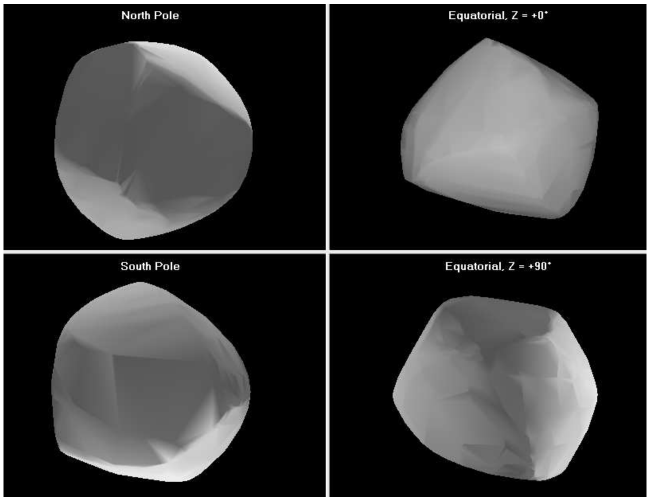


Figure 19. The shape model for 185 Eunike (λ = 136°, β = 4°).

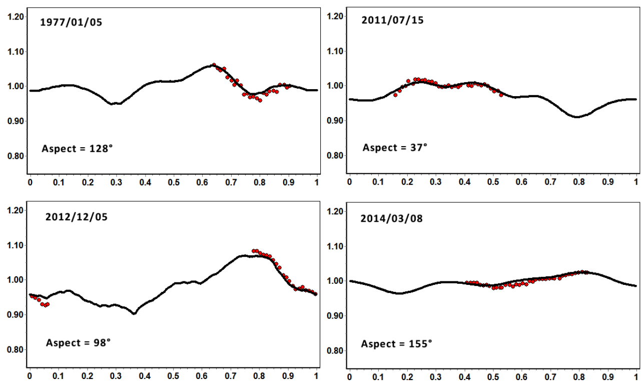


Figure 20. Comparison of model lightcurve (black line) versus a sample of four observed lightcurves (red points).

ROTATION PERIOD DETERMINATIONS FOR 24 THEMIS, 65 CYBELE, 108 HECUBA, 530 TURANDOT, AND 749 MALZOVIA

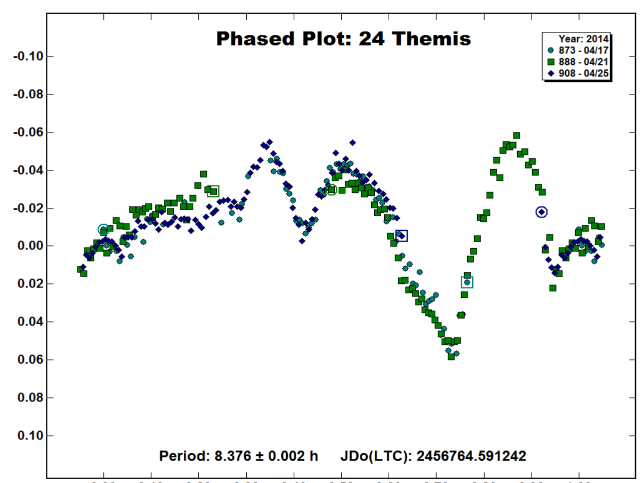
Frederick Pilcher
4438 Organ Mesa Loop
Las Cruces, New Mexico 88011 USA
fpilcher35@gmail.com

(Received: 7 July)

CCD photometric observations were made of five main-belt asteroids: 24 Themis, 65 Cybele, 108 Hecuba, 530 Turnadot, and 749 Malzovia. These were used to determine the synodic rotation period of the asteroids and their lightcurve amplitudes. In the cases of 108 Hecuba and 530 Turnadot, the results were able to exclude some periods previously reported by other authors.

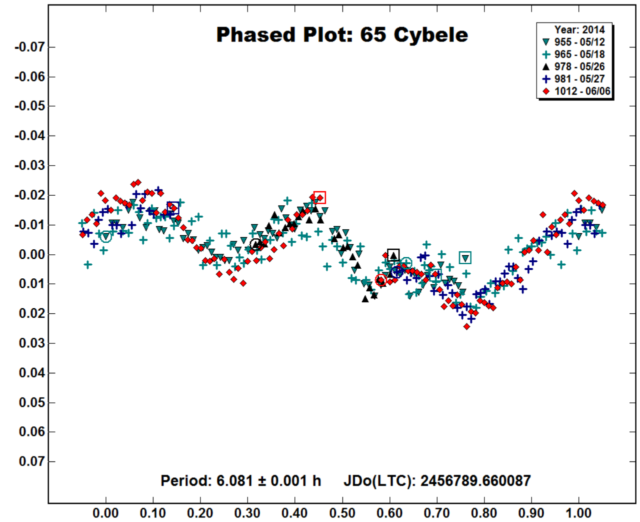
Reported here are CCD photometric observations of five main-belt asteroids that were made at the Organ Mesa Observatory with a 0.35-m Meade LX200 GPS Schmidt-Cassegrain (SCT) and SBIG STL-1001-E CCD. Photometric measurement and lightcurve construction were made with *MPO Canopus* software. All exposures were 60 sec, unguided, and used a clear filter. To reduce the number of points on the lightcurves and make them easier to read, data points have been binned in sets of 3 with maximum time difference of 5 minutes. In all cases, the lightcurve of the double period has been examined and shows complete or nearly complete phase coverage with the two halves almost the same, and may be safely rejected.

24 Themis. The asteroid lightcurve database (LCDB; Warner *et al.*, 2009) states a secure period of 8.374 hours based on several independent and consistent investigations. New data were obtained on 3 nights, 2014 Apr 17-25, to contribute toward a lightcurve inversion solution. They show a period of 8.376 ± 0.002 hours, amplitude 0.10 ± 0.01 magnitudes, which is consistent with previous studies.

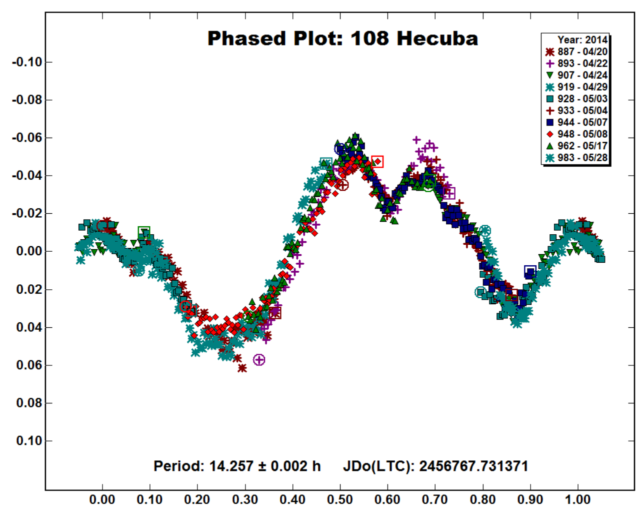


65 Cybele. The LCDB (Warner *et al*., 2009) states a secure period of 6.0814 hours based on several independent and consistent investigations. A period near 4.03 hours suggested by several other studies listed in this reference is now ruled out. New data were

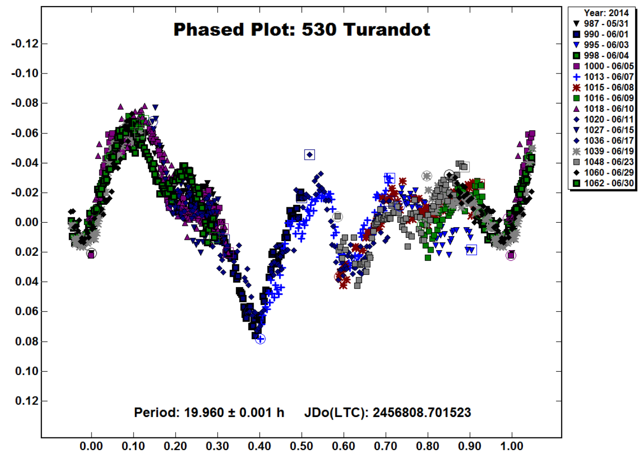
obtained on 5 nights, 2014 May 12 - June 6, to contribute toward a lightcurve inversion solution. They show a period of 6.081 ± 0.001 hours, amplitude 0.03 magnitudes, which is consistent with previous studies.



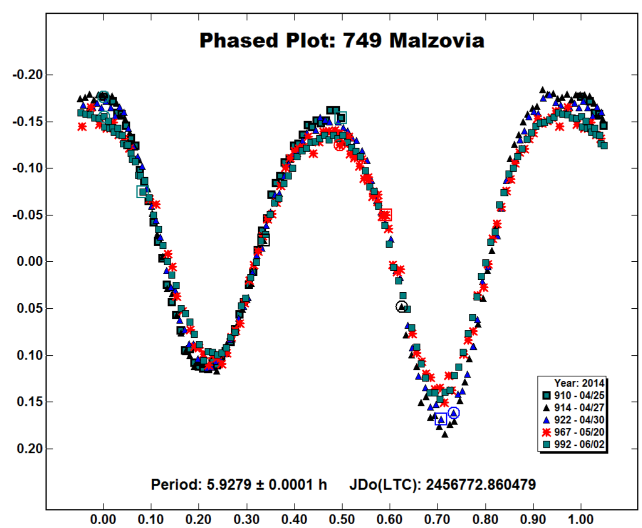
108 Hecuba. Previous period determinations are by Behrend (2005; 19.8 hours), Blanco *et al*. (1994; 14.46 hours), Warner (2007; 17.859 hours), and Pilcher (2013; 14.256 hours). New observations on 10 nights from 2014 Apr 20 - May 28 provide a good fit to a lightcurve with period 14.257 ± 0.001 hours and amplitude 0.09 ± 0.01 magnitudes. Among the previous period determinations, this is consistent with Blanco *et al*. (1994) and with Pilcher (2013).



530 Turandot. Previous period determinations are by Behrend (2002; 19.95 hours), Behrend (2005; 19.947 hours), and Di Martino *et al.* (1995; 10.77 hours). New observations on 16 nights from 2014 May 31 - June 30 provide a moderately good fit to an irregular lightcurve phased to 19.960 ± 0.001 hours, amplitude 0.13 ± 0.01 magnitudes. This is consistent with Behrend (2002) and Behrend (2005), but not with Di Martino *et al*. (1995). The lightcurve contains many small irregularities of amplitude near 0.02 magnitudes or smaller. The target was traveling through a dense Milky Way star field. Although star subtraction routines were used in the measurement process, these are often less than complete and some very faint stars may have been overlooked. Larger misfits are found in the descending part of the lightcurve between phases 0.2 and 0.3, which are probably caused by the usual changes in lightcurve shape with phase angle. Examination of other local minima in the period spectrum between 8 and 48 hours show that periods other than 19.960 hours and the double period can be ruled out. The same small misfits in the 19.960 hour lightcurve are also found in the double period lightcurve. Because the two sides of the double period lightcurve look almost the same, and the lightcurve is irregular, the double period may also be safely rejected. Therefore I claim that the 19.960 hour period is secure.



749 Malzovia. The LCDB (Warner *et al*., 2009) shows no previous observations. New observations on 5 nights from 2014 Apr 25 - June 2 provide a good fit to a lightcurve phased to 5.9279 ± 0.0001 hours and amplitude 0.30 ± 0.03 magnitudes.



References

Behrend, R. (2002, 2005). Observatoire de Geneve web site. *http://obswww.unige.ch/~behrend/page_cou.html*

Blanco, C., Di Martino, M., Lazzarin, M., Cellino, A., Riccioli, D. (1994). "A Physical Study of the Asteroid 108 Hecuba." in *Seventy-five (75) years of Hirayama asteroid families: The role of collisions in the solar system history."* (Kozai, Y, Binzel, R.P., and Hirayama, T., eds.). *ASP Conf. Ser.* **63**, pp 280-285.

Di Martino, M., Dotto, E., Celino, A., Barucci, M.A., Fulchignoni, M. (1995). "Intermediate size asteroids: Photoelectric photometry of 8 objects." *Astron. Astrophys. Suppl. Ser.* **112**, 1-7.

Pilcher, F. (2013). "Rotation Period Determinations for 102 Miriam, 108 Hecuba, 221 Eos, 255 Oppavia, and 745 Mauritia, and a note on 871 Amneris." *Minor Planet Bull.* **40**, 161-163.

Warner, B.D. (2007). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory – December 2006 – March 2007." *Minor Planet Bull.* **34**, 72-77.

Warner, B.D., Harris, A.W., Pravec, P. (2009). "The asteroid lightcurve database." *Icarus* **202**, 134-146. Updated 2014 Mar 1. *http://www.minorplanet.info/lightcurvedatabase.html*

ROTATION PERIODS AND *R* MAGNITUDES OF THREE KORONIS FAMILY MEMBERS

Anicia Arredondo, Anne-Marie Hartt, Sormeh K. Yazdi
Department of Astronomy
Whitin Observatory
Wellesley College
106 Central Street
Wellesley, MA 02481
ahartt@wellesley.edu

(Received: 8 July)

We report synodic rotation periods for three Koronis family asteroids: 1443 Ruppina, 5.880 ± 0.001 h; 1848 Delvaux, 3.639 ± 0.001 h; and 2144 Marietta, 5.489 ± 0.001 h.

Koronis family asteroids 1443 Ruppina, 1848 Delvaux, and 2144 Marietta were observed at Whitin Observatory in Wellesley, Massachusetts between 2014 February and April. The observations were made in order to determine the asteroids' *R* magnitudes and rotation periods, specifically in support of future spin vector determinations.

Observations

Ruppina, Delvaux, and Marietta were observed for three nights over spans of 13, 18, and 40 nights, respectively, following the observing principles described by Slivan *et al*. (2008). Table I presents a summary of the observing circumstances. The images were taken on a 2048-pixel square back-illuminated CCD camera with a 2x2 binned e2v detector. The scale was 1.2 arc seconds per pixel using Whitin Observatory's 0.61-m Sawyer telescope. Lightcurve image integrations of 240 s were collected using an *R* filter. The *IRAF* software package was used for bias level and dark signal subtraction and twilight field flattening as well as for measuring instrumental magnitudes using synthetic aperture photometry. The standard uncertainties of the lightcurves, with respect to the on-chip comparison stars, were estimated from the RMS dispersion of the differential brightness of non-variable on-chip field stars of comparable brightness to the asteroid.

To determine *R* magnitudes, we used the simplified method for standard star calibration described by Binzel (2005) and Neugent and Slivan (2008). On one night of each object's lightcurve observations, we included a standard star from Landolt (1992). Prior to the observations, the "airmass plot calculator" application at the Web site *http://www.koronisfamily.com* was used to determine the times at which the asteroid and its comparison star were at the same airmass as the standard star.

Analysis

To determine the rotation periods from on-chip differential photometry, light-time corrections were applied and then features were matched by inspection as described by Slivan *et al.* (2008). Each object's period estimate was then refined using a Fourier series model to the folded composite lightcurve shape including all data, while adjusting the nightly brightness zero points to best match the calibrated *R* lightcurves until the overall RMS residual was minimized. Our rotation period results are summarized in Table II, which lists the derived periods with their uncertainties. Amplitude ranges were calculated by using the brightness of the Fourier series model primary and secondary extrema.