

COLLABORATIVE LIGHTCURVE PHOTOMETRY OF ONE MARS-CROSSING AND TWO MAIN BELT ASTEROIDS

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Overcoming the 24 hour commensurability of the Earth's rotation for mid-latitude observatories requires multiple sites widely separated in longitude. In addition, collaboration is useful in general due to differences in weather patterns and observing opportunities, as well as for relatively long-period asteroids. We report an ongoing collaborative lightcurve investigation between Thornton Observatory in the United States and Flarestar Observatory in Malta (separated in longitude by 119 degrees). Asteroid (713) Luscinia was determined to have a period of 9.703 ± 0.006 hours and an amplitude of $0.54 \text{ mag} \pm 0.05$ magnitude. Mars-crossing asteroid 2000 OL was found to have a period of $3.136 \text{ hours} \pm 0.003 \text{ hours}$, with an amplitude of $0.30 \text{ magnitude} \pm 0.04 \text{ magnitude}$. Asteroid (535) Montague was found to have a period of $10.28 \text{ hours} \pm 0.01 \text{ hours}$, with an amplitude of $0.24 \text{ magnitude} \pm 0.03 \text{ magnitude}$.

Equipment and Procedures

Thornton Observatory is located in Thornton, Colorado, at an elevation of 5530'. Since 1997, the observatory, operating as Minor Planet Center observatory code 713, has been performing asteroid astrometry and photometry.

Flarestar Observatory is located in San Gwann, Malta at an altitude of 300 feet. In 1999, Flarestar started operation as Minor Planet Center observatory code 171 and has been performing asteroid astrometry and photometry. Details of both observatories equipment may be found in Koff and Brincat (2000).

Targets were selected based on their magnitude and position in the sky, to maximize the length of time they would be observable, particularly under the restricted sky visibility of Thornton Observatory. Targets were selected for which no lightcurve data had been previously reported, or for which only uncertain data was available (Harris, 1997). The images were obtained in unfiltered light, with the exception of one night's observations from Thornton of 713 Luscinia using an R filter. Differential photometry was performed using the program "Canopus" by Brian Warner, which uses aperture photometry. Magnitudes were calculated using reference stars from the LONEOS catalog. The same reference stars were used by each observatory, but comparison stars differed from night-to-night due to movement of the asteroid. Lightcurves were prepared using "Canopus", based on the method developed by Dr. Alan Harris (Harris et al, 1989). This program allows compensation for night-to-night comparison

star variation by manually shifting individual night's magnitude scales to obtain a best fit. Such adjustment is especially necessary when combining data from two observatories using cameras with different spectral sensitivities.

Observations and Results

713 Luscinia

Luscinia, a main-belt asteroid, was observed initially by Thornton Observatory on June 21, 2000. Observations from Thornton were made on 4 nights during the period from June 21, 2000 to July 1, 2000. Exposure times at Thornton for these investigations were four minutes each. Images were taken at 10-minute intervals. Dark frames and flat fields were used to calibrate each image. At Flarestar, observations were made on two nights, on June 21-22, 2000 and June 27-28, 2000. Exposure times were 90 seconds each at an average interval of six minutes. Images were calibrated with dark frames and flat field frames. Observations made at Thornton on June 22 were made using an R filter. The individual lightcurve sessions for 713 were shifted in magnitude scale to align with the data taken with the R filter. The magnitude calibration for the R filter observations were derived by comparison with stars from the LONEOS reference catalog, which lists stars with magnitude accuracies within 0.05 magnitude (Skiff 2000). A total of 140 images were made, of which 101 were used in the solution.

Figure 1 shows the resulting lightcurve. The zero point of the curve is J.D. 2451716.6687. The period was determined to be $9.703 \text{ hours} \pm 0.006 \text{ hours}$, with an amplitude of 0.54 ± 0.05 . The mean measured magnitude was 13.45 R.

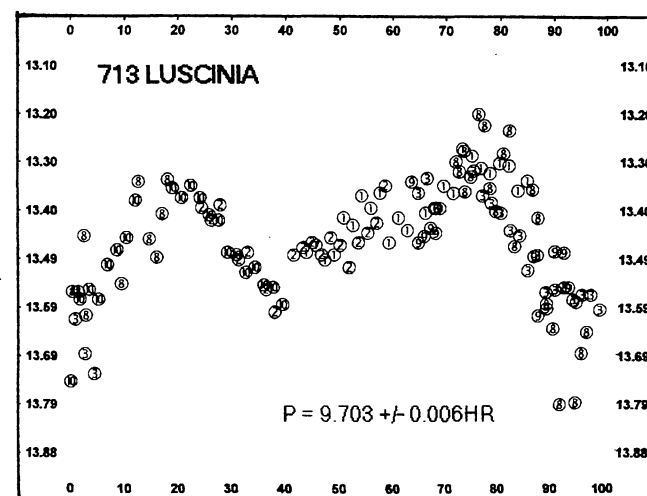


Figure 1. Lightcurve of 713 Luscinia, based on a period of 9.703 hours $\pm$ 0.006 hours. Ordinate is R magnitude. Curves 8 (6/21/2000) and 9 (6/27/2000) are Flarestar observations. Curves 10 (6/21/2000), 1 (6/22/2000), 2 (6/30/2000) and 3 (7/1/2000) are Thornton observations.

2000 OL

Mars-Crossing asteroid 2000 OL (perihelion distance = 1.34 AU) was observed initially by Thornton Observatory on July 27, 2000. At the time, the newly-discovered object was on the NEO Confirmation Page of the Minor Planet Center, and was designated as G70139. At the conclusion of the astrometric session, observations were extended to attempt to detect

magnitude variation. The observations did indeed show a variation. Dr. Petr Pravec of Ondrejov Observatory was notified of this fact, as part of his program involves lightcurves of near-earth objects. Dr. Pravec encouraged Thornton Observatory to attempt to obtain a lightcurve of this object. Flarestar Observatory was invited to participate in further observations. Subsequently, 2000 OL was found to be a Mars-crosser but not an NEO.

Observations from Thornton were made on four nights during the period from July 27, 2000 to August 7, 2000. Exposure times at Thornton for this investigation were two minutes each. Images were taken at five-minute intervals. Dark frames and flat fields were used to calibrate each image. At Flarestar, observations were made on one night, July 31, 2000. Exposure times were 90 seconds each at an average interval of ten minutes. Images were calibrated with dark frames and flat field frames. A total of 169 images were taken, of which 160 were usable.

Figure 2 shows the resulting lightcurve. The zero point of the curve is J.D. 2451752.8180. The period was determined to be 3.136 ± 0.003 hours, with an amplitude of 0.30 ± 0.04 . The mean measured magnitude was 12.75, and is to be considered an instrumental magnitude.

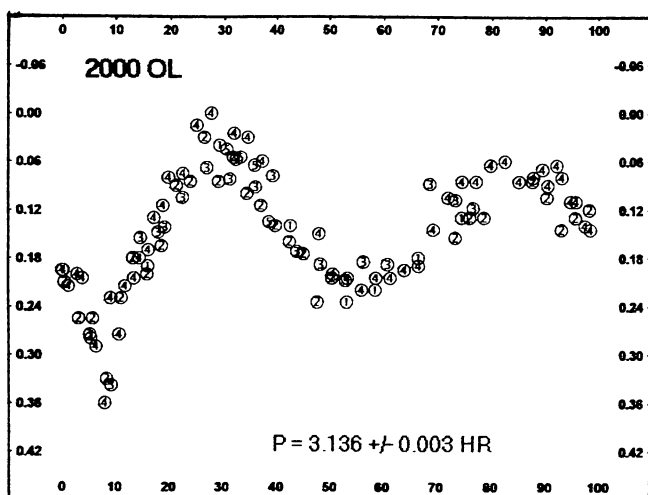


Figure 2. Lightcurve of 2000 OL, based on a period of 3.136 ± 0.003 hours. Ordinate is relative magnitude. Curves 1 (7/27/2000), 2 (7/28/2000) and 4 (7/31/2000) and 5 (7/31/2000) are Thornton observations. Curve 3 (7/31/2000) is Flarestar observations.

535 Montague

Montague is a main-belt asteroid. This object, for which no previous lightcurve data were available, was observed initially by Flarestar Observatory on September 17, 2000. Observations from Flarestar were made on 2 nights, September 17 and September 23, 2000. Exposure times were 90 seconds. Images were taken at an average interval of 6.5 minutes. Dark frames and flat fields were used to calibrate each image. At Thornton, observations were made on five nights during the interval from September 21 to September 27, 2000. Exposure times were 120 seconds each at an average interval of four minutes. Images were calibrated with dark frames and flat field frames. A total of 362 images were made, of which 347 were used in the solution.

Figure 3 shows the resulting lightcurve. The zero point of the curve is J.D. 2451805.4093. The period was determined to be

10.28 ± 0.01 hours, with an amplitude of 0.24 ± 0.03 . The mean measured magnitude was 13.1, and is an instrumental magnitude.

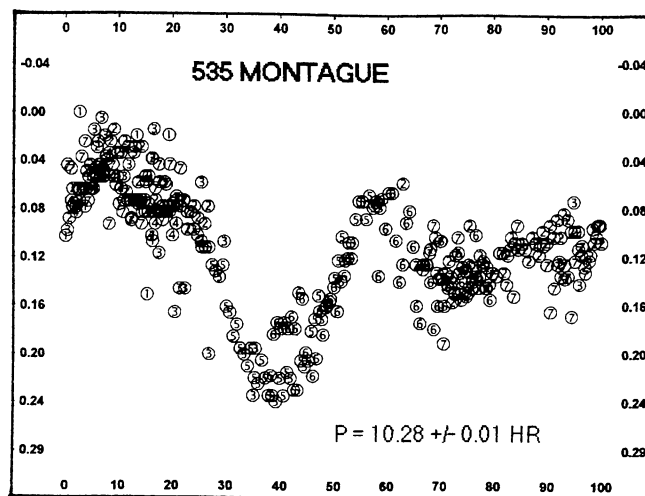


Figure 3. Lightcurve of 535 Montague, based on a period of 10.28 ± 0.01 hours. Ordinate is relative magnitude. Curves 1 (9/17/2000) and 3 (9/23/2000) are Flarestar observations. Curves 2 (9/21/2000), 4 (9/25/2000), 5 (9/25/2000), 6 (9/26/2000) and 7 (9/27/2000) are Thornton observations.

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