Hint:* To find the volume of the planet, assume it is spherical and use  $V = 4/3\pi r^3$ . Be careful with unit conversions.)
3. The star 51 Pegasi has about the same mass and brightness as our Sun. A planet discovered orbiting it has an orbital period of 4.23 days. The mass of the planet is estimated to be 0.6 times the mass of Jupiter.
  - a. Use Kepler's 3rd Law to find the planet's average distance (semimajor axis) from the star. (*Hint:* Because the mass of 51 Pegasi is about the same as the mass of our Sun, you can use Kepler's 3rd Law in its original form,  $P^2 = a^3$ , provided you first convert the period to years.)
  - b. Suppose the planet reflects 15% of the incoming sunlight. Calculate its "no greenhouse" average temperature. How does it compare to that of the Earth? (*Hint:* Look at Mathematical Insight 10.1 in your book.)
  - c. Repeat part b, but assume that the planet is covered in bright clouds that reflect 80% of the incoming sunlight.
  - d. Based upon what you know about this planet, do you think it is likely to harbour life?