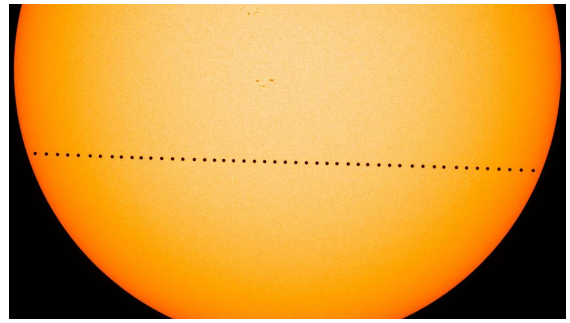
Saturday Morning Astrophysics at Purdue

Instructor notes

Discovering Exoplanets with Transit Photometry



Learning Goals

- Students can explain how a star's light curve may provide evidence of an exoplanet
- Students can describe the conditions under which transit photometry is useful
- Students can interpret photometry data to predict properties of planets and their orbits
- Students can explain useful terminology; exoplanet, transit, flux, orbital period.

Identifying the Arduinos

When students activate Phyphox to collect data, they will need to be able to identify the Arduino they are provided. In uploading the program code to the Arduinos, each one is given a unique identifier. In our case, we chose to name the Arduinos in relating to known exoplanets; Kepler, Gliese, Osiris, Cancrie, Trappist and Pegasi. Within a set of sensors, students will find Arduino names, for example, K-1, G-1, C-5, T-6, etc.

Assumptions and Approximations

- Assuming negligible background light pollution to the sensor (may be accounted for)
- Model is not to scale
- No limb darkening (stars appear darker toward the edges)
- Spherical bulb
- Constant orbital speed and orbital distance
- Planet crosses the equatorial diameter of the bulb (impact parameter = 0)

Simultaneous Data Collection and Physical Position

An aide to helping understand the correlation to the modeling of the data (plotted graph) to the physical positions of the star and planet can be shown in real time by recording the positions of the bodies with the Phyphox display simultaneously in view.

Accounting for Background

If you are doing this experiment in an environment with a lot of ambient light (i.e. light pollution), you may want to measure the background and subtract it out from your data. In most cases the background will be insignificantly small, but you may also want to take a reading just for students to see how small it actually is.

Accounting for Background (continued)

To measure the background:

1. Turn off the lightbulb
2. Make sure your Arduino is in the same position as for the transit measurement
3. Record data until the measured flux is relatively stable
4. If your background is large enough (or you want to practice removing it) export this data to Excel
5. Plot the flux vs. time in Excel and identify a region that is approximately constant
6. Find the average flux for this region
7. Subtract this value from every data point in your transit data

Additional Resources and References

- Tutorial for understanding and interpreting transit photometry: https://avanderburg.github.io/tutorial/tutorial.html
- How to Detect Exoplanets; https://bit.ly/3NbhiJc
- Cool animations of various exoplanet detection methods: https://exoplanets.nasa.gov/alien-worlds/ways-to-find-a-planet/
- Lots of cool info: https://exoplanets.nasa.gov/
- Check out our other lesson, the ***Searching for Exoplanets*** interactive model, https://bit.ly/SMAPExoplanetsLessons; and accompanying YouTube Zoom video, https://bit.ly/Exoplanets2023