AS202 Observing Project: Neptune’s Moon

Overview
Neptune was discovered in 1846 by Johann Galle but it was predicted earlier by Alexis Bouvard due to its gravitational effect on Uranus. Neptune is the furthest planet from the Sun, with an average distance of 30 AU (4.538 billion km) and is not visible to the unaided eye. The largest of Neptune’s moons, Triton was discovered shortly after the planet’s discovery by an English astronomer William Lassell. In this lab we will take observations of this system to estimate the mass of Neptune from the orbit of Triton. During this lab Neptune will be in the east with a magnitude of around 7.66.

Observation Goals
You will use pixel coordinates recorded during the lab using the 14” reflector and its associated equipment to take a series of CCD images of Neptune and the moon Triton. The moon may not always be visible due to the position with respect to Neptune and the Earth.

A series of images will be taken over ~35 days. Using the platescale of the CCD setup and the small angle formula (see lunar topography project) you can convert the distances from pixels into kilometers. Then, by plotting the physical distance of Triton from Neptune as a function of time you will be able to deduce both the period and radius of the moon’s orbit.

Then using Newton’s laws of gravity and motion you can use the orbital periods and radii to estimate the mass of Neptune. As a quick reminder, Newton’s version of Kepler’s Third law is:

\[ P^2 = \frac{4\pi^2}{G(M_1 + M_2)}a^3. \]

A quick and easy way to find the mass of Neptune would be to plot \( P^2 \) vs \( a^3 \) and determining the slope of the line. Feel free to use Excel to help you with your calculations.

Report
Your report should include an introduction explaining the objective of the lab, any equations used in your calculations, the concepts studied by the lab, and why they are important. You should also attach your tables from the spreadsheet, the IDL produced plots, and the plot of the linear fit to \( a^3 \) vs \( P^2 \). Be sure to report your calculated mass of Neptune and the associated percent error. Finally, comment on a few possible sources of error.