

ASTEROID PHOTOMETRY AT THE PALMER DIVIDE OBSERVATORY: RESULTS FOR 706 HIRUNDO, 957 CAMELIA, AND 1719 JENS

Brian D. Warner
17995 Bakers Farm Rd.
Colorado Springs, CO 80908
brianw_mpo@compuserve.com

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Lightcurves for three asteroids were measured in 2000 July and September at the Palmer Divide Observatory located near Colorado Springs, CO. For 706 Hirundo, a period of 22.072 ± 0.005 h and amplitude of 0.96m was found. The period for 957 Camelia was found to be 5.391 ± 0.02 h with an amplitude of 0.32m. The parameters for 1719 Jens were found to be 5.867 ± 0.02 h and 0.54m maximum amplitude.

The goal of the Palmer Divide Observatory asteroid photometry program is to measure the lightcurves of as many asteroids as possible given the limitations of the equipment. The current instrumentation is a 0.5m Ritchey-Chretien working at f/4.7 instead of the usual f/8.1. This is achieved by using a commercial focal reducer in a modified cell so that the distance from the lens to the CCD chip is closer to the designed specifications. An SBIG ST-8 camera using a non anti-blooming non-enhanced chip was used. The temperature was kept at approximately -10°C , as it is at all times of the year to help maintain some consistency of results. Initial targets are selected by referring to the list of lightcurves maintained by Alan Harris (Harris 1997, 1999). At least two nights are dedicated to the initial run for every target. Depending on the preliminary analysis of the lightcurve data from those two nights, additional runs are allocated as necessary to assure full coverage of the lightcurve with no significant gaps, if possible. For asteroids with periods approaching and exceeding 24 hours, this becomes difficult.

Custom software written by the author, Canopus, is used to measure the images since it allows automatic storage of the measured magnitudes of the comparison stars and targets. It uses aperture photometry with magnitudes determined by calibrating images against field or, preferably, standard stars. The package includes a Fourier analysis routine, the original FORTRAN code for which was supplied by Alan Harris (Harris et al, 1989) and converted to Delphi Pascal. If the data from a single night appears to cover at least half a period or more, then an estimate based on a plot of the raw data is used to help narrow the possibilities when using data from two or more nights.

706 Hirundo

Hirundo is a unclassified main-belt asteroid of about 24km size. It was discovered by J. Helffrich in Heidelberg on 1920 October 9. It is named after a bird in the swallow family. 352 observations of Hirundo were made during runs on 2000 September 13, 15-17, 19, and 25. The period was found to be 22.072 ± 0.005 h with an amplitude of 0.98m. The first maximum is well rounded with the following minimum being very sharp. This might suggest that the asteroid is fairly elongated and that the viewing angle was close to a right angle with the axis of rotation. Despite the gap between second maximum and second minimum, there was enough overlap of data at other inflection points to determine the period with a fair

degree of precision. The period being almost 24 hours made this a difficult target for which to get a complete lightcurve. It would have been a perfect case for a collaborative effort. Unfortunately, the several amateurs contacted were already involved with other collaborations or working other targets. This is quite a reversal from years past when the trouble was finding anyone at all interested in asteroid lightcurves let alone willing to take time to work a given target.

957 Camelia

About 180 data points were measured for this 39km unclassified asteroid during runs on 2000 July 30 and August 9. The derived period is 5.391 ± 0.02 h and the amplitude 0.32m. Camelia was discovered by K. Reinmuth on 1921 September 7 and is named after a group of plants in the tea family that has glossy evergreen leaves and rose-like flowers. There is a decided asymmetry to the descending branch following the first maximum while the second maximum is much sharper than the first.

1719 Jens

Discovered by K. Reinmuth in 1950 February, Jens is named after Reinmuth's grandson. It is an unclassified asteroid of about 24km size and a member of the main-belt with a slightly larger than usual orbital inclination of just over 14 degrees. This makes it very similar to the orbit of 706 Hirundo (see above). 166 data points were obtained during runs on 2000 September 26 and 27. The derived period is 5.867 ± 0.02 h with a maximum amplitude of 0.54m occurring between second minimum and the following maximum. The minimum between first and second maximum is about 0.14m shallower, i.e., about 0.40m amplitude. Each of the runs was more than 6 hours in length and so covered more than one full revolution of the asteroid. This allowed for a fair amount of overlap at the inflection points, making the determination of the period easier. This was a rare treat as often many of the selected targets, e.g. 706 Hirundo above, have periods exceeding what can be done in a single night and, to make matters worse, have periods closely commensurate with 24 hours.

Acknowledgments.

Thanks go to Alan Harris of the Jet Propulsion Laboratory for making available the source code to his Fourier Analysis program.

References

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COMBINING COLLABORATIVE WORK

Robert D. Stephens
11355 Mount Johnson Court
Rancho Cucamonga, CA 91737
rstephens@foxandstephens.com

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Many amateur photometric observations are not converted to the Standard System. Combining results from collaborative work is difficult when using instrumental observations. Canopus software by BW Publishing can be used to combine instrumental observations from different systems.

Thanks to recent publicity, in publications and at conferences, there is a growing community of amateur astronomers desiring to do photometry of asteroids in order to determine rotational periods. It is only natural, that with the growth of the Internet, many of these amateur astronomers would wish to collaborate on projects. The benefits are obvious; (1) more complete coverage can be obtained on lightcurves from observatories stationed around the globe and, (2) the collaborative work can be used to verify each other and reduce errors.

However, on the downside, there are problems in trying to combine work from remote observatories. Most important is that most amateur observatories tend to make instrumental measurements as opposed to absolute magnitude determinations. In calculating these instrumental measurements, the amateur observatories typically calculate the slopes, but not the zero points. This is simply because they often use comparison stars in the same field of view without transforming to a standard system. So the problem becomes how to combine data from different observatories that are not adjusted to the standards system. One approach is to calibrate each observatories data by determining a minimum or maximum, for the lightcurve in comparison with data from the other observatories. In order to do this, start with an observing session whose length of time covers at least 25 percent of the asteroid's rotational period. This will typically contain at least one minimum or maximum of the curve. Having both, or other identifiable features is an extra advantage. I use Brian Warner's Canopus software to measure and analyze the data. This software has the ability to import data from other observatories, if measured using the same software.

As stated in the accompanying article on 27 Euterpe, four observatories contributed observations to an observing campaign on the asteroid. This was a very difficult target for which to find a solution, as it turned out not have the traditional two-peaked curve. My first step was to identify which sessions had the longest continuous amount of data, typically at least four hours long. I selected the six best sessions, all of which had at least a minimum or a maximum. Several had other identifying features. The Canopus program has the ability to adjust the zero point with what it calls a 'DeltaComp' adjustment. This adjustment is used to correct differences resulting from different comparison stars used on different nights, different cameras used, or the asteroid being at a different distance from Earth during different sessions. The six sessions were roughly adjusted with the DeltaComp adjustment. Then, using the Fourier Analysis portion of Canopus, every period between 5 and 18 hours was checked at 0.01 hour increments. A few possibilities were found for the six sessions used. One of which was the previously published 8.5-hour period. However, by far the best fit was a 10.41-hour period with the data

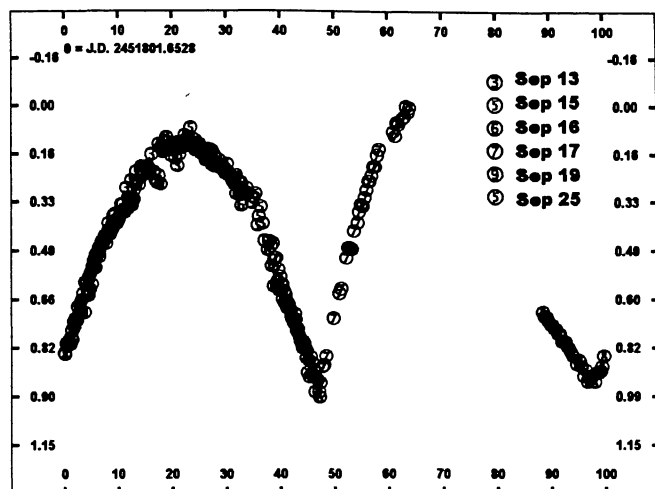


Fig. 1 – The lightcurve plot for 706 Hirudo. The period is $22.072 \pm 0.02h$ with an amplitude of 0.98m. Note the sharp inflection point at first minimum versus the very rounded first maximum.

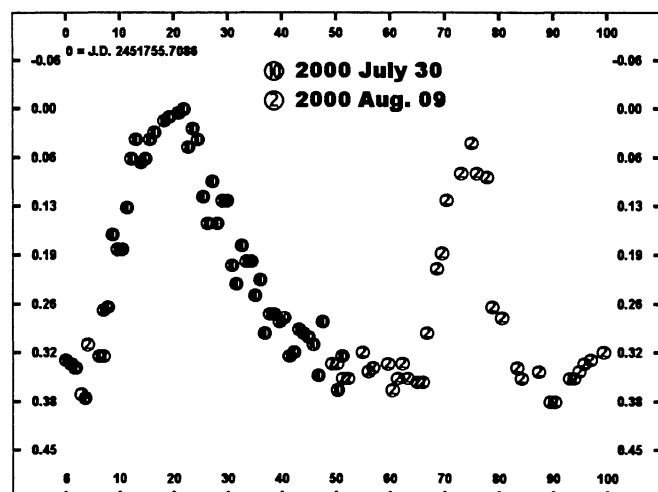


Fig. 2 – The lightcurve plot for 957 Camelia. The derived period is $5.391 \pm 0.02h$; the amplitude is 0.32m. The shape of the two maximums is distinctly different with the first showing a curved shape on the descending slope.

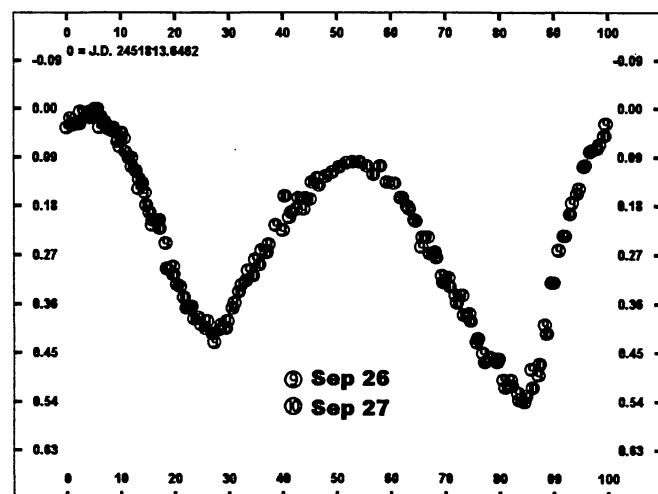


Fig. 3 – The lightcurve plot for 1719 Jens. The period is $5.867 \pm 0.02h$ and the maximum amplitude is 0.54m. The first, shallower minimum has an amplitude of about 0.40m.