Determining the "Light-curves" and Periods of Variable Stars

The apparent brightness of some stars has been observed to change with time. And of these "variable stars", some go from dim to bright to dim… in a very regular or "periodic", way. These projects explore the periodic variable stars.

1. Plot the apparent brightness against time (known as a light-curve) for Delta (δ) Cephei. The constellation Cepheus is in the Northern sky, and in the Fall is above Polaris. Use a star chart or planetarium program to identify δ-Cep. Estimate apparent brightness by comparing the appearance of δ-Cep with that of nearby stars whose brightness (magnitude) is known (see charts - you will find that Zeta (ζ)- and Epsilon (ε)-Cephi make excellent comparison stars). The brightness of δ-Cep varies between magnitudes 3.5 to 4.4. You will need to observe the variable on every good night for several weeks to establish a good light-curve. From your light curve, estimate the "period" of this star's brightness oscillation. Delta-Cephei is the prototype for a large group of stars now known as "Cepheid variables". Your research should include determining the common properties of this group, and why they exhibit this interesting periodic behavior. How has this group of stars been instrumental in helping astronomers "measure the Universe"?

2. Another group of variable stars are the "eclipsing binary" stars. Most of the stars in the Universe are found to be in multiple-star systems, two or more stars revolving around one another. In a few cases, the orbital plane of a pair will be aligned with the line of sight to Earth, and we observe one star passing in front of ("transiting") the other star. If they are of different brightness, we will observe a dip in brightness when this eclipse of one star by the other happens. Of course, the duration of the dip is small compared to the orbital period of the stars. So the signature light-curve for eclipsing binary variables is very different from that of Cepheid variables.

Plot the light curve for an eclipsing binary star. One of the most famous is Algol, in the constellation Perseus, visible in Fall and Winter. Algol, also labeled Beta (β) Persei, goes from magnitude 2.1 to 3.4 during the eclipse lasting about 10 hours. You can find the mid-eclipse time of the "minima of Algol" at the Sky & Telescope web site, www.skyandtelescope.com, and going to Sights, Variable Stars. The minimum brightness is during the center 2 hours of the eclipse, so to get a good light curve you will need to take frequent measurements during the eclipse, again using nearby comparison stars of known brightness. Take data every night for a week or 10 days, so that you can estimate the orbital period of the binary pair.

Another eclipsing binary variable is Beta (β) Lyra, high overhead on Fall evenings. Its light curve is very different from Algol's as it changes in brightness about 1 magnitude (3.3 → 4.4) over a longer period. Using Gamma (γ)- and δ-Lyra as comparison stars, plot the light curve of β-Lyra for two to four weeks and determine the orbital period of the two stars.