A Comparison of Photometry Methods Using Data from Asteroids 343 Ostara and 807 Ceraskia

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Abstract

Asteroids spin on their axis and this spinning changes the amount of light seen at Earth. In order to study this change in light, photometry of multiple images of the asteroid is used. Along with these images, special images are needed to get rid of thermal noise and account for differing pixel sensitivity. The corrected images are then used to create a lightcurve. Two of these methods, differential and absolute photometry, will be discussed using data from 807 Ceraskia and 343 Ostara.

Asteroids

Asteroids are rocky remnants from the formation of the planets that range in size from 10 meters to 1000 kilometers. Some other names for asteroids are minor planets, planetoids, and small solar system bodies. There are at least 90,000 known asteroids with a majority in the Asteroid Belt between Mars and Jupiter. Studying these celestial bodies may help us better understand the beginning of the Solar System and its dynamics.

343 Ostara in aperture at beginning of the night taken in R filter

What is a Lightcurve?

- A graph of light intensity of a celestial object over time
- Can be used to find period of rotation and spin

Data Acquisition

- Used 24-inch telescope at Hobbs Observatory located in Beaver Creek Reserve in Fall Creek, Wisconsin
- Took darks, flats, biases, filtered images using a CCD camera
- Used visible (green), R (red), CLR (clear) filters

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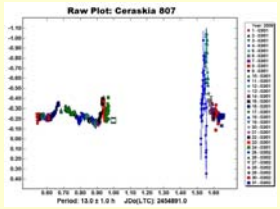
Image Calibration and Setup

- Darks are images taken with the shutter closed at the same temperature as the images to eliminate thermal noise.
- Biases are zero exposure time exposures and are used to get rid of instantaneous noise due to the camera's shutter. These can scale darks to same exposure time as filtered images if need be.
- Flats are images of evenly distributed light and are used to determine pixel sensitivity.

Making a Lightcurve

- Find target asteroid and choose comparison stars and put apertures on them
- Iterate data of comparison stars, asteroid, and standard field stars to find coefficients of an equation converting instrumental magnitude to standard magnitude

Lightcurve of 807 Ceraskia data including both nights not having been corrected for air mass differences



Difference Between Differential and Absolute Photometry

Differential Photometry

- Pros
  - No filters needed
  - Can observe asteroids that have a large magnitude (low brightness)
- Cons
  - Only apparent brightness is measured
  - Cannot be put on standard magnitude scale

Absolute Photometry

- Pros
  - Can be put on standard magnitude scale
  - Apparent magnitude and difference in color measured
- Cons
  - Filters used
  - Asteroids must be fairly low on magnitude scale (high brightness)

Results

Differential Photometry

- CLR filter caused interference
- Unable to establish a baseline for asteroid magnitude variation due to field rotation and therefore couldn't see a visible trend in data

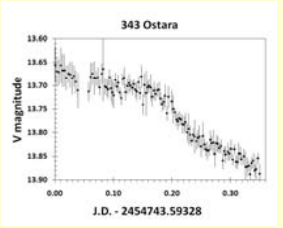
Absolute Photometry

- Able to create a baseline for asteroid magnitude variation using data about comparison stars even with field rotation
- Data able to be used by others

343 Ostara

- Able to obtain lightcurve in R and V filters
- Relatively small error bars

343 Ostara in aperture at end of the night taken in visible fliter



Lightcurve of 343 Ostara in visible filter with error bars

807 Ceraskia

- Period trend inconclusive
- Unable to see a distinct pattern due to not having baseline magnitude

807 Ceraskia in aperture towards end of second night in CLR filter. Background streaking is interference that we were unable to remove.

Lightcurve of 807Ceraskia without error bars

Even though one is able to study dimmer asteroids using differential photometry, absolute photometry is a better method because the data can be easily be analyzed in small pieces. In addition, the data obtained through absolute photometry is a lightcurve on the standard scale which is more informative than differential photometry. This allows others to easily incorporate our lightcurve data with their own and derive other rotational properties of the asteroid.