PocketLab Voyager: How to Discover an Exoplanet by Richard Born, Associate Professor Emeritus, Northern Illinois University

Over the past twenty years, scientists have discovered hundreds of what are known as *exoplanets*—planets that orbit stars outside of our own solar system.   Different groups of scientists worldwide have used a variety of methods to detect these planets. In this lesson we will investigate a method that has been quite fruitful in finding exoplanets as a result of the *Kepler* Mission, launched by NASA in 2009. Another similar mission is *CoRoT*, led by the French Space Agency. These missions identify exoplanets by a method called *transit*, in which the brightness of a star decreases when a planet passes directly between the star and the observer. In this lesson, students will use PocketLab Voyager to simulate the discovery of an exoplanet using the transit method. They also learn how to compute the orbital period of the exoplanet.

Figure 1(a) shows the setup for our experiment. A light bulb is suspended over the center of a record player turntable. This light represents the star being observed from Earth. A small opaque sphere, the green object, is mounted to the turntable so that it will go around the light bulb while the turntable rotates. This sphere represents the exoplanet. An iPhone with the PocketLab Voyager taped to its back (see Figure 1(b)) has its light sensor directly facing the light bulb and is mounted to a tripod for stability. The Voyager represents a viewer on planet Earth who is looking out in the nighttime sky.

Figure 1(a)

Figure 1(b)

The data rate is set to 20 points per second. The light bulb is turned on, the turntable is started, and then the PocketLab app is used to record a movie of several revolutions of the exoplanet around its star. The csv file created by the PocketLab app is opened in Excel, and the graph of Figure 2 is constructed. Every time that the exoplanet passes between its star and Voyager, there is a clearly visible dip in the light intensity. (Note that the light intensity in Lux is actually about 50 times higher than shown in the graph, as the data was collected with an earlier version of the PocketLab app for which calibration had not yet been established.) The orbital period is found to be about 1.66 seconds. (This corresponds to 36 rpm, which is close to the value of 33 rpm that for which the turntable was set.)
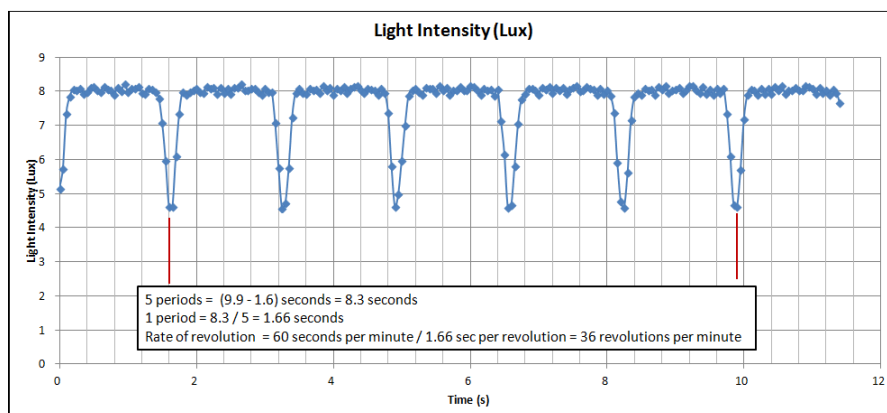

Figure 2