

## ROTATION PERIOD DETERMINATION FOR 285 REGINA

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The synodic rotation period and amplitude for 285 Regina are found to be  $9.542 \pm 0.001$  hours,  $0.16 \pm 0.03$  magnitudes

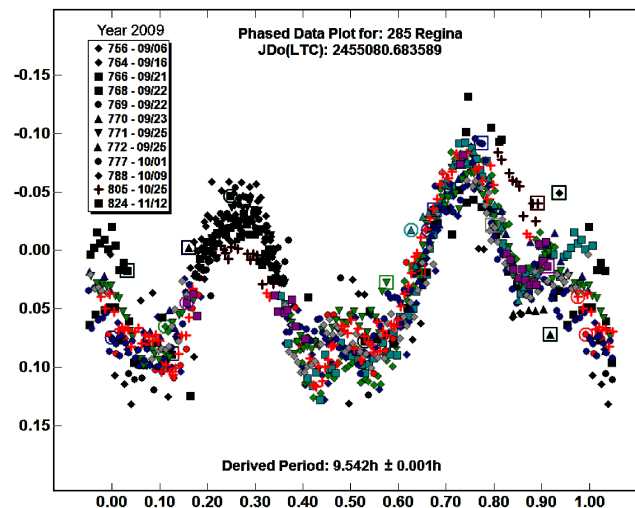
Observations by Pilcher were obtained at the Organ Mesa Observatory. Equipment consisted of a 35 cm Meade S-C, SBIG STL-1001E CCD, clear filter and unguided. Observations by Benishek were obtained at the Belgrade Astronomical Observatory with a 40 cm Meade S-C, SBIG ST-10 XME CCD, unfiltered and unguided.

Molnar et. al. (2008) published the only previous period determination with a period 31.64 hours. New observations on 12 nights 2009 Sept. 6 – Nov. 12 show a period of  $9.542 \pm 0.001$

hours, amplitude  $0.16 \pm 0.03$  magnitudes, and rule out the much longer period.

### References

Molnar, L. A., and 17 collaborating authors (2008). "Lightcurve Analysis of a Magnitude Limited Asteroid Sample." *Minor Plan. Bull.* **35**, 9-12.



## ASTEROID LIGHTCURVE ANALYSIS AT THE VIA CAPOTE OBSERVATORY: 4TH QUARTER 2009

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Nine asteroids were observed and their lightcurves periods and amplitudes were measured at the Via Capote Observatory from 2009 September through December 2009: 449 Hamburga ( $18.263 \pm 0.004$  h; 0.09 mag), 527 Euryanthe ( $26.06 \pm 0.01$  h; 0.12 mag), 1023 Thomania ( $17.65 \pm 0.01$  h; 0.38 mag), 1345 Potomac ( $11.41 \pm 0.01$  h; 0.24 mag), 1398 Donnera ( $7.23 \pm 0.01$  h; 0.15 mag), 1564 Srbija ( $9.135 \pm 0.001$  h; 0.17 mag), 1994 Shane ( $8.220 \pm 0.001$  h; 0.26 mag), 2888 Hodgson ( $6.905 \pm 0.001$  h; 0.14 mag), and 15967 Clairearmstrong ( $5.90 \pm 0.01$  h; 0.33 mag).

CCD observations of nine asteroids were made at the Via Capote Observatory from 2009 September to December. The telescope was a Meade LX-200 0.36-m Schmidt-Cassegrain (SCT) working at the f/10 prime focus. The CCD imager was an Alta U6 with a 1024x1024 array of 24-micron pixels. All observations were made unfiltered at 1x binning yielding an image scale of 1.44 arcseconds per pixel. All images were dark and flat field corrected. The images were measured using *MPO Canopus* (Bdw Publishing) with a differential photometry technique. The data were light-time corrected. Period analysis was also done with *Canopus*, which incorporates the Fourier analysis algorithm

developed by Harris (1989). Most target selections were made using the Collaborative Asteroid Lightcurve Link (CALL) website (Warner, 2009) and "Lightcurve Opportunities" articles from the *Minor Planet Bulletin*. Priority was given to asteroids that did not have a published rotational period.

The results are summarized in the table below along with individual lightcurves and additional comments, as required. Four of the six targets studied during the reporting period did not have previously published lightcurves.

**1023 Thomania.** Behrend (2009) reports a period of 17.561 h, which agrees well with the period derived during this campaign (17.56 hr). The amplitude was observed to be somewhat higher here than what Behrend reported (0.25 mag vs. 0.38 mag).

**1345 Potomac.** Both Hartman et al. (1988) and Dahlgren et al. (1998) report a period of 11.40 h and curve amplitude of 0.22 mag. The results here agree those previous studies.

**1398 Donnera.** Behrend (2009) reports a period of 7.3 h and amplitude of 0.23 mag based on incomplete coverage. Complete coverage obtained during this campaign allows for the period to be further refined to 7.23 h with an amplitude of 0.15 mag.

**1564 Srbija.** Anglionto and Mijic (2007) report a period of 29.64 h and amplitude of 0.37 mag with incomplete coverage. Complete coverage, spanning opposition, was obtained during this campaign. The period was determined to be 9.135 h and the amplitude 0.17 mag. This is a very substantial departure from the Anglionto result. The period spectrum shown below reveals a candidate period matching the Anglionto report; it is less preferred than the 9.135 h period.

**1564 Srbija** has a rather unusual-shaped lightcurve exhibiting a very prominent minimum. An attempt was made to sample data

more densely in this transitional area of the lightcurve. The result shows how the amplitude of this feature seemed to flatten out and shift phase somewhat as the measurements approached opposition. This may be the result of some pronounced shadowing occurring over a very prominent physical feature on the asteroid itself, the general result of the dependency of amplitude on phase angle (see Zappalà et al., 1990), and/or a change in the synodic period over the span of the observations.

1994 Shane. Florczak et al. (1997) report a period of 25 h and amplitude of  $> 0.1$  mag with fragmentary data. Complete coverage obtained during this campaign suggests a period of 8.220 h and amplitude of 0.26 mag. The period spectrum does reveal a candidate period matching the Florczak et al. report; however, this appears to be a third harmonic of the preferred period.

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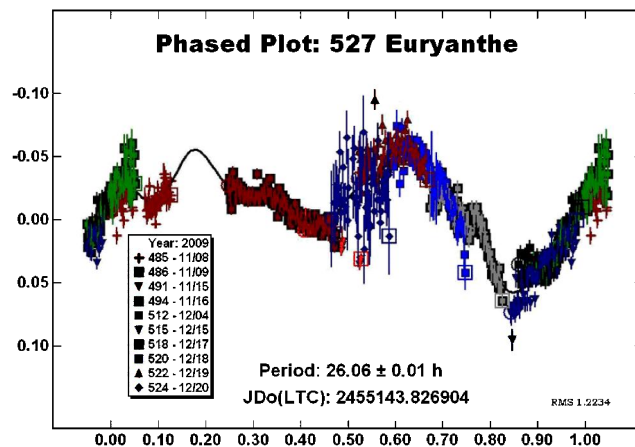
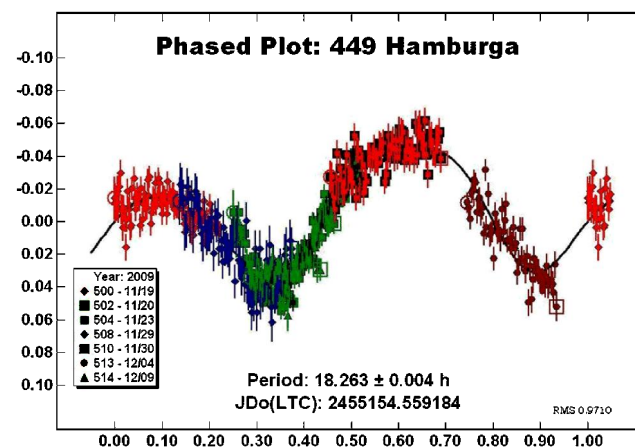
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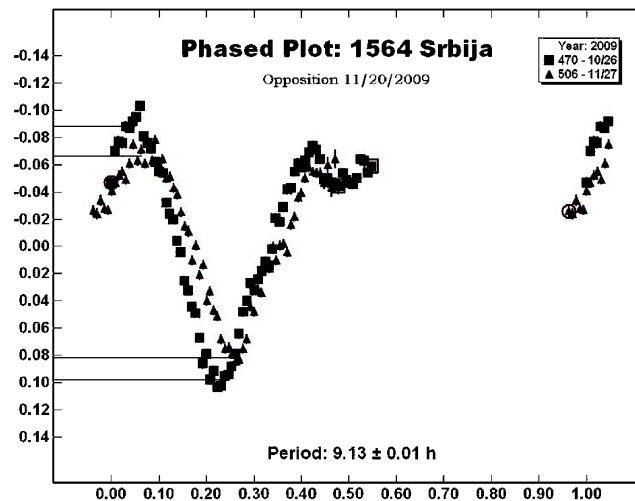
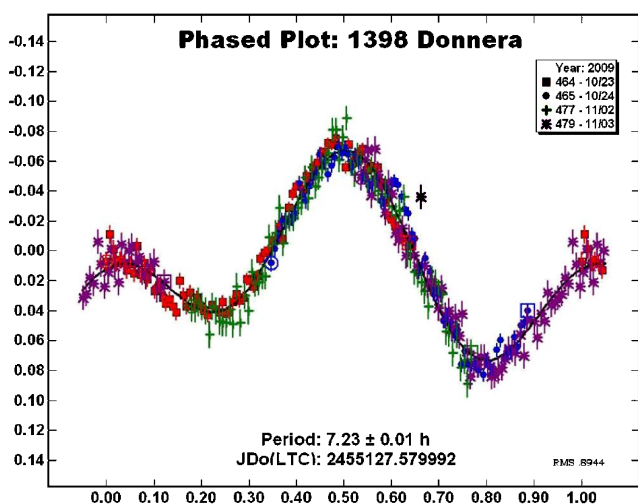
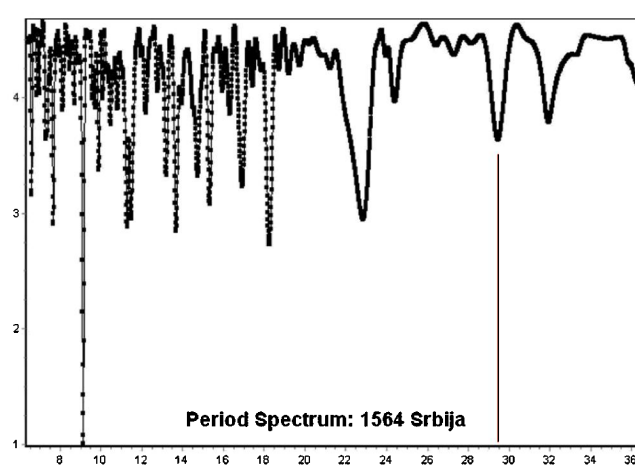
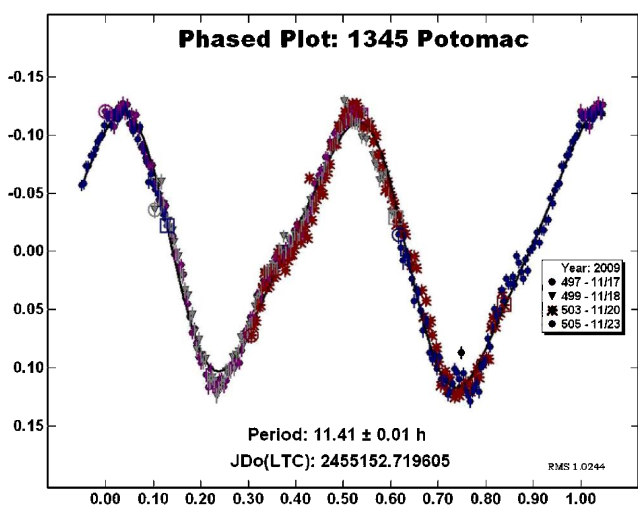
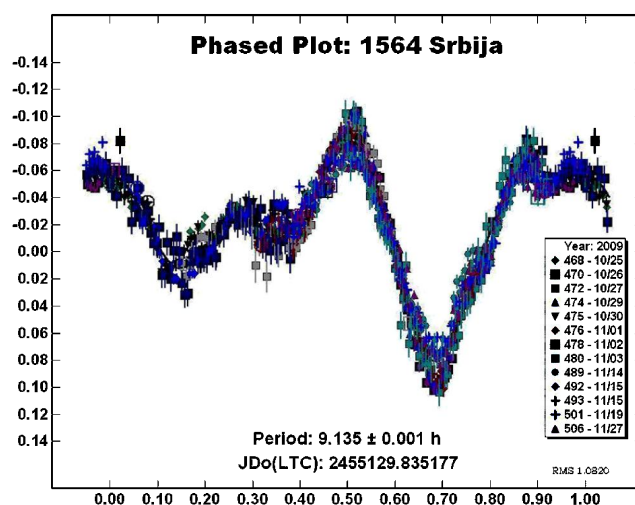
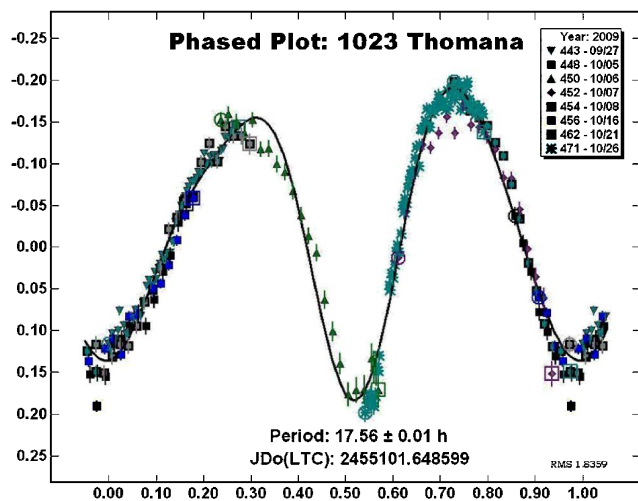
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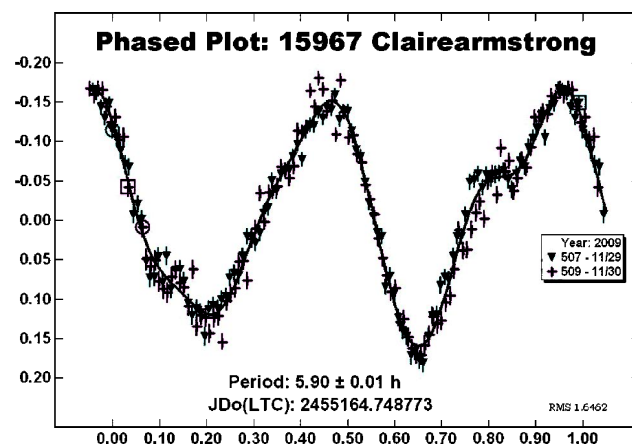
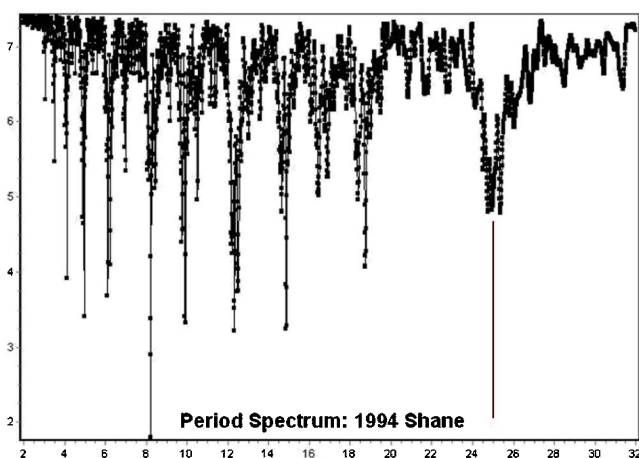
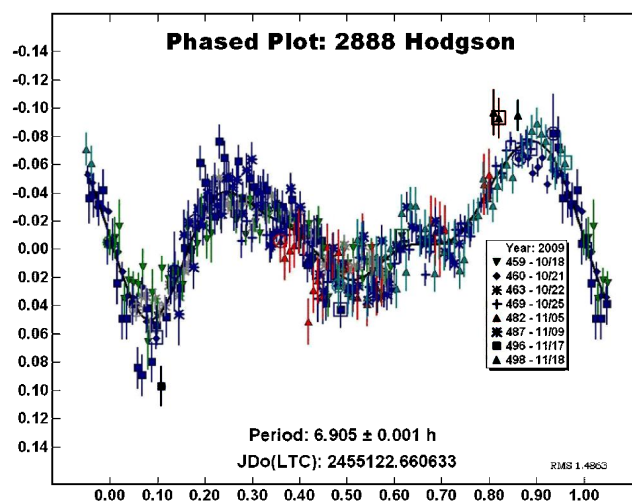
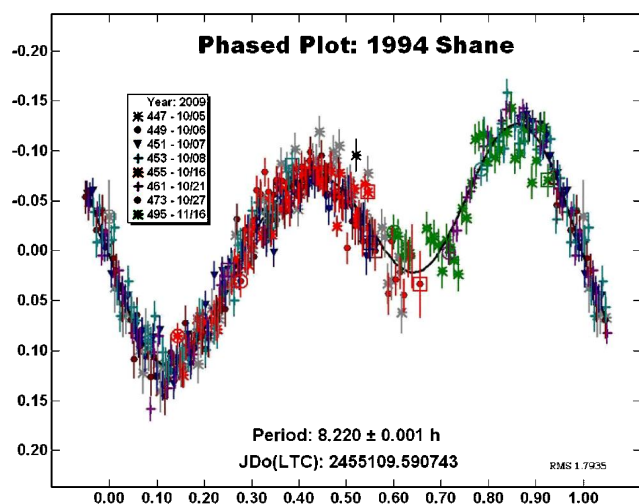
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| Asteroid              | Date Range<br>(mm/dd/2009) | Data<br>Points | Phase          | L <sub>PAB</sub> | B <sub>PAB</sub> | Per(h) | PE    | Amp<br>(m) | AE   |
|-----------------------|----------------------------|----------------|----------------|------------------|------------------|--------|-------|------------|------|
| 449 Hamburga          | 11/19-12/09                | 508            | 19.9           | 7                | -3               | 18.263 | 0.004 | 0.09       | 0.02 |
| 527 Euryanthe         | 11/08-12/20                | 774            | 5.7, 5.4, 15.2 | 50               | -11              | 26.06  | 0.01  | 0.12       | 0.02 |
| 1023 Thomana          | 09/27-10/26                | 259            | 14.7           | 336              | 6                | 17.56  | 0.01  | 0.38       | 0.02 |
| 1345 Potomac          | 11/17-11/23                | 446            | 4.7            | 63               | -13              | 11.41  | 0.01  | 0.24       | 0.02 |
| 1398 Donnera          | 10/23-11/03                | 320            | 14             | 1                | 14               | 7.23   | 0.01  | 0.15       | 0.02 |
| 1564 Srbija           | 10/25-11/27                | 866            | 11.6, 5.8, 7.2 | 55               | -12              | 9.135  | 0.001 | 0.17       | 0.04 |
| 1994 Shane            | 10/05-11/16                | 448            | 22.4           | 346              | 12               | 8.220  | 0.001 | 0.26       | 0.05 |
| 2888 Hodgson          | 10/18-11/18                | 392            | 17.2           | 10               | 5                | 6.905  | 0.001 | 0.14       | 0.03 |
| 15967 Clairearmstrong | 11/29-11/30                | 221            | 10.3           | 73               | -15              | 5.90   | 0.01  | 0.33       | 0.02 |

Table I. Observing circumstances. Where 3 numbers are indicated for phase angle, measurements of the target occurred over opposition. The middle value is the minimum phase angle observed and the two end values are the phase angles at the beginning and end of the observing campaign.





## 2705 WU: A TUMBLING ASTEROID

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2705 Wu was observed in 2009 July through September. The initial results showed a lightcurve with synodic period of  $150.5\text{h} \pm 0.5\text{h}$ . The observations were also checked for variations seen in the mean lightcurve. After eliminating other causes of the variations, it was concluded that 2705 Wu exhibited Non-Principal Axis (NPA) rotation, or tumbling behavior. Attempts to derive the secondary period were unsuccessful.

Observations of 2705 Wu were made at Kingsgrove Observatory in 2009 July through September. The asteroid was selected because there were no previous reports of its lightcurve and because it was listed as a target of opportunity on the CALL web site (Warner, 2008). A 0.25-m Schmidt-Cassegrain telescope (SCT) operating at f/10 was used in combination with an SBIG ST-9XE CCD camera operating at 1x binning. This resulted in a

resolution of 1.67 arcseconds per pixel (Oey 2008). Exposures of 300s through a clear filter maximized the signal-to-noise ratio (SNR). *MPO Canopus* v.9.4.0.10, which incorporates the Fourier analysis algorithm developed by Harris (1989), was used for period analysis. Data were linked internally using the Comp Star Selector (CSS) feature of *Canopus*. Since the system is sensitive towards the red, R magnitudes were used in the CSS. A careful reduction of the data using this method resulted in an error of 0.03–0.05 m in the nightly zero points (see Stephens, 2008).

After having established the initial period of 150 h in the first few observing runs, a tendency to shift from the mean lightcurve started to show. There are a number of reasons for these apparently random deviations. One is the well-known phase-amplitude relationship where the amplitude decreases as the object approaches opposition. Another, to a smaller extent, is the opposition effect where the asteroid brightens more than expected by simple geometry near opposition. The third is a change in the synodic period brought on by changing viewing aspects over a relatively long observing run. This slight speeding up or slowing down in the synodic period is quantified by the equation (Pravec, 2005):

$$\Delta|\text{Psyn-Psid}| \sim d(\text{PAB})/d(T) * P^2$$

Where  $|\text{Psyn-Psid}|$  is the difference between the synodic and sidereal periods,  $d(\text{PAB})/d(T)$  is the rate of change in the Phase Angle Bisector (Harris, 1984), and  $P$  is the period in the same