Determination of Asteroid Rotational Period Via Lightcurve Analysis

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Abstract

In observational astronomy, there is a variety of data that needs to be collected on celestial objects. For minor planets, or asteroids, one such parameter is how fast the object is rotating. To collect rotational data, the light reflected from the minor planet is used as a proxy for the planet's period in a process called lightcurve analysis. This method uses sinusoidal patterns in the light reflected from a minor planet as an indicator for how often an asteroid completes a full rotation. In our research, we are outfitting West Point's observatory to take such measurements. Then, we will conduct lightcurve analysis on a minor planet with a known period to confirm our method is accurate.

Background: *Lightcurve Analysis*

Generally, the composition of minor planets are non-homogenous, comprising of many different materials. The variation in material causes different magnitudes of light to be reflected to Earth as the asteroid rotates. If the magnitude of light is plotted over time, a roughly sinusoidal pattern will emerge. This pattern can be used as a proxy for the rotational period of the asteroid.

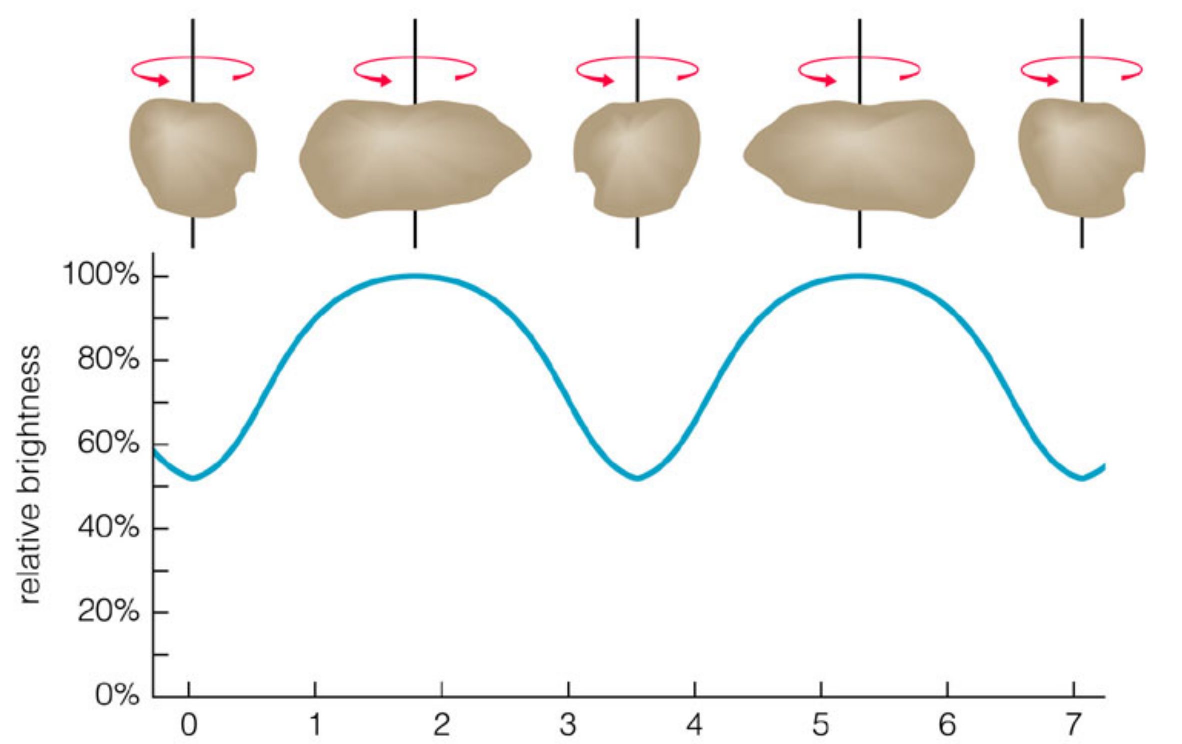

Figure 1. The relation between an asteroid's rotational period and its relative brightness

$$Phase = t \% T$$

t = time elapsed since first measurement

T = rotational period

Equation 1. The relation between phase and rotational period.

Background: *Lightcurve Analysis*

Major limitations to lightcurve analysis include the high light pollution and inclement weather in the Hudson Valley area, the potential for a sinusoidal pattern to occur for a half period due to the asteroid having similar composition on both sides, and experimental difficulties such as tracking the minor planet or having a long enough exposure to detect it.

Equipment

Figure 2. LX200 ASF

Figure 3. SBIG STX-16803

This project uses a 16-inch, f/10 Telescope, with a 16-million-pixel CCD for imaging. Additionally, an external Gemini Focuser was used to make fine adjustments to the resolution of the picture. TheSkyX and MaximDL software were used to both track minor planets and process images.

Methods

For our research, we will first verify that we can find an accurate period on a minor planet with a known rotation, then use our method on a minor planet with an unknown period and publish our findings. To find the rotational period, we will first identify an asteroid, preferably one with a luminous magnitude of less than 15 and relatively short period. We will then verify its position in the sky using background object such as stars. Once its position has been verified, we will take images that are exposed around 3-4 minutes to ensure the asteroid is detected. We will repeat this process once every 10 minutes for the duration of the asteroids period and then plot the asteroid's luminous magnitude vs time and then identify any patterns that emerge.

Progress

We have identified two asteroid for our research, 2822 Sacagawea and 1489 Dodonson, both of which have known rotational periods. Dodonson is the preferred candidate of observation due to its low luminous magnitude of 12.1 and low known period of 4.5 hours.

Unfortunately, We have not proceeded far enough into our research to collect data on our own. Currently, we have set up our observatory and telescope rig to take pictures; however, we have identified an issue with the telescope mount's calibration. The telescope does not track the asteroid perfectly, causing streaks in our imaging during long exposed shots. We are taking action to mitigate the telescope's tracking by recalibrating its sidereal rate, and troubleshooting it tracking rate manually.

Once we have completed calibration, we will be ready for data collection. Our plan is to start with the more luminous asteroid, Dodonson, to confirm our methods. Further anticipated problems are decreasing noise from surroundings, such as ambient movement from observatory, and ambient light from observatory and West Point.

Imaging

Figure 4. Image of 1489

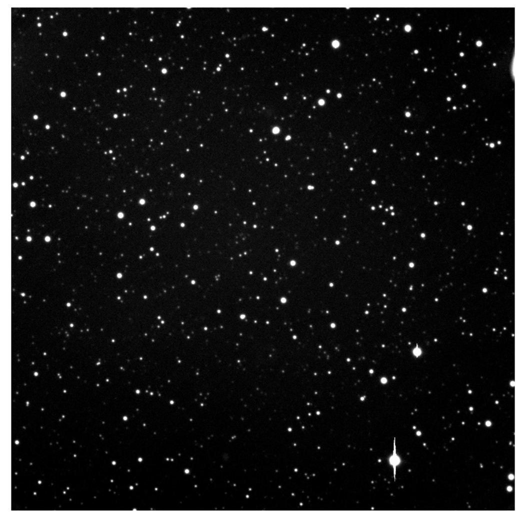

Figure 5. Image of 2822

Imaging

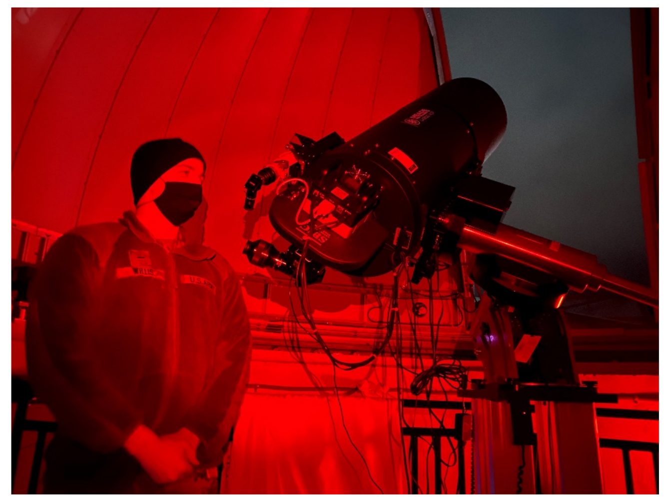

Figure 6. Telescope with supporting equipment attatched

Conclusion

While the observatory rig still needs to be calibrated to match the movement of our two candidate minor planets, we are close to collecting data. Once we have samples of the asteroid's luminous magnitude, we can determine its lightcurve and rotational period.

Our research develops West Point's astronomical capabilities by tuning the observatory to accurately track and image objects. After our research is complete, we can develop new research plans on other objects such as pulsars or deep space objects.

Acknowledgments

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