Lab 7 Finding Planets in the Habitable Zone

Goals

1) Become familiar with the Transit Method of planet detection. This is the method used by the Kepler mission which has found the majority of all known exoplanets.

2) Determine the size of the habitable zone around each of the four stars with data given below

3) Use Newton's version of Kepler's 3rd Law and observations of the orbital period of the planets to determine the size of the planets orbit, then determine which planets are in the habitable zone around their star.

Part 1: Go over the handout given in class

Part 2: The size of the habitable zone in our solar system ranges from 0.84AU to 1.7AU. We can determine the habitable zone around stars with a different luminosity than the sun by using the following equations.

$$D_{in} = 0.84\text{AU}\sqrt{\frac{L}{L_{sun}}} \qquad D_{out} = 1.7\text{AU}\sqrt{\frac{L}{L_{sun}}}$$

Star Name	Mass [M_{sun}]	Luminosity [L_{sun}]	Habitable Zone D_{in}	D_{out}
Kepler 69	0.81	0.8	0.6162	1.2470
Kepler 62	0.69	0.21	0.8727	1.7662
Kepler 186	0.54	0.06	1.0000	2.0238
TRAPPIST-1	0.08	0.00053	0.2335	0.4726

Part 3: Newton's version of Kepler's Laws : $M_{total} P^2 = A^3$

Solving this equation for orbital size results with $A = \sqrt[3]{MP^2}$ which can be used since the orbital period of the planet is directly observed, and the stellar type of the star gives an estimate of its mass. Use the data in the table below to determine which planets are in the habitable zone around their star, and put a checkmark next to each of those planets.

Planet	Orbital Period [yr]	A [AU]	
Kepler 69b	0.0375	<u>0.1044</u>	
69c	0.663	**<u>0.7088</u>**	*
Kepler 62d	0.0515	**<u>0.1223</u>**	*
62f	0.7315	<u>0.7174</u>	
Kepler 186b	0.0107	<u>0.0395</u>	
186f	0.356	<u>0.4090</u>	
TRAPPIST-1c	0.00657	<u>0.0151</u>	
1f	0.0252	<u>0.0370</u>	

Lab Report: Include a brief introduction describing the idea of the Habitable zone and what you will do to determine if a planet is in it. Show your results for the size of the Habitable zone around each star, the size of each planet's orbit, and a list of which planets are in the habitable zone.

The habitable zone is the orbital area around a given star in which a given planet is likely to support life and also contain water (as water is key in supporting all life), when given sufficient atmospheric pressure. This zone should neither be too hot nor too cold as it should be suitable for water to occur on the surface.

In determining whether a planet is in the habitable zone, one must first find out the total radiation emmited by the star, for example stars more massive than the sun are definitely hotter and emit a lot of radiation hence the habitable zones are further outwards, when compared to planets with stars smaller than the sun. Stars smaller than the sun have less radiation.
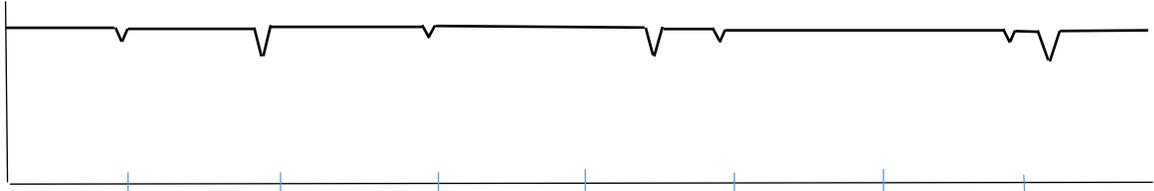
Brightness measurements of 4 Sun-like stars are shown below. Each mark on the horizontal axis corresponds to 6 months of observation. Note: the size of transits are greatly exaggerated so you can see them easily on the figures.
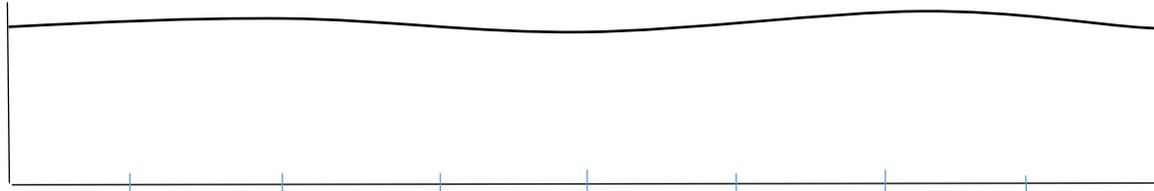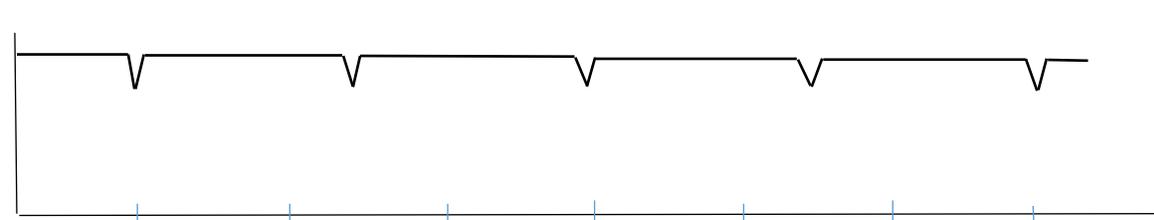
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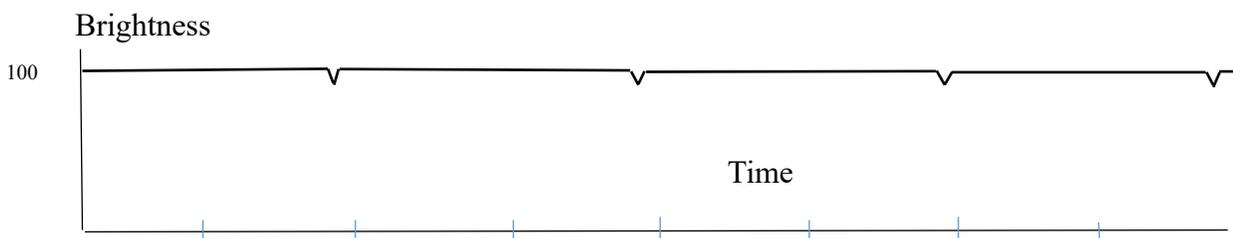
B

C

D

1 Which stars indicate an orbiting planet?

  A B C D

2 Which star has more than one planet?

  B

3 Rank the planets from shortest to longest orbital period.

   Shortest orbit   Longest orbit

                                    D   A   B   C

4 TRUE or FALSE
 In the multiple planet system, the larger planet orbits farther from the star than the smaller planet.

  FALSE