Exoplanet Names: ____________________

Scale Models of Extrasolar Systems Lab

November 9, 2018

Below you will find tables of information about 4 real (exo)solar systems, and you must make scale models of planet size and separation for each one, much like the "pocket solar system" scale model that we did in class at the start of unit 2. The simplest version of these scale models would simply be drawn on paper, where you would decide a scale (for example 1cm=1AU or 1cm =1 earth radius) that utilizes the space on the paper wisely. Your scale should be the same for all 4 systems wherever possible, but in some cases one system may be extreme enough that you wish to modify the scale. If you would like to be more creative with your models than simply drawing them on paper, you are welcome to (and will likely be rewarded with some extra credit!). In any case, you need to SPECIFY YOUR SCALE on your models and show your work for all calculations.

System 1: Our Solar System

Planet	Semimajor Axis (AU)	Planet Radius (Earth Radii)
Mercury	0.4	0.39
Venus	0.7	0.95
Earth	1	1
Mars	1.5	0.53
Jupiter	5.2	11.2
Saturn	9.5	9.5
Uranus	19.2	4.0
Neptune	30.1	3.9

System 2: Trappist-1

Planet	Semimajor Axis (AU)	Planet Radius (Earth Radii)
b	0.011	1.09
c	0.015	1.06
d	0.021	0.77
e	0.028	0.92
f	0.037	1.05
g	0.045	1.13
h	0.060	0.72

System 3: Upsilon Andromedae

The radii of the planets in this system are unknown, so you'll have to leave them out of Model 1. The masses are provided instead in the table below, and will be useful in answering question 2d.

Planet	Semimajor Axis (AU)	*Mass (Jupiter Masses)*
b	0.06	*0.62*
c	0.83	*13.98*
d	2.53	*10.25*
e	5.25	*0.96*

System 4: HR 8799

Planet	Semimajor Axis (AU)	Planet Radius (Earth Radii)
e	14	12.3
d	24	14.6
c	38	13.4
b	68	unknown

1. Make scale models of the four systems.

(a) First, make a scale model that shows the ***sizes*** of the planets in all 4 systems relative to one another (you may space them out however you please – the point is to show the difference in sizes between them regardless of where they "live" around their star)

(b) Make a second scale model showing the ***distances*** between the planets in the 4 systems relative to our own solar system (this time ignoring planet size and focusing on distance).

Tips/further instructions

- In model 1, the planets should be circles (or spheres), but note that you are given the **radius** in the table and will need to turn that into a properly sized circle given your scale.
- You may wish to "embed" your planets inside one another for model A (draw one circle inside another) in order to utilize the space on your paper wisely. Make sure to label each circle with the name of the planet and/or use different colors for each.
- Each solar system should be on its own separate line in Model B, but you should stack or line up the different systems on the same sheet of paper so that they're easily comparable. For example, you might wish to place the star on one (same) edge of the page for each system and space them out vertically. Make sure to

label each scaled solar system with its name and the names of each planet (For 2-4 it's ok to just label them b, c, d etc.).

2. After you have completed the scale models, answer the following question ***for each system*** in 2-3 sentences each:
    i. Discuss, using quantitative specifics/ratios from the tables above, how the planets in this system are different from those in our own solar system.
    ii. Do you think that these planets may be able to harbor life? Why or why not?
3. The Trappist-1 system was discovered with the transit method and the Upsilon Andromeda system was discovered with the radial velocity method. Given what you learned in class this week and in your prelab about the transit and radial velocity methods, explain how the properties of each system are consistent with the detection method (Hint: think about what kinds of objects each method is best at detecting. In other words, what are the observational biases?)
4. The HR8799 system was discovered with a method that we haven't talked about yet called direct imaging. What does it's vastly different nature relative to the other two extrasolar systems tell you about the biases of direct imaging as a detection method.