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PHOTOMETRY OF 628 CHRISTINE, 754 MALABAR, 815 COPPELIA, AND 1025 RIEMA

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Results for the following asteroids (lightcurve period and amplitude) observed from Santana Observatory during the period April to June 2003 are reported: 628 Christine (16.135 ± 0.01 hours and 0.22 mag.), 754 Malabar (11.740 ± 0.005 hours and 0.45 mag.), 815 Coppelia (4.421 ± 0.005 hours and 0.24 mag.), 1025 Riema (3.580 ± 0.005 hours and 0.14 mag.).

Santana Observatory (MPC Code 646) is located in Rancho Cucamonga, California at an elevation of 400 meters and is operated by Robert D. Stephens. Details of the equipment used can be found in Stephens (2003) and at the author's web site (http://home.earthlink.net/~rdstephens/default.htm.)

All of the asteroids were selected from the "CALL" web site "List of Potential Lightcurve Targets" (Warner 2003) or from the "Complete" list.

Aperture photometry was done using the software program "Canopus" developed by Brian Warner and including the Fourier analysis routine developed by Alan Harris (Harris et al., 1989). This program allows combining data from different observers and adjusting the zero points to compensate for different equipment and comparison stars. All observations were unfiltered. Dark frames and flat fields were used to calibrate the images.

628 Christine

Christine is a member of the Marias family and was discovered March 7, 1907 by A. Kopff at Heidelberg. Christine is 25 km in diameter. There is no known reference to the name Christine.

Christine was selected from the "Complete List of Potential Lightcurve Targets" (Warner 2003), as no suitable targets were found on the abridged list. H. J. Schober had previously reported in 1981 that the period was greater than 14 hours and the amplitude greater than 0.4 magnitudes. Indeed, the period is greater than 14 hours, but at this opposition the amplitude was much less than when Schober observed it.

Between April 20 and May 2, 2003, 450 observations over 6 sessions were used to derive the synodic rotational period of 16.135 ± .01 hours with an amplitude of 0.22 ± 0.03 magnitude. During this period the phase angle changed from 7 to 9 degrees.

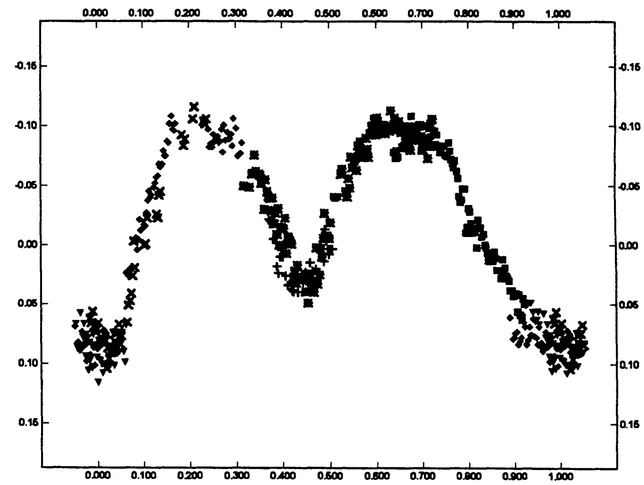

Figure 1. Lightcurve of 628 Christine based upon a derived period of 16.135 ± 0.01 hours.

754 Malabar

Malabar is a main-belt asteroid discovered August 22, 1906 by A. Kopff at Heidelberg. It is 44 km in diameter. Malabar is named in remembrance of the Dutch-German solar eclipse expedition to Christmas Island in 1922. Malabar is a city and mountain on Java. On 6 nights between May 31 and June 16, 2003, 674 observations were obtained to derive the synodic rotational period of 11.740 ± .005 hours with an amplitude of 0.45 ± 0.03 magnitude. During this period the phase angle stayed around 11 degrees. This was initially a difficult period to determine because of the flattened shape of the lightcurve at both maximums. It was hard to differentiate between the two maximums and eliminate aliases. However, eventually the different depths of the minimums was the factor that eliminated all other possibilities.

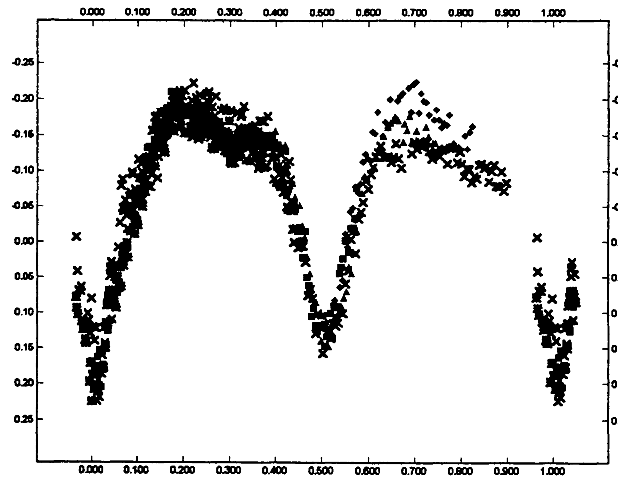

Figure 2. Lightcurve of 754 Malabar based upon a derived period of 11.740 ± 0.005 hours.

815 Coppelia

Discovered February 2, 1916 by M. Wolf at Heidelberg, Coppelia belongs to the Marias family of asteroids. It is named for the short ballet in two acts by Leo Delibes, which is based on a tale by T. A. Hoffman. 348 observations over 5 sessions between March 12 and 19, 2003 were used to derive the synodic rotational period of 4.421 ± 0.005 hours with an amplitude of 0.24 ± 0.04 magnitude. During this period the phase angle changed from 9 to 10 degrees. This was the best opposition of Coppelia until 2012.

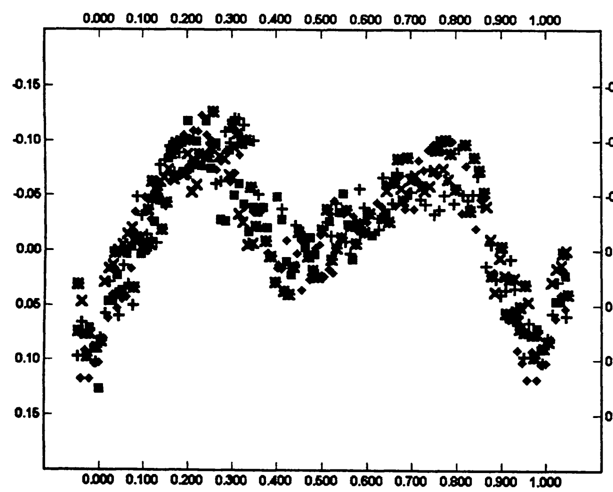

Figure 3. Lightcurve of Coppelia based upon a derived period of 4.421 ± 0.005 hours.

1025 Riema

Discovered by K. Reinmuth at Heidelberg on August 13, 1923, Riema is a member of the Hungarias family. Riema is estimated to be between 8 and 19 km in diameter. It is named in honor of Johannes Riem (1868-1945) a German astronomer. Between April 1 and 9, 2003, 5 sessions and 368 observations were used to derive the synodic rotational period of 3.580 ± 0.005 hours with an amplitude of 0.14 ± 0.04 magnitude. During this period the phase angle changed from 13 to 15 degrees. The low amplitude and asymmetric lightcurve contributed to difficulties in determining the period. The next good opposition of Riema will occur in 2014.

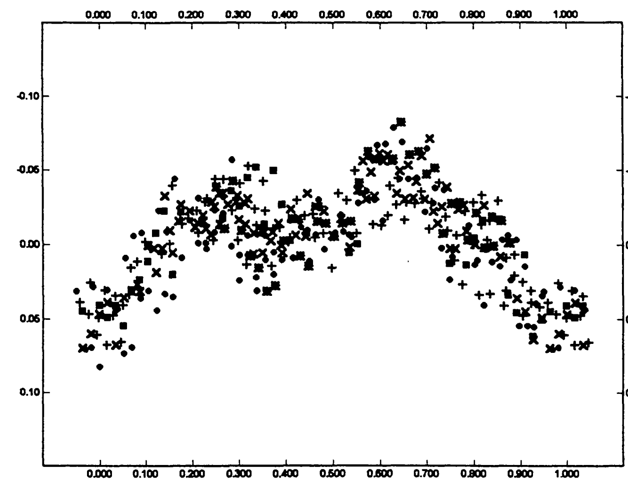

Figure 4. Lightcurve of Riema based upon a derived period of 3.580 ± 0.005 hours.

Acknowledgements

Many thanks to Brian Warner for his continuing work and enhancements to the software program "Canopus" which makes it possible for amateur astronomers to analyze and collaborate on asteroid rotational period projects and for maintaining the CALL Web site which helps coordinate collaborative projects between amateur astronomers. Also, I am indebted to Brian Warner for writing a scripting program capable of controlling the Paramount German equatorial mount temporarily in use at Santana Observatory.

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A WEB-BASED TOOL TO CALCULATE OBSERVABILITY OF KORONIS PROGRAM ASTEROIDS

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Results derived from rotation lightcurve studies of asteroids in the Koronis family have recently attracted much interest in the asteroid research community. I've developed a software application to identify which Koronis program objects that are in need of rotation lightcurve data are observable on a given date from a given location. This tool is now accessible on the Web at http://www.koronisfamily.com . Observers who wish to participate in the ongoing observing program may use this tool for targeting these objects' lightcurves.

Members of the Koronis family of asteroids are thought to be the shattered remains of a single body that was catastrophically disrupted by a collision; these main belt objects share similar orbits and reflectance spectra (e.g., Bendjoya and Zappala 2002, Zappala et al. 2002). Presumably they've experienced similar evolution for similar lengths of time, and so have long been recognized as a potential source of valuable information to help understand the processes that are at work on asteroids in the main belt. The largest Koronis member, (208) Lacrimosa, has an estimated diameter of 42 km and an opposition brightness of about V 12.7. Family member (243) Ida was visited by the Galileo spacecraft in 1993.

Koronis member objects have been the subjects of a series of rotation lightcurve studies (Tedesco 1979, Binzel 1987, Binzel 1988, Binzel et al. 1993, Slivan and Binzel 1996, Slivan et al. 2003). Recent analysis of lightcurve observations spanning several decades revealed a very surprising clustering in the distribution of spin periods and spin vector orientations (Slivan 2002), contrary to the random orientations predicted by current theories of family formation and collisional evolution. The striking difference between theory and observation suggests that the correct interpretation of the alignment will reveal interesting and important science results.

So far, spin vectors have been determined for only half of the largest 20 Koronis family members, and the corresponding model shapes remain poorly-constrained. New observations of lightcurves are needed to determine spin vectors of the remaining large Koronis members, as well as those of smaller members and also of a statistical control sample of non-family asteroids. I'm continuing my own lightcurve observing program, but there's still a lot of data collection to do, and I hope that observers interested in helping to solve the puzzle of the clustered spins in the Koronis family will also take the opportunity to join in. I'm assembling materials and information at the Web site http://www.koronisfamily.com in support of the ongoing observations.

The first tool already available at the site is a calculator which identifies which program objects are observable from a given Earth location on a given date. The user specifies constraints of limiting (predicted) magnitude, minimum target altitude, maximum Sun altitude, and Moon proximity. Program objects are divided into several lists according to which spin properties need to be determined (spin vector, spin period, refined model shape). There's also a "control group" list of non-family asteroids whose location in the main belt and estimated sizes are similar to those of the Koronis family program objects. The calculator output includes the times for sunset/sunrise and twilight, the coordinates and time span of observability for each listed program object, and a link to extract an image centered on the target object's position from the DSS Digitized Sky Survey for use as a finder chart. A note line for each object gives additional information such as the rotation period (if already known), apparitions especially useful to observe for pole and shape determination, or the need for a single-apparition solar phase curve.

The calculator's default settings, including the list of "highest priority" objects, are primarily for the use of the undergraduate student observers with whom I work at the Whitin Observatory at Wellesley College. Though we've successfully been using the site since April, I'd be happy to hear from observers elsewhere who can suggest improvements to better meet the needs of a broader community of participants in the Koronis observing program. Site feedback and other questions about the research program are most welcome at my e-mail address given above.

Acknowledgments

The original tool wouldn't have been written without the invitation and continuing support of Wendy Bauer, Kim McLeod, and Dick French at Wellesley College to "plug in" to their student observer program. Tim Shepard and Anne LaVin helped me learn how to put the calculator on the Web. The Digitized Sky Survey http://stdatu.stsci.edu/dss/ was produced at the Space Telescope Science Institute under U.S. Government grant NAG W-2166.

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INSTRUCTIONS FOR AUTHORS

The *Minor Planet Bulletin* is open to papers on all aspects of minor planet study. Theoretical, observational, historical, review, and other topics from amateur and professional astronomers are welcome. The level of presentation should be such as to be readily understood by most amateur astronomers. The preferred language is English. All observational and theoretical papers will be reviewed by another researcher in the field prior to publication to insure that results are presented clearly and concisely. It is hoped that papers will be published within three months of receipt.

The *MPB* will not generally publish articles on instrumentation. Persons interested in details of CCD instrumentation should join the International Association of Amateur and Professional Photoelectric Photometers (IAPPP) and subscribe to their journal. Write to: Dr. Arnold M. Heiser, Dyer Observatory, 1000 Oman Drive, Brentwood, TN 37027 (email: heiser@astro.dyer.vanderbilt.edu). The *MPB* will carry only limited information on asteroid occultations because detailed information on observing these events is given in the *Occultation Newsletter* published by the International Occultation Timing Association (IOTA). Persons interested in subscribing to this newsletter should write to: Craig and Terri McManus, 2760 SW Jewell Ave., Topeka, KS 66611-1614. Astrometry measurements should be submitted to the IAU Minor Planet Center and are no longer being published or reproduced in the *MPB*.

Manuscripts

All manuscripts should be typed double-spaced and should be less than 1000 words. Longer manuscripts may be returned for revision or delayed pending available space. Manuscripts should consist of the following: a title page giving the names and addresses of all authors (editorial correspondence will be conducted with the first author unless otherwise noted), a brief abstract not exceeding four sentences, the text of the paper, acknowledgments, references, tables, figure captions, and figures. Please compile your manuscripts in this order.

For lightcurve articles, authors are encouraged to combine as many objects together in a single article as possible. For general articles, the number of tables plus figures should not exceed two. Tables should be numbered consecutively in Roman numerals, figures in Arabic numerals. We will typeset short tables. Longer tables must be output using a 300 dpi or higher quality printer, black text on white paper. Font size should be large enough to allow for clear reproduction within the column dimensions described below. Similarly, figures should be printed at 300 dpi or higher quality, black markings on white paper. Because of their high reproduction cost, the *MPB* will not print color figures. Labeling should be large enough to be easily readable when reproduced to fit within the *MPB* column format. If at all possible, you are strongly encouraged to supply tables and figures at actual size for direct reproduction. Tables and figures intended for direct reproduction to occupy one-half page width should be 8.6 cm wide, or full-page width, 17.8 cm. Size your tables and figures to fit one-half page width whenever possible. Limit the vertical extent of your figures as much as possible. In general they should be 9 cm or less.

References should be cited in the text such as Harris and Young (1980) for one or two authors or Bowell et al. (1979) for more than two authors. The reference section should list papers in alphabetical order of the first author's last name. The reference format for a journal article, book chapter, and book are as follows:

Harris, A.W., and Young, J.W. (1980). "Asteroid Rotation Rates III: 1978 Results". *Icarus* **43**, 20-32.

Bowell, E., Gehrels, T., and Zellner, B. (1979). "Magnitudes, Colors, Types, and Adopted Diameters of the Asteroids". In *Asteroids* (T. Gehrels, Ed.), pp 1108-1129. Univ. Arizona Press, Tucson.

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Authors with access to Apple Macintosh or IBM compatible computers are *strongly* encouraged to submit their manuscripts by electronic mail, or on diskette. A prototype document file with instructions (Microsoft Word format) can be downloaded from

http://www.minorplanetobserver.com/astlc/default.htm

If you cannot use this file to format your manuscript, then format your article with any text editor. Save the manuscript as ASCII text and submit this text-only version via email (rpb@mit.edu) or on diskette (a printed version of the file must accompany the diskette). Please label the diskette with the author's name and the type of computer (Mac, PC).

When time permits, proofs of articles will be sent to authors. Submit two complete copies of the manuscript and the original tables and figures to: Dr. Richard P. Binzel, MIT 54-410, Cambridge, MA 02139, USA (email: rpb@mit.edu).

CCD PHOTOMETRIC OBSERVATIONS OF THE MINOR PLANET 4979 OTAWARA

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The minor planet 4979 Otawara was observed during its 2001-2002 opposition. Unfiltered photometric CCD observations have revealed a 0.28 ± 0.03 mag peak-to-peak amplitude and a rotation period consistent with the 2.707 h value already known.

Introduction

Until the January 2003 delay in the launching of the Rosetta space probe, the main-belt asteroid 4979 had been targeted by the European Space Agency (ESA) to be visited by the Rosetta mission. To optimize the flight parameters, international campaigns of observations were carried out during the oppositions of 1998-1999 (Doressoundiram et al., 1999), 2000 (Le Bras et al., 2001) and 2001-2002 (Fornassier et al., 2003). It has been established that, in particular, this small (~2 km circular effective diameter) S-type object presents (i) a sideral rotation period of 2.707 ± 0.005 hours, probably retrograde; (ii) a ratio of the triaxial ellipsoid shape a/b = 1.21 ± 0.05; (iii) ecliptic coordinates of the its north pole (lambda, beta) = (50 or 230 ± 5 deg, -30 ± 16 deg).

The data presented in this paper are the results of observations performed during the 2001-2002 opposition of 4979 Otawara.

Observations

Observations were carried out from the astronomical station of Chateau-Renard (Saint-Veran, French Alps; longitude: 6° 54' 24" E; latitude: 44° 41' 52" N; altitude: 2930 m), a facility operated by professionals of Meudon Observatory and by Astroqueyras, an amateur association. Measurements were obtained during the night of January 6-7, 2002 for about 5 hours. At this moment, Otawara was at a 2.4 deg solar phase angle with a 17.4 V magnitude. CCD images were taken with a 14 bit Hi-SIS 22 camera attached to a 0.62 m Cassegrain telescope. A focal reducer was used to obtain a final ratio F/D = 3. This camera uses Kodak's KAF 0400 front-side illuminated chip with a 768-by-512 array of 9 micron-square pixels. No filter was used, and the effective wavelength of the observations matched approximately the V+R band. Images were taken in binning 2x2 mode. The pixel size was 2 arcseconds and the integration time of each image was 200 seconds.

Reductions

CCD images have been corrected for bias, dark and flat-field effects. Measurements were performed by synthetic aperture photometry, i.e., by integrating the counts inside a circular diaphragm of 10 to 15 arcseconds radius; a concentric annulus was used for computing and substracting the median mean of the sky background. Some images were taken with a V Cousins filter. This permitted having an estimate of the color indices of the field stars, and to select the comparison stars which had a color similar to that of Otawara. Therefore, as the extinction effects were neglected, differential colors do not affect the lightcurve.

Results

The phased lightcurve of 4979 Otawara, obtained in January 6-7, 2002, is presented in Figure 1. The composite lightcurve is based on and is consistent with the previous rotational period that has been found to be 2.707 hours. The peak-to-peak unfiltered amplitude is 0.28 ± 0.03 mag. One-sigma uncertainties in brightness are represented by error bars, estimated to be ± 0.03 mag, in agreement with the dispersion of the measurements of the local comparison stars.

The present results as well as the original data may be asked for at our e-mail address.

Acknowledgments

We gratefully acknowledge Jean-Pierre Sareyan (Observatoire de la Cote d'Azur, Nice) for his precious advices and to have improved our manuscript.

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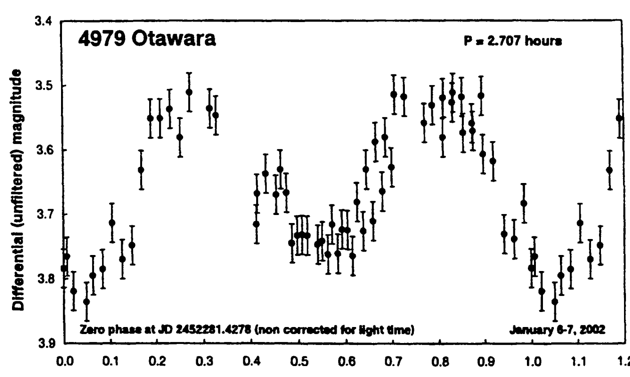

Figure 1. CCD photometric lightcurve of 4979 Otawara based on a period of 2.707 hours. Error bars are the one-sigma uncertainty of the measurements.

THE MINOR PLANET OBSERVER: MEETINGS OF MINDS

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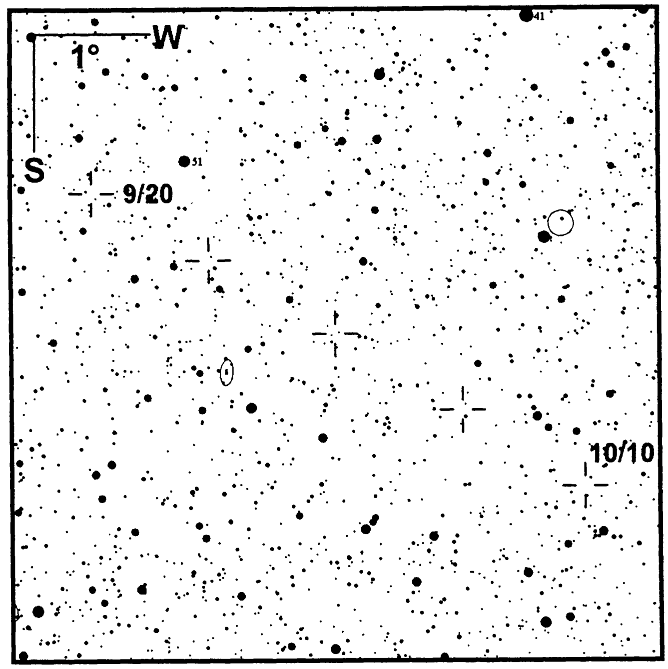
As promised in the last issue, I thought I would give a summary of the IAPPP-West and MPAPW 2003 meetings. For those not familiar with the acronyms, IAPPP-West is the Western Wing of the International Amateur-Professional Photoelectric Photometry group and MPAPW is the Minor Planet Amateur-Professional Workshop. As the titles convey, one of the guiding philosophies for both groups is to develop and maintain working relations between amateur and professional astronomers.

The IAPPP-WW conference has been held annually at Big Bear, CA, for the past few years, though the organization has been around for many more. This year's meeting was another success with about 100 people attending. Arne Henden of USNO-Flagstaff gave a talk on improving photometry precision and accuracy while Dirk Terrell of Southwest Research Institute talked about eclipsing binaries and using a program to model systems from lightcurve data. Both were very well received and would have gone on much longer if the audience had allowed. This brings out the point that "amateurs" are very motivated to do not only high quality work but to work on more complex projects.

That was proved by additional talks this year on spectroscopy at both the IAPPP and MPAPW meetings. At the latter (attended by about 65 people on the first day), Jim Roe and Art Lucas presented an intriguing talk on a technique that would allow BVRI photometry on asteroids using diffraction gratings. What precision they can eventually achieve is not certain but there seems at least some promise of doing general large-scale surveys of asteroids. Of particular note is that they can get reasonable data on 14-15m targets in 10 minutes using a 20-25cm telescope. That's much more efficient than the longer exposures required with slit spectroscopy only to reach much brighter targets.

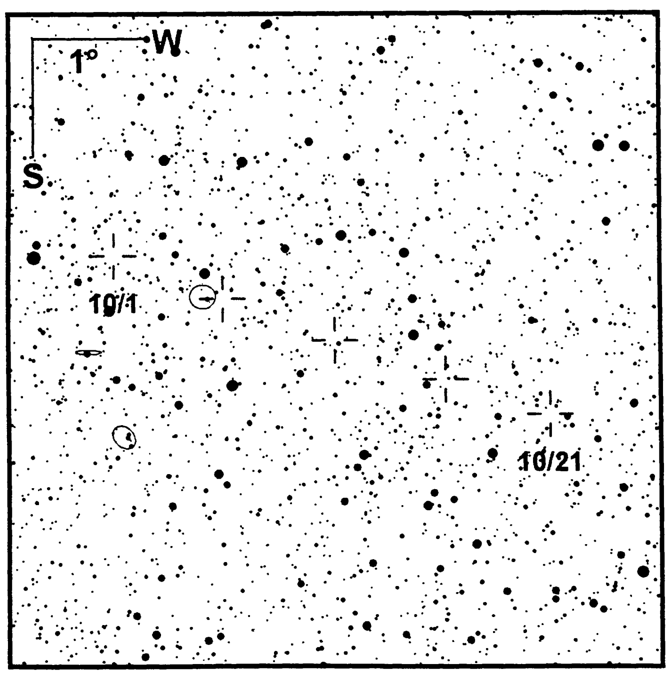
Of concern to any researcher is whether or not his results will benefit science. In astrometry, turning in a position can help refine an orbit. However, where does lightcurve data go? I've mentioned before Mikko Kaasalainen's proposed web site where researchers can submit their raw data for use by researchers. There is also the program being developed by Richard Kowalski to coordinate efforts with Mikko's program to determine asteroid shapes from lightcurves. There, observers will have specific targets and know their efforts will have immediate impact but what of lightcurve work of a more general nature?

In short, one can't win the lottery unless he buys tickets. There may not be a guarantee that one's data will be used immediately but it is certain that if there is no data, it will never be used. Until Mikko's site is ready, I encourage every lightcurve worker to develop a web page where he posts his results and the raw data as well. If you want to wait until your results are published in the *Minor Planet Bulletin* or elsewhere, that's fine, but do post the data eventually. The CALL site allows you to include notes and a URL for letting people know about your data. It also allows you to upload that data for eventual inclusion on Mikko's site. The responsibility of making sure the data we collect is eventually used is as much ours as anyone's. Make your data available and then make its availability known. Clear Skies.



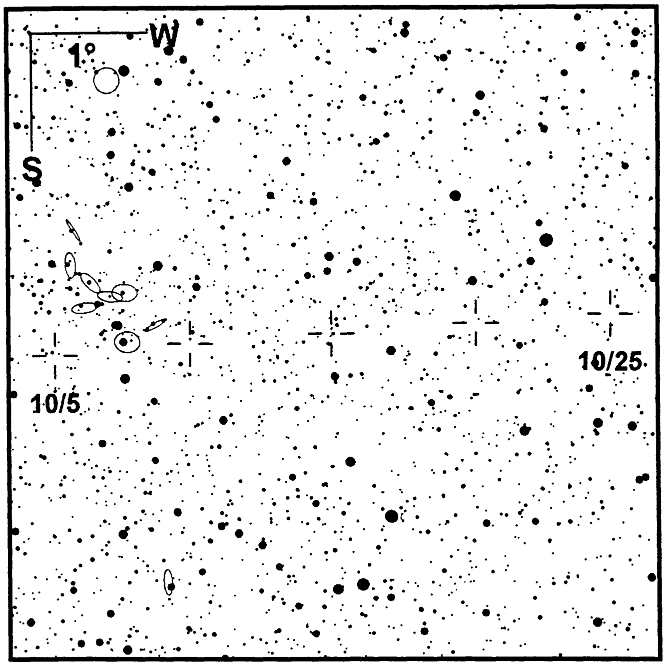
703 Noemi Named after a Biblical heroine in the chapter of Ruth, Noemi was discovered in 1910 October by J. Palisa. It's an unclassified asteroid of about 9km diameter. The field is in Pisces. Maybe the nearby galaxies are worth a quick look or image?

Date	RA2000	Dec2000	RA1950	Dec1950	M	PA	E
09/20	0 35.63	+ 6 40.9	0 33.05	+ 6 24.4	13.8	7.6	166
09/25	0 31.58	+ 6 06.7	0 29.01	+ 5 50.1	13.6	4.5	171
09/30	0 27.27	+ 5 29.3	0 24.70	+ 5 12.7	13.4	1.6	177
10/05	0 22.92	+ 4 50.3	0 20.35	+ 4 33.7	13.5	2.5	175
10/10	0 18.74	+ 4 11.4	0 16.17	+ 3 54.7	13.7	5.5	170



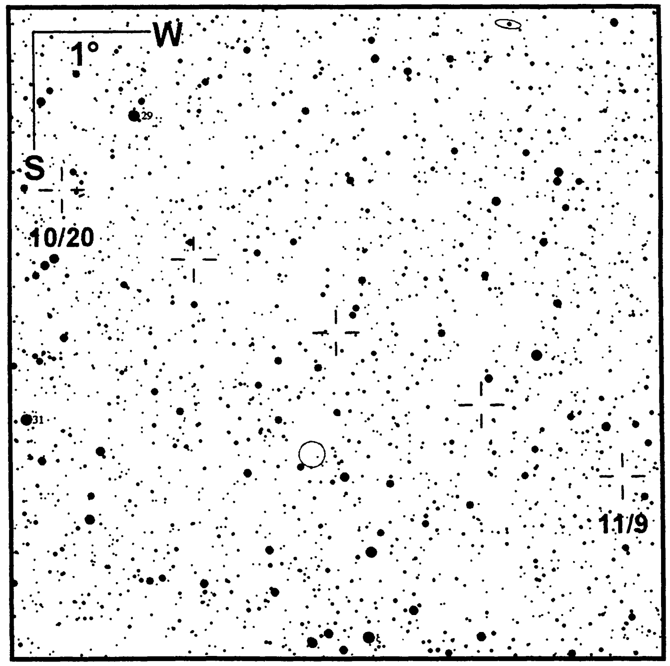
2525 O'Steen O'Steen was discovered in 1981 November by Brian Skiff of Lowell Observatory, who named the asteroid after his mother. The IRAS survey gives an approximate diameter of 24km. The field covers the Pisces-Cetus border. The galaxy near the 10/6 position is IC 1613.

Date	RA2000	Dec2000	RA1950	Dec1950	M	PA	E
10/01	1 07.81	+ 2 28.0	1 05.24	+ 2 12.0	13.8	4.0	170
10/06	1 04.12	+ 2 06.1	1 01.55	+ 1 50.0	13.7	2.1	175
10/11	1 00.34	+ 1 44.9	0 57.77	+ 1 28.7	13.7	2.0	175
10/16	0 56.60	+ 1 25.1	0 54.03	+ 1 08.9	13.8	3.7	170
10/21	0 53.03	+ 1 07.5	0 50.46	+ 0 51.2	14.0	5.8	165



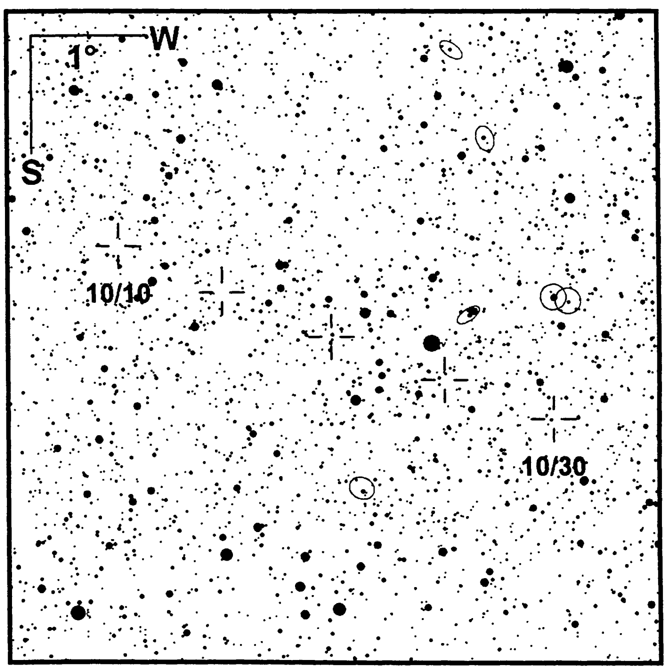
1501 Baade Walter Baade was the well-known German astronomer who worked for many years at Mt. Wilson and Palomar. A.A. Wachmann named this asteroid in Baade's honor after discovery in 1938 October. The cluster of galaxies at far left should make an interesting imaging diversion.

Date	RA2000	Dec2000	RA1950	Dec1950	M	PA	E
10/05	1 25.31	+ 8 56.1	1 22.69	+ 8 40.5	13.9	6.0	168
10/10	1 20.62	+ 9 02.6	1 18.00	+ 8 46.9	13.7	3.0	174
10/15	1 15.72	+ 9 07.9	1 13.10	+ 8 52.1	13.5	0.6	179
10/20	1 10.82	+ 9 12.6	1 08.21	+ 8 56.6	13.7	3.3	174
10/25	1 06.15	+ 9 17.3	1 03.54	+ 9 01.3	13.9	6.4	168



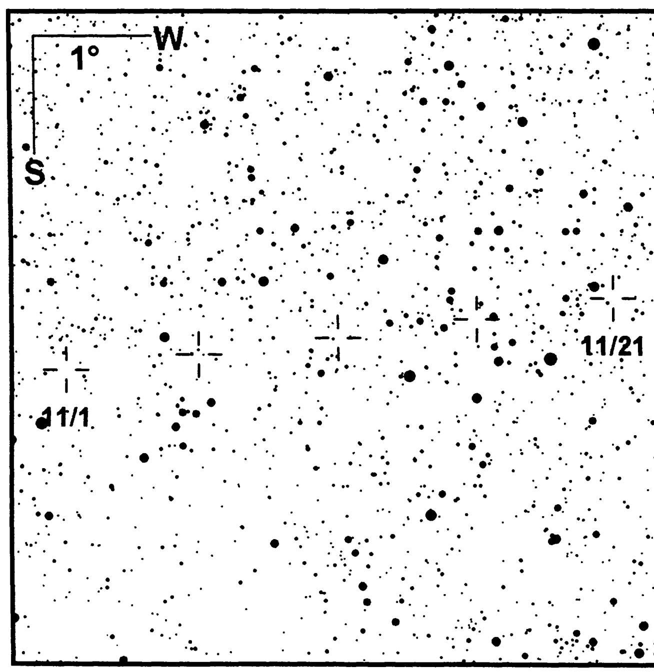
496 Gryphia Max Wolf discovered Gryphia in 1902 October and subsequently named it after poet Andreas Gryphius. This is one of many asteroids numbered 1000 or less that have no or poorly known lightcurve parameters. The field is Aries. NGC 927 is just below chart center.

Date	RA2000	Dec2000	RA1950	Dec1950	M	PA	E
10/20	2 35.45	+14 24.1	2 32.72	+14 11.1	14.1	6.9	165
10/25	2 30.79	+13 48.9	2 28.07	+13 35.6	13.9	4.1	171
10/30	2 25.85	+13 11.9	2 23.13	+12 58.4	13.7	1.2	177
11/04	2 20.83	+12 34.4	2 18.12	+12 20.7	13.7	2.0	176
11/09	2 15.93	+11 57.6	2 13.24	+11 43.7	13.9	4.9	170



1171 Rusthawelia The mouthful of a name comes from a 14th century Georgian poet: Schota Rusthaweli. S. Arend and G.N. Neujmin were given discovery credit, though they made their independent discoveries four days apart. Nu Piscium is the bright star just to the right of chart center.

Date	RA2000	Dec2000	RA1950	Dec1950	M	PA	E
10/10	1 52.13	+ 6 18.8	1 49.51	+ 6 04.0	13.4	5.0	167
10/15	1 48.55	+ 5 55.5	1 45.94	+ 5 40.6	13.3	3.0	172
10/20	1 44.81	+ 5 32.6	1 42.20	+ 5 17.5	13.2	1.9	175
10/25	1 41.01	+ 5 10.6	1 38.41	+ 4 55.5	13.2	2.9	172
10/30	1 37.31	+ 4 50.5	1 34.71	+ 4 35.2	13.4	4.9	167



1041 Asta The origin of the name for K. Reinmuth's 1925 March discovery is not absolutely certain, but it may be for Danish actor, Asta Nielsen. The IRAS diameter is about 36km for the unclassified asteroid, which you'll find meandering among the stars of Aries during November.

Date	RA2000	Dec2000	RA1950	Dec1950	M	PA	E
11/01	3 23.33	+13 05.4	3 20.57	+12 54.8	13.6	5.5	165
11/06	3 18.69	+13 13.7	3 15.93	+13 02.8	13.4	3.4	171
11/11	3 13.85	+13 22.5	3 11.10	+13 11.4	13.3	1.8	175
11/16	3 08.97	+13 31.9	3 06.21	+13 20.5	13.4	2.3	174
11/21	3 04.17	+13 42.2	3 01.41	+13 30.5	13.5	4.2	169

ASTEROID PHOTOMETRY USING A REMOTE, COMMERCIAL TELESCOPE: RESULTS FOR ASTEROIDS 808, 1225, AND 28753

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CCD images taken with the Tenagra Observatory 0.81-m telescope were used to plot lightcurves for three main-belt asteroids. A period of 4.993 ± 0.001 h was found for asteroid (28753) 2000 HA. A period of 5.505 ± 0.002 h was found for 1225 Ariane. Also, a period of 30.631 h was confirmed for 808 Merxia.

Over the years, my students and I (Richard Ditteon) have often tried to use Rose-Hulman's Oakley Observatory (MPC code 916) during the winter. But, from the middle of November until the middle of March the skies in Indiana are almost constantly cloudy. On those rare occasions when we do get a clear night, it is both very clear and very cold. Unfortunately for asteroid photometry work, it is necessary to get several clear nights in a short span of time to get adequate data for a light curve and we just can't count on that happening.

I've long wished for access to an observatory somewhere with clear skies during the winter. When Michael Schwartz, Director of Tenagra Observatories (MPC code 926), announced that he was selling time on his telescope in Arizona, I jumped at the opportunity.

The Tenagra telescope is an 0.81 m, F/7, Ritchey-Chretien telescope. The camera uses a SITe chip with 1024 by 1024 pixels. Pixel size is 24 μm, which gives a pixel field-of-view of 0.87 arcseconds. The camera is liquid cooled to -45 °C. All of the images I requested used a V filter (Schwartz, 2003).

To make observations, I simply e-mailed Paulo Holvorcem, Director of Minor Planet and Comet Studies, a list of targets with the exposure duration and frequency. I also specified a reference star field for use during processing. Paulo would send an e-mail back when the images were available for download via ftp. Tenagra also included master bias, dark, and flat-field frames with the data images. Initially, images made use of the full resolution of the camera, but the download times were very long. Later images were 2 x 2 binned, with no apparent affect on the results. Table I summarizes the observations made.

Standard image processing was done using the supplied bias, dark and flat-field frames and MaxIm DL. Photometry and lightcurves were constructed using MPO Canopus.

With one exception, targets were selected by consulting the "CALL" website (Warner, 2003). The exception was 761 Brendelia, which was targeted simply because it was close to 808 Merxia at the time the observations were made.

One of the first targets was (28753) 2000 HA. This turned out to be an easy target with a large amplitude and short period. Figure 1 is based on a period of 4.993 ± 0.001 h. (28753) 2000 HA was only observed for three nights.

The second target, 808 Merxia, also showed a large amplitude, but it was clear from the very first night that the period was much longer. As shown in Table I, data were collected on this asteroid on nine nights over a period of more than a month to get a complete light curve. Unfortunately, while we were collecting

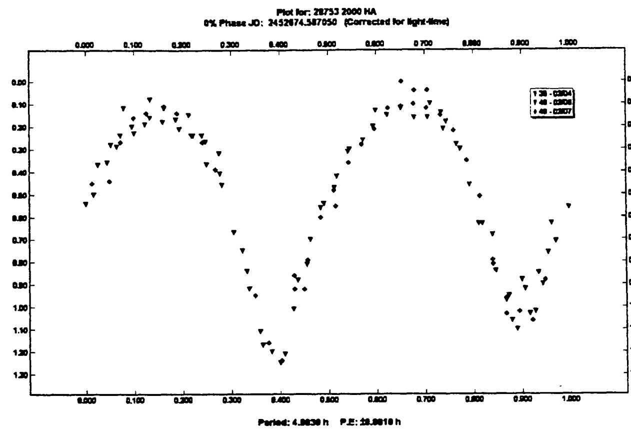

Figure 1. Lightcurve for (28753) 2000 HA based on a period of 4.993 ± 0.001 h.

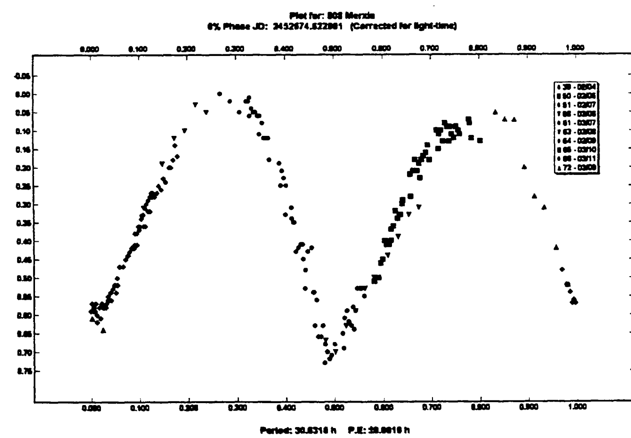

Figure 2. Lightcurve for 808 Merxia based on a period of 30.631h as derived by Bob Koff.

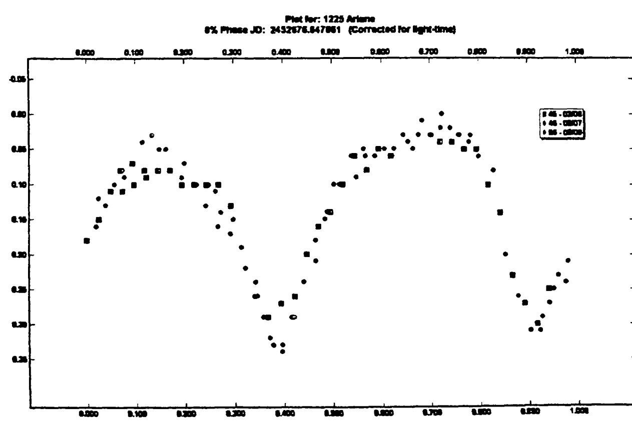

Figure 3. Lightcurve for 1225 Ariane based on a period of 5.505 ± 0.002 h.

data on 808 Merxia, I didn't think about checking the "CALL" website to see if anyone else was observing 808 Merxia. When I did finally check, I found that Bob Koff and Janel Brown of Antelope Hills Observatory were interested in 808 Merxia. Bob informed me (Koff, 2003) that they had determined a period of 30.631 h for this asteroid and had already submitted a paper to the Minor Planet Bulletin. Figure 2 is based on their period. I'm not convinced that our data alone would have been sufficient to determine this period, but it certainly fits their results well.

Another success was 1225 Ariane. After three nights of observation, a period of 5.505 ± 0.002 h was found (Figure 3).

We did not get clean light curves on the remaining three asteroids, 761 Brendelia, 5399 Awa, and 7887 1993 SU2. To conserve our limited funds, I stopped requesting observations on these asteroids as soon as it became clear that they were going to be difficult targets.

Acknowledgments

This research was supported in part by NASA through the American Astronomical Society's Small Research Grant Program. Matching funds were provided by Rose-Hulman Institute of Technology and Tenagra Observatories.

We also want to thank Michael Schwartz and Paulo Holvorcem for making remote observing with their telescope both possible and enjoyable.

References

Schwartz, M. (2003). "Tenagra Observatories, Ltd." http://www.tenagraobservatories.com/

Warner, B. D. (2003). "Potential Lightcurve Targets, 2003 January March." http://www.minorplanetobserver.com/astlc/targets_1Q_2003.htm

Koff, R. (2003). Personal communication.

Table I. Summary of observations.

Date	Asteroid	# images taken	used	exp (s)	bin
2003-02-04	808 Merxia	49	40	30	1x1
	28753 2000 HA	51	41	60	1x1
2003-02-06	808 Merxia	37	37	30	1x1
	1225 Ariane	37	37	60	1x1
	5399 Awa	37	37	60	1x1
	7887 1993 SU2	37	34	60	1x1
	28753 2000 HA	37	36	60	1x1
2003-02-07	808 Merxia	44	44	30	1x1
	1225 Ariane	40	39	60	1x1
	5399 Awa	44	37	60	1x1
	7887 1993 SU2	44	41	60	1x1
	28753 2000 HA	44	40	60	1x1
2003-02-09	808 Merxia	38	37	30	1x1
	1225 Ariane	39	39	60	1x1
	5399 Awa	39	39	60	1x1
	7887 1993 SU2	37	35	60	1x1
2003-03-06	761 Brendelia	11	9	90	2x2
	808 Merxia	11	11	30	2x2
	5399 Awa	11	11	80	2x2
2003-03-07	761 Brendelia	11	11	90	2x2
	808 Merxia	10	10	30	2x2
	5399 Awa	10	10	80	2x2
2003-03-08	808 Merxia	10	7	30	2x2
2003-03-09	808 Merxia	10	10	30	2x2
2003-03-10	808 Merxia	10	10	30	2x2
2003-03-11	808 Merxia	10	10	30	2x2

CCD PHOTOMETRY OF 934 THURINGIA

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The asteroid 934 Thuringia was observed for two nights using CCD Photometry during the month of October 1998. The period of rotation was 8.166 ± 0.006 hours, and the lightcurve had amplitude of 0.66 ± 0.03 magnitudes.

Observations

Observations of 934 Thuringia were made at the Paul Feder Observatory, which is located on the Buffalo site of Minnesota State Regional Science Center. This facility is located 15 miles east of Moorhead, Minnesota, and is adjacent to the Buffalo River State Park. Data was collected on the nights of October 24, 1998 and October 28, 1998.

The Paul Feder Observatory has a sixteen-inch computer controlled DFM telescope with an associated Photometrics Star 1 CCD camera system. The CCD camera was used to collect data. Seventy images were taken of 934 Thuringia over the two nights. Of these 69 were used in the analysis. The other was discarded because the exposure was taken too close to dawn.

The exposures were five minutes long, and were generally taken every fifteen minutes. A filter was not used when taking the exposures. Dark current and flat field corrections were made to the data. Five stars were selected as magnitude standards for each night. The magnitudes of the comparison stars were taken from the Guide 7 program (Hubble Guide Star Catalog). A least squares fit was done and the relation between the magnitudes and the log of the total count determined from this relationship. The slope of the least squares fit was typical (-2.6) on the first night, but about (–1.1) on the second of the two nights. We adopted a model for the second night which used the same slope as the first night. When that was done the light curves for the two nights matched well as they should. There was also an adjustment made in the form of an additive constant for the second night as the comparison stars were different for the two nights. See Figure 1. We feel that the problem was the magnitudes given for the comparison stars. A circular aperture of thirteen-pixel diameter was used and an equal sized region of nearby background was used for the background correction.

Results

Times were corrected for the time it takes the light to travel from the asteroid to the earth, and were taken at the center times for the image. Lightcurves were plotted for the two nights of usable data. Relative magnitudes from night to night were uncertain as different comparison stars were used. This was dealt with by

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using an additive constant for the second night magnitudes to bring them into agreement with the first. A single lightcurve for the two nights was then least squares fit with a Fourier series including 10 harmonics. The additive constant for night two and the period were adjusted so the fit minimized the sum of the squares of the residual. The resulting values were a period of 8.166 ± 0.006 hours. The additive constant for the second night was 0.000001 after the adjustment noted earlier. The standard deviation of the residuals was 0.024 magnitudes, which should be a good measure in the relative magnitudes.

A period of 8.166 ± 0.006 hours was found, and the second night was translated to fall on the first night of data to give the composite lightcurve shown in Figure 1. The time scale is given in phase. There are 2 maxima per period. The amplitude of the lightcurve is 0.66 ± 0.03 magnitudes. The absolute magnitudes given on the graph must be considered to be uncertain by ± 0.40 magnitudes, which the relative magnitudes are uncertain by about ± 0.024 magnitudes. The phase angles during observations varied between 14.26° and 12.73°.

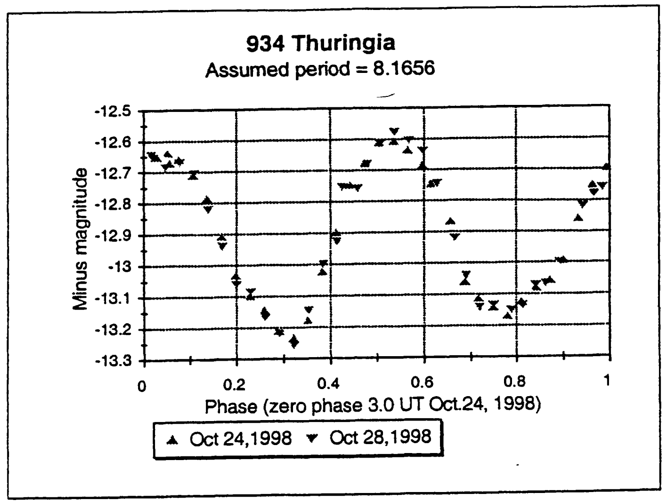

Figure 1. Lightcurve for 934 Thuringia plotted against rotational phase.

ASTEROID PHOTOMETRY OPPORTUNITIES OCTOBER-DECEMBER 2003

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This time we would like to point out some markers along the path from photometry to detailed asteroid shape and spin models. We cannot overemphasize the fact that all data are valuable (and will be used, most of them soon after the observations). In the Table below, we have marked with P/S some modeling targets for this quarter (the general alert list can be found at http://www.astro.helsinki.fi/~kaselain/observations.html). An efficient practice is to make a personal shortlist of these and email the list to Mikko (mikko.kaasalainen@astro.helsinki.fi) who can then advise which targets are currently the most promising ones.

At the moment, the easiest way to send the data is by email to Brian or Mikko (we hope to have a website for this purpose up and running later this year). There is no mandatory format, but we prefer a simple one, such as two columns (JD – observed mag), and a header stating the filter, or whether the data are unfiltered, which is quite acceptable and even preferable for small telescopes for maximal signal-to-noise ratio. The header should also indicate whether the epochs are light time corrected or the magnitudes distance corrected, and if yes, please let us know exactly how the correction was applied. Unmodified magnitudes and epochs are preferred. Any other info can be put in the header as well (observers, equipment, etc.). The header can contain a zero time/magnitude if convenient, and the epochs can also be given in hours (please be sure to mention this). Note that relative photometry is sufficient, no absolute calibration is required. Even for relative photometry it is always useful if magnitudes from successive nights can be tied together.

An efficient way of getting the most of one apparition is to obtain two lightcurves at the largest useful solar phase angles (to get a meaningful part of the period covered; more than one night is good for this), and one at a smaller phase just to get as long a stretch as possible. The high phase angles are important for reaching maximal shadowing effects (and light-scattering behavior different from the simple near-geometric mode near opposition). A dense lightcurve sequence contains a wealth of information and helps to rule out errors. Several tens of points per rotation period are the optimum. A good practice is to eliminate potential systematic errors by observing on two adjacent or at least nearby nights, particularly if the rotation period is not short enough for overlapping rotational phases during one night. In this way one can be sure that possible features in the lightcurve are really repeated and not artificial. If previously unpublished data are used in modeling, the data will be published in the corresponding scientific journal paper (typically in Icarus or Astronomy & Astrophysics) and the observer will be a co-author. Examples of such papers can be found at http://www.astro.helsinki.fi/~kaselain /asteroids.html.

We would also like to remind the observers that while "what do they look like" is the natural prime incentive for acquiring photometric data, the follow-up question "why do they look like that" is just as important. When we have a large number of asteroid shape and spin models at our disposal, we can draw important statistical inferences on the origins and evolution of this population. To mention just one example, Slivan et al. (2003, Icarus **162**, 285 – the paper can be found at the website above) used these methods to investigate the curious clustering of the spin states of small (20-40 km) members in the Koronis family. Recent results (Vokrouhlicky et al., to appear in Nature) suggest that such clustering could generally take place in this size region in outer main belt at low inclinations. If evidence for this is found in the overall asteroid population, we will have important new clues to dynamical evolution particularly due to the so-called YORP (Yarkovsky-Opik-Radzievskii-Paddack) thermal radiation pressure effect. So keep the data coming, please, you are doing important scientific work!

In the Table below, we present a list of suitable photometric targets for the October-December 2003 period. Most of the objects have been selected from a more extensive list prepared by Brian Warner. We selected objects with the predicted V<14 in opposition and unknown periods. Three bright NEAs, namely 1998 TU3, 4197 1982 TA, and 1996 GT have been also added. For 4197, the accurate synodic period of 3.5380 h has been derived during its 1996 apparition (Pravec et al., Planet. Space Sci., **48**, 59-65, 2000); new observations in different geometric conditions of this Autumn's apparition could allow a pole and shape model to be created. Periods of the other two NEAs are unknown, so interested observers should be prepared to work them intensively, or in coordination in a larger group. Observers interested in asteroids fainter than V=14 are encouraged to check the full list on the Brian Warner's CALL website (http://www.MinorPlanetObserver.com/astlc/default.htm).

Asteroid	Opp'n Date 2003	Opp'n V	Dec [deg]	Per [h]	Ampl	Rem.
1998 TU3	Oct 01	12.9	-28			
423 Diotima	Oct 05	11.7	- 8	4.77	0.06-0.18	P/S
707 Steina	Oct 07	13.9	+15			
804 Hispania	Oct 08	11.2	+18	7.42	0.19	P/S
2525 O'Steen	Oct 10	13.7	+ 2			
228 Agathe	Oct 10	13.5	+12			
4197 1982 TA	*Oct 13	13.6	+45	3.54	0.29-0.49	P/S
460 Scania	Oct 13	13.4	+ 8			
1501 Baade	Oct 14	13.5	+ 9			
1607 Mavis	Oct 19	13.2	-10			
1171 Rusthawelia	Oct 21	13.2	+ 6			
6386 1989 NK1	Oct 29	13.5	-10			
496 Gryphia	Nov 01	13.6	+13			
110 Lydia	Nov 03	11.1	+13	10.93	0.10-0.20	P/S
1041 Asta	Nov 13	13.3	+13			
130 Elektra	Nov 15	11.0	-17	5.22	0.19-0.58	P/S
1236 Thais	Nov 16	13.7	+21			
2617 Jiangxi	Nov 26	13.4	+16			
899 Jokaste	Nov 29	13.1	+24			
1996 GT	xDec 05	13.8	+21			
196 Philomela	Dec 08	10.8	+24	8.34	0.07-0.37	P/S
295 Theresia	Dec 17	12.8	+24			
4497 Taguchi	Dec 20	13.0	+22			
1127 Mimi	Dec 22	13.2	+ 5			
931 Whittemora	Dec 27	12.5	+18			
776 Berbericia	Dec 28	11.3	+32	7.67	0.13-0.21	P/S
3674 Erbisbuhl	Dec 29	13.3	+42			

*Date of BRIGHTEST given
xDate of MAXIMUM ELONGATION given

(Index continued from page 80)