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8 have never been observed before thus the data of these objects are the first in the literature. The majority showed well detectable light variations, exceeding 0.1. We have determined synodic periods for 756 Lilliana (9.136),1270 Datura (3.14), 1400 Tirela (13.136), 1503 Kuopio (9.1498), 3682 Welther (3.159), 7505 Furushu (4.14) and 11436 1969 QR (2.166), while uncertain period estimates were possible for 469 Argentina (12.13), 546 Herodias (10.14) and 1026 Ingrid (5.13). The shape of the lightcurves of 3682 Welther changed on a short time-scale and showed dimmings that might be attributed to eclipses in a binary system. For the remaining objects, only lower limits of the periods and amplitudes were concluded.

Keywords: Minor planets, asteroids – techniques: photometric

More than 200 years after the discovery of the first main-belt asteroid, 1 Ceres, highly automatized and sensitive surveys yielded an unimaginable number of newly discovered minor planets. As of writing this paper, the numbered asteroids exceed 65.000, while the total number of asteroid discoveries reached 220.0001. The process is still accelerating, and the observations arrived to the realm of the faintest, thus the smallest objects (e.g. Morbidelli et al. 2002). On the other hand, the huge number of objects causes a strong limitation in determining and understanding their physical properties. The overwhelming majority of these newly found objects goes without further notice and a large body of solar system objects is accumulating without known observable properties (e.g. rotation, shape). That is why a new field has emerged, to which even well-equipped amateur astronomers or small college observatories can make significant contribution: follow-up photometric observations of moderately faint and small asteroids (roughly from 12 mag to 17 mag). The study of asteroid spin rates (Binzel et al. 1989, Fulchignoni et al. 1995, Pravec & Harris 2000), requires a large amount of time-resolved photometric data for the determination of synodic periods (see Angeli et al. 2001 for a recent example), so that period determination of minor planet lightcurves is a potentially useful project for small and moderate-sized telescopes.

Our group has been working on a photometric project addressing rotational properties of main-belt and Near-Earth asteroids since 1998 (Sárneczky et al. 1999, Kiss et al. 1999, Szabó et al. 2001). The main aim of this project is to extend available data toward fainter and therefore smaller minor planets. Here we report the results of new observations of 23 minor planets obtained in the years 1999-2003.

# **Observations**

We carried out CCD observations on 39 nights from September, 1999 to February, 2003. Geometric data of the examined asteroids are listed in Table 1. The full log of observations is given in Table 2. Standard Johnson R filtered and unfiltered data were obtained using the 60/90/180 cm Schmidt-telescope of the Konkoly Observatory, equipped with a Photometrics AT200 CCD camera (1536×1024 KAF 1600 MCII coated CCD chip). The projected area is 29′ × 18′, which corresponds to an angular resolution of 1″1/pixel. The operational temperature of the camera was below –40 °C.

The bulk of the data was acquired with the 0.4m Cassegrain-telescope of the Szeged Observatory, which is located in the outskirts of the city of Szeged, though hampered by heavy light pollution. This telescope was used with a cooled SBIG ST–9E CCD camera ( $512\times512$   $20\mu$ m sized,  $2\times2$  binned pixels, angular resolution 1".4/pixel). The field of view was  $6'\times6'$ . Most single-filtered *R*-band and unfiltered observations were made with this instrument. The achieved photometric accuracy varies between 0.01–0.1 mag, depending on the brightness of the target and weather conditions, typically 0.0.05. The precision was estimated with the rms scatter of comparison *minus* check data.

<sup>&</sup>lt;sup>1</sup>http://cfa-www.harvard.edu/iau/lists/ArchiveStatistics.html

cause of the small-sized apertures of these telescopes we were limited to observe asteroids usually brighter than 17<sup>m</sup>0 with the 0.6m Schmidt and 15<sup>m</sup>0 with the 0.4m Cassegrain, respectively. Exposure times were constrained by two factors. Firstly, objects were not allowed to move more than the half of the full width at half maximum of the stellar profiles (varying from night to night). On the other hand, signal-to-noise ratio had to be kept at least 10. This parameter was estimated by comparing the peak pixel values with the sky background during the observations.

The CCD observations were reduced with standard routines in IRAF<sup>2</sup>, including flat-field correction utilizing sky-flat images taken during the evening or morning twilight. Differential magnitudes were calculated with quick aperture photometry (*qphot* and *phot* routines) using two or more nearby comparison stars of similar brightnesses, selected from the Guide Star Catalogue (GSC). Because of the trailed images of asteroids we did not attempt point spread function (PSF) photometry. In cases of larger observational scatter, we rejected the bad data points and performed a noise filtering of the data by taking median means of 3, 5, 7 or 9 lightcurve points.

Period determination was carried out by a self-developed code, which implemented a modified Phase Dispersion Minimization method (Stellingwerf 1978). The modification included the determination of the nightly photometric zero-points caused by the use of different comparison stars from night to night. The optimal period and magnitude shifts were determined by a grid-search method. Individual data are available electronically at the CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via

http://cdsweb.u-strasbg.fr/cgi\_bin/qcat?J/A+A/.../....

<sup>&</sup>lt;sup>2</sup>IRAF is distributed by the National Optical Astronomy Observatories, which are operated by the Association of Universities for Research in Astronomy, Inc., under cooperative agreement with the National Science Foundation.

In this section of our paper we present the simple and composite lightcurves of individual asteroids and discuss the obtained rotational periods.

- **469 Argentina**: 469 Argentina was the largest observed asteroid by us (with a diameter near 130 km). There are unequal maxima and noticeable near-linear branches in the first third of the presented unfiltered lightcurve. Hazy weather in the second half of the night greatly increased the scatter. Although the amplitude is fairly low, this asteroid showed well-detectable light variations ranging 0.14. The lightcurve is plotted in Fig. 1. The estimated synodic period is 12.15 The composite lightcurve with use of two first nights is presented in Fig. 2. Wang (2003) gives a period of approximately 3 hours with low reliability for this asteroid, although she did not present lightcurve.
- **531 Zerlina**: During our one night run 531 Zerlina showed apparently monotonic variation over about 4 hours, as can be seen in Fig. 3. The R-filtered range was over 0.17. This small minor planet probably has long rotation period. On the web site of Raoul Behrend (Observatoire de Genève) one can find data for this asteroid. The observer was Bernard Christophe. The given values are 2.1352 for the synodic period and 0.12 for the amplitude of the light variation, respectively. However, judged from the rotational phase diagram found there this applied period does not fit very well.
- **546 Herodias**: Although this mid-sized minor planet had well-detectable light variations, the small, 0.07 amplitude become indiscernible later, due to unfavourable observing circumstances. The best fit yielded a synodical period of 10.4, however this is a fairly uncertain value. The unfiltered lightcurves of 546 Herodias are presented in Fig. 4. We found no other lightcurve in the literature.
- **549 Jessonda**: The short single-night lightcurve of 549 Jessonda did not show a clear pattern of variation above the observational scatter. On the web site of Collaborative Asteroid Lightcurve Link, CALL)<sup>4</sup> one can find rotational parameters for this asteroid. Stephen M. Brincat and Robert Koff. made the observations listed on the CALL web site and Laurent Bernasconi on the Behrend web site, respectively. Based on 5 observing sessions the synodical period is 4<sup>h</sup>.5 and the amplitude is 0<sup>h</sup>.1, although they publish no lightcurve. The reliability of this data is low. Besides the detected slight amplitude our lightcurve shows data obtained amidst unfavourable weather conditions, therefore it is not inconsistent with the above mentioned results of CALL.
- **697 Galilea**: This asteroid was observed in December, 2001 by Sheridan (2002), who obtained a period of 16<sup>h</sup>.538±0<sup>h</sup>.002 and amplitude of 0<sup>m</sup>.28. Our one-night lightcurve of 1.7 hours duration shows a moderate linear trend consistent with this period and amplitude, as can be seen in Fig. 6.
- **756 Lilliana**: 756 Lilliana was the first target with the 0.4m Cassegrain telescope. The curve exhibits 0.56 R-filtered amplitude with asymmetric humps and unequal minima. Our four observing runs were grouped and the light curves acquired during different sessions showed

<sup>3</sup>http://obswww.unige.ch/~behrend/page2cou.html

<sup>4</sup>http://www.minorplanetobserver.com/DATA/submissions\_results.htm

Raoul Behrend one can find a different rotation period of 6.151 with an amplitude reaching 1.0. That result is based on data points obtained by several observers and stamped as temporary. The analysis of our data consisting of four observing nights gives the above mentioned synodic period as lowest-sigma case that is 9.361. When applying 6.151 as synodic period our data did not fit as composite lightcurve. However we cannot exclude the existence of different true value therefore further observation is recommended in order to solve this ambiguity. The composite lightcurve is shown in Fig. 7.

**894** Erda: Being a minor planet with ambiguous behaviour in our photometric programme, 894 Erda showed cyclic light variations with small amplitude during the observations, as plotted in Fig. 8. Interesting feature of the curve is the sudden sharp dimming visible near the center of the graph. One possible explanation of this phenomenon is the probable binarity nature of 894 Erda. Assuming this, the fading was caused by a hypothetical secondary component. Unfortunately, we did not succeed in observing other eclipses during the following nights.

In addition to our results, 894 Erda was observed during five nights between 15th and 19th of July, 2001 from Santana Observatory, California, USA (Stephens 2002). However those observing sessions are fairly close in time to our presented ones, no dimming events were observed. This author has derived a rotational period of  $4^h.69\pm0^h.01$ . The observed  $0^m.08$  amplitude is consistent with our data. Our composite lightcurve from three nights data with applying  $4^h.69$  as rotational period is shown in Fig. 9.

**1026 Ingrid**: This very small asteroid was the faintest investigated minor planet by us and a serendipitouos by-product while observing 2448 Sholokhov: the two previously photometrically uninvestigated asteroids were in the same CCD frames on February 18th, 2003. The lightcurve of this  $17^{\text{m}}$ 0 object presented in Fig. 10 implies fast rotation. Even though the single lightcurve covers less than the full rotation cycle, the time between the two minima is almost certainly very close to half the full rotation period, because the amplitude is so large,  $>0^{\text{m}}$ 5. Thus, the full period is about  $5^{\text{h}}.3\pm0^{\text{h}}.3$ .

**1108 Demeter**: This mid-sized asteroid exhibited very ambiguous light variations on three nights. One of the lightcurves is presented in Fig. 11. The R-filtered amplitude is  $0^m$ 15. The bizarre lightcurve is also noticed on the web site of Behrend. The complex light variation of this asteroid is hard to be explained. A possibility can be the fast precession of the rotation axis or binary nature.

In addition to the observations of this asteroid, we have discovered the light variability of GSC 2127-0056, which served as a comparison star on August 1, 2001. One night of data suggests the possible eclipsing binary nature of the star (Székely, in preparation).

Besides our observations, 151 data points were acquired in Santana Observatory during seven runs between 9th and 29th of July, 2001 (Stephens 2002), resulting in a synodical period of 9.70±0.01. The unfiltered amplitude was 0.717, in good agreement with our results. The published lightcurve is fairly normal with no anomalous features. When applying 9.70 as synodical period our composite lightcurve does not fit well as can be seen in Fig. 12.

**1170 Siva**: The lightcurve of 1170 Siva is plotted in Fig. 13. The complex lightcurve shape reveals the presence of two unequal extrema, however, the observing time-span is rather short and the R-filtered amplitude is only 0.0.07. Based on this lightcurve the synodic period may

only 0.04. The reliability of that period determination is low. It can be noted that the ratio of the two mentioned period is almost exactly 2/3. Further observation is recommended for this object.

**1270 Datura**: The asteroid was observed during two nights in 1990 and 1991 (Wisniewski et al. 1997). The detected amplitude was  $0^m$ . 41 and the derived synodic period was  $3^h$ . 2± $0^h$ . 1. The latter run covered only a fraction of the rotational phase. This, and the two months separation between of the two datasets resulted in a large uncertaintity of the rotational period. Our observations suggest an amplitude over  $0^m$ . 6 and  $3^h$ . 4± $0^h$ . 3 synodical period, respectively. However the two period are consistent within uncertainties. The R-filtered lightcurve is presented in Fig. 14. The plot shows humps with different maxima and minima.

**1286 Banachiewicza**: Our one short lightcurve of 1286 Banachiewicza, covers a minimum and shows an amplitude of variation greater than 0.4. Behrend lists a period of 8.631 for the period and an amplitude of 0.54. Our short dataset of only 1.2 duration is consistent with these parameters.

**1400 Tirela**: The phase diagram of 1400 Tirela using data of four observing nights is plotted in Fig. 16. It is worth mentioning that this composite lightcurve does not cover fully the rotational period. There are noticeable irregularities on both branches likely to be caused by surface structures. The amplitude of variations is 0.55. The rotational period is  $13.356\pm0.07$ . On the web site of Behrend is a single-night lightcurve covering less than a full cycle with amplitude of 0.3. Behrend suggests a period of  $10.3\pm5.8$ , which spans a range consistent with our derived period. In spite of the fact that our result has higher reliability, we cannot exclude the possibility of another period. Further observations are recommended for this small asteroid.

**1503 Kuopio**: The composite lightcurve of 1503 Kuopio plotted in Fig. 17 shows asymmetric humps with strikingly even branches and sharp minima. Individual R-filtered lightcurves have low scatter and exhibit an amplitude of 0.77. The obtained synodic period is 9.98±0.03. Behrend gives 9.958 as synodic period calculated from fully covered rotational phase thus the period reliability is rather high. The observed amplitude varied between 0.69 and 1.601.

**1506 Xosa**: One of the obtained lightcurves of 1506 Xosa is given in Fig. 18. The plot displays light variations with R-filtered amplitude of 0.22. Though there are signs of periodicity shown here, our data were insufficient to calculate rotational period.

Robinson & Warner (2002) also observed this asteroid, concluding that the synodical period was  $5^h.9\pm0^h.01$ . Their observations revealed the amplitude to be about  $0^m.28$ , which agrees with our result. Our noise hampered datasets composited with  $5^h.9$  as synodical period does not fit well as can be seen in Fig. 19.

**1695 Walbeck**: The lightcurve of 1695 Walbeck is shown in Fig. 20. We found ambiguous light variations during 3 observing sessions with amplitude exceeding 0.34. In spite of the large amplitude, we were not able to determine the period of variations, however it can be implied around 5.3. There is no other lightcurve in the literature.

**2448 Sholokhov**: Spanning just 3<sup>h</sup>.6, the lightcurve of 2448 Sholokhov exhibited steadily increasing brightness. Unfiltered amplitude is above 0<sup>m</sup>.25, and the rotation period appears to be longer than 14 hours, probably in the range 20-24 hours. We found no other lightcurve in the literature.

variations. The curve plotted in Fig. 22 exhibits sharp dimmings with different minima and unequal maxima. The observed unfiltered amplitude was 0.35. The shape of the lightcurve showed noticeable changes in merely a two-days long interval, as can be seen in the presented composite lightcurves in Fig. 23 (especially between 0.8 and 1.0 phase in the bottom panel).

This is similar what has been found by Stephens et al. (2002). In the course of a collaborative observing campaign (Collaborative Asteroid Lightcurve Link, CALL)<sup>5</sup>, they acquired data for this minor planet on 36 nights in the autumn of 2001. Their run was initiated by an unexpected brightness variation attributed to the probable binarity of the asteroid. However, after a detailed analysis of the extensive dataset, the authors assigned the intensity drop (accompanied with two other suspicious events) to an artifact of the reduction procedure, i.e. the asteroid moved close to relatively bright stars that likely affected the background level determination. We have checked this possibility for our observations and found that there was indeed a 7 mag star just 4 arcminutes from the asteroid on Oct. 8, 2001, when the lightcurve suggested a rapid brightening. Since we have used the Schmidt telescope of the Konkoly Observatory, it might be possible that some reflection within the telescope caused such an artifact as that of Stephens et al. (2002). Nevertheless, we cannot firmly exclude the possibility of real intrinsic changes of the asteroid itself. The derived synodic period is 3\(^h\).597\(^h\).001 and it is in agreement with 3\(^h\).597\(^h\).0003 as given by Stephens et al. (2002).

**5349 Paulharris**: Taken under very unfavourable weather conditions, the R-filtered photometric data of the small-sized 5349 Paulharris showed only a slight monotonic increase in brightness of about 0.06 in 0.7. If the trend in brightness is real, it implies a period of greater than 3 hours. Due to this meagre and noise hampered dataset we cannot establish firm rotational parameters. This is the first published lightcurve for this minor planet.

**5690 1992 EU**: This asteroid was observed on two nights in the autumn of 2000. The lightcurves resulted in from the sessions are given in Fig. 25. The data suggest an amplitude of 0.4, while no firm conclusion is drawn on the period although based on the lightcurve it can be around 5 hours. The is fit is obtained with synodical period as 6.457 as can be seen in Fig. 26. There is no other lightcurve in the literature.

**6510 Tarry**: The lightcurve of 6510 Tarry (Fig. 27) shows one and a half different humps with unequal maxima. We were not able to fully track the second rising-branch, therefore, it is possible that the amplitude is larger than the observed one (0.54 in R). The synodic period can be quite close to 7 hours. This is the first published lightcurve for this small asteroid.

**7505 Furushu**: This small asteroid was observed under its temporary designation as 1997 AM<sub>2</sub> in autumn of 2000. The composite phase diagram for 7505 Furushu is given in Fig. 28. This minor planet showed high-amplitude variations exceeding  $0^{\text{m}}$ 75. The computed synodic period is  $4^{\text{h}}.14\pm0^{\text{h}}.035$ . There are data in the literature referring to synodical period and amplitude of this small asteroid (Stephens 2001). Our data are fully consistent with their derived rotational period,  $4^{\text{h}}.14\pm0^{\text{h}}.02$  and the observed amplitude,  $0^{\text{m}}.74$ , respectively.

11436 1969 QR: This small-sized and faint minor planet had fairly detectable amplitude of  $0^{m}$ 27. The computed phase diagram given in Fig. 29. The synodical period is  $2^{h}$ .65± $0^{h}$ 24. The results are affected by the fact that the exposure times were 3 to 5 minutes because of

<sup>&</sup>lt;sup>5</sup>http://www.minorplanetobserver.com/astlc/default.htm

of short period and long exposures may cause the decreasing of amplitude due to averaging of brightness during exposing. There is no other lightcurve in the literature referring to this asteroid.

# **Summary**

We presented CCD R-filtered and unfiltered photometric data for 23 small and intermediate-sized main-belt asteroids. 8 of them were not investigated previously. 17 minor planets exhibited detectable light variations. With composite lightcurves, we derived synodical periods for seven objects. In case of three minor planets we estimated the rotational period. For the rest only lower limits of rotational parameters can be concluded. In two cases (894 Erda, 3682 Welther), we have found rapid brightness changes superimposed on the much slower rotationally induced variations, which might be attributed to possible binarity, though the presented datasets are far shorter than that is required for drawing firm conclusions on such an interesting issue. Judged from the plot of the synodical period versus asteroid size, it is clearly discernible that smaller asteroids tend to have shorter rotational periods. However, it is rather difficult to say something conclusive about this topic based on this insufficiently large number of target objects. The photometric properties of the studies minor planets are summarized in Table 3.

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The lightcurve of 469 Argentina.

The composite lightcurve of 469 Argentina.

The lightcurve of 531 Zerlina.

The lightcurves of 546 Herodias.

The lightcurve of 549 Jessonda.

The lightcurve of 697 Galilea.

The composite lightcurve of 756 Lilliana.

The lightcurve of 894 Erda.

The composite lightcurve of 894 Erda.

The lightcurve of 1026 Ingrid.

The lightcurve of 1108 Demeter.

The composite lightcurve of 1108 Demeter.

The lightcurve of 1170 Siva.

The lightcurve of 1270 Datura.

The lightcurve of 1286 Banachiewicza.

The composite lightcurve of 1400 Tirela.

The composite lightcurve of 1503 Kuopio.

The lightcurve of 1506 Xosa.

The composite lightcurve of 1506 Xosa.

The lightcurve of 1695 Walbeck.

The lightcurve of 2448 Sholokhov.

The lightcurve of 3682 Welther.

The composite lightcurve of 3682 Welther.

The lightcurve of 5349 Paulharris.

The lightcurve of 5690 1992 EU.

The composite lightcurve of 5690 1992 EU.

The lightcurve of 6510 Tarry.

The composite lightcurve of 7505 Furushu.

The composite lightcurve of 11436 1969 QR.

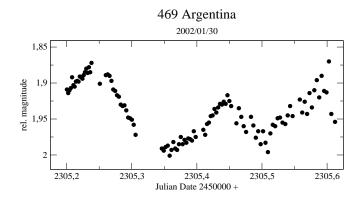


Figure 1: The lightcurve of 469 Argentina.

# 1,85 1,85 2001/01/28 + 2001/01/30 1,95 0,2 0,4 0,6 rotational phase

Figure 2: The composite lightcurve of 469 Argentina.

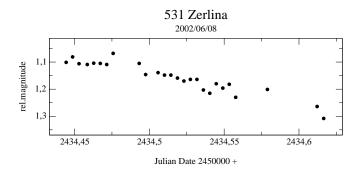


Figure 3: The lightcurve of 531 Zerlina.

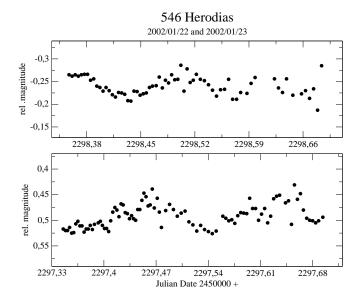


Figure 4: The lightcurves of 546 Herodias.

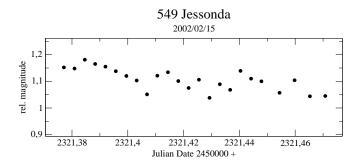


Figure 5: The lightcurve of 549 Jessonda.

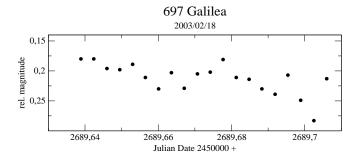


Figure 6: The lightcurve of 697 Galilea.

## 756 Lilliana composite lightcurve

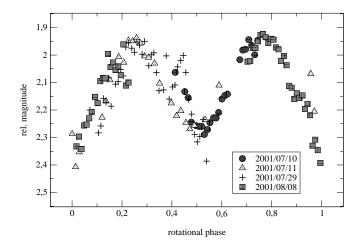


Figure 7: The composite lightcurve of 756 Lilliana.

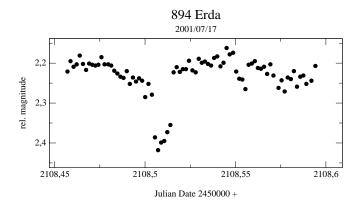


Figure 8: The lightcurve of 894 Erda.

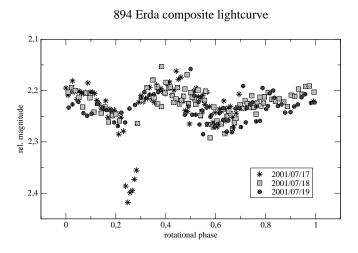


Figure 9: The composite lightcurve of 894 Erda.

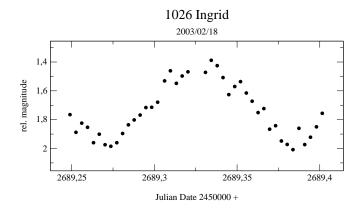


Figure 10: The lightcurve of 1026 Ingrid.

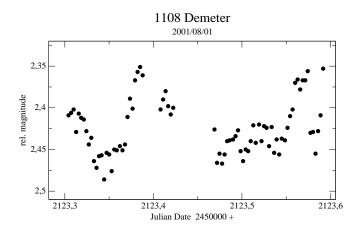


Figure 11: The lightcurve of 1108 Demeter.

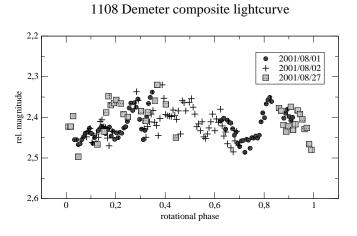


Figure 12: The composite lightcurve of 1108 Demeter.

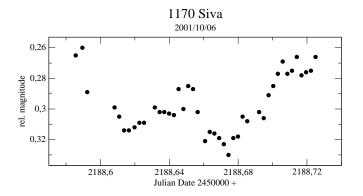


Figure 13: The lightcurve of 1170 Siva.

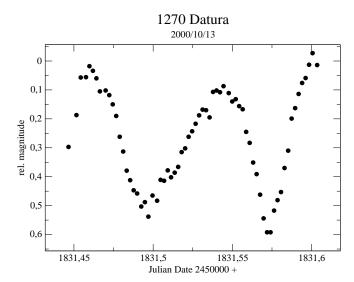


Figure 14: The lightcurve of 1270 Datura.

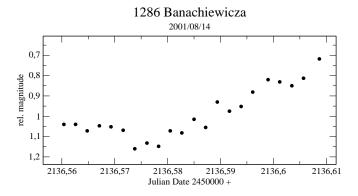


Figure 15: The lightcurve of 1286 Banachiewicza.

### 1400 Tirela composite lightcurve

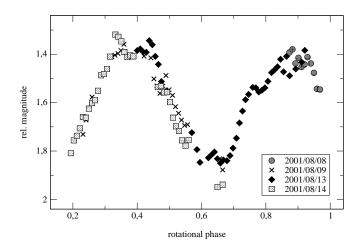


Figure 16: The composite lightcurve of 1400 Tirela.

# 1503 Kuopio composite lightcurve

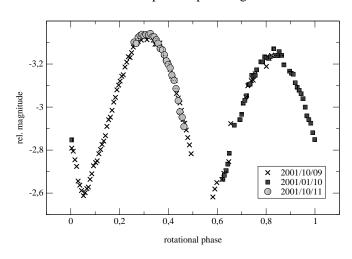


Figure 17: The composite lightcurve of 1503 Kuopio.

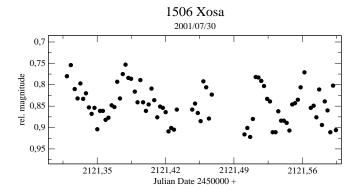


Figure 18: The lightcurve of 1506 Xosa.

# 1506 Xosa composite lightcurve

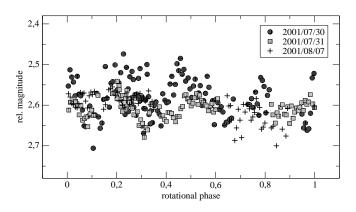


Figure 19: The composite lightcurve of 1506 Xosa.

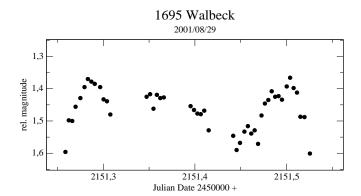


Figure 20: The lightcurve of 1695 Walbeck.

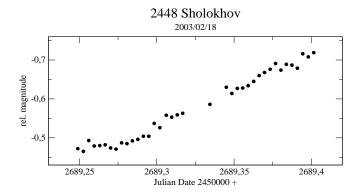


Figure 21: The lightcurve of 2448 Sholokhov.

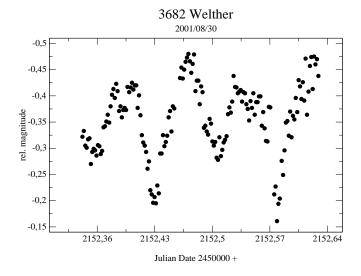


Figure 22: The lightcurve of 3682 Welther.

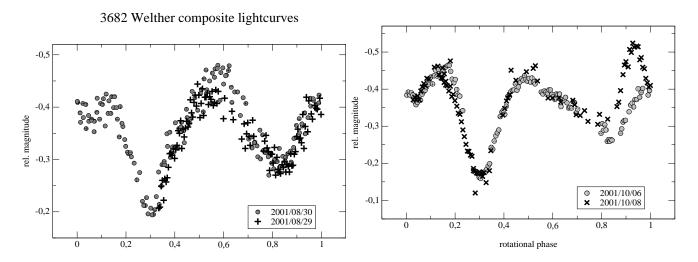


Figure 23: The composite lightcurve of 3682 Welther.

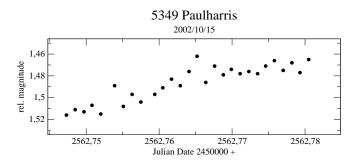


Figure 24: The lightcurve of 5349 Paulharris.

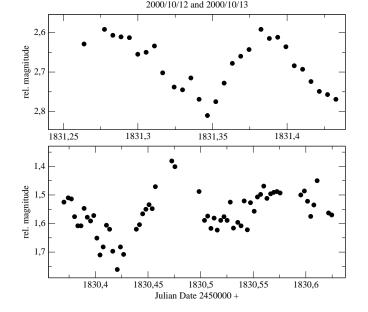


Figure 25: The lightcurve of 5690 1992 EU.

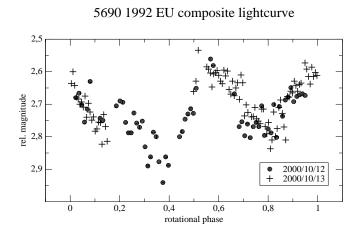


Figure 26: The composite lightcurve of 5690 1992 EU.

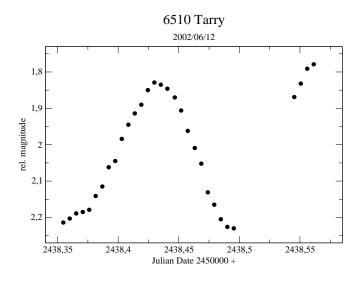


Figure 27: The lightcurve of 6510 Tarry.

# 7505 Furushu composite lightcurve

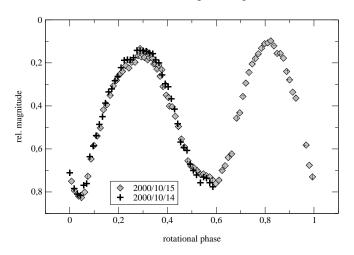


Figure 28: The composite lightcurve of 7505 Furushu

# 11436 1969 QR composite lightcurve

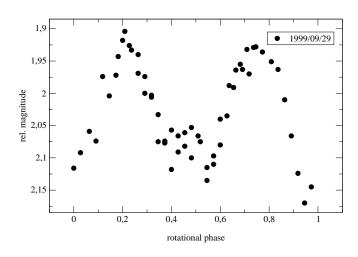


Figure 29: The composite lightcurve of 11436 1969 QR.

Table 1: Aspect data for the mid-time of observations. Abbreviations: r=heliocentric distance [AU],  $\Delta$ =geocentric distance [AU],  $\alpha$ =solar phase [deg],  $\lambda$ =geocentric longitude [deg],  $\beta$ =geocentric latitude [deg]

Asteroid	V	Date <sup>a</sup>	r	Δ	α	λ	β
469 Argentina	12 <sup>m</sup> 9	2002/01/30.91	2.857	1.922	7.69	110.88	10.51
531 Zerlina	15.m4	2002/06/08.87	2.232	1.445	20.50	105.07	50.46
546 Herodias	13 <sup>m</sup> 2	2002/01/23.04	2.320	1.449	14.40	95.30	24.00
549 Jessonda	13 <sup>m</sup> 6	2002/02/16.04	2.115	1.169	10.45	124.65	-2.84
697 Galilea	14 <sup>m</sup> 4	2003/02/18.08	3.287	2.325	4.72	149.30	15.69
756 Lilliana	14 <sup>m</sup> 2	2001/07/12.08	2.950	2.042	10.74	86.17	28.64
894 Erda	13 <sup>m</sup> 4	2001/07/18.91	2.741	1.771	7.54	52.18	18.37
1026 Ingrid	17 <u>m</u> 0	2003/02/18.91	2.662	1.694	5.43	136.14	5.06
1108 Demeter	14 <sup>m</sup> 3	2001/02/08.83	1.804	0.974	25.51	66.02	47.62
1170 Siva	13 <sup>m</sup> 5	2001/07/10.04	1.744	0.754	7.04	14.76	12.32
1270 Datura	15.m8	2000/10/13.91	1.955	1.342	28.17	88.23	-5.37
1286 Banachiewicza	14. <sup>m</sup> 7	2001/08/15.04	2.756	1.760	4.71	36.96	14.14
1400 Tirela	15 <sup>m</sup> 0	2001/08/09.91	2.377	1.465	13.64	65.32	25.36
1503 Kuopio	14 <sup>m</sup> 5	2001/10/10.91	2.738	1.769	6.21	11.30	16.13
1506 Xosa	13 <sup>m</sup> 8	2001/07/31.91	1.936	0.971	13.14	61.44	23.93
1695 Walbeck	15 <sup>m</sup> 3	2001/08/29.79	2.071	1.195	18.30	52.75	28.97
2448 Sholokhov	14 <sup>m</sup> 0	2003/02/18.91	2.612	1.644	5.54	136.21	5.05
3682 Welther	13. <sup>m</sup> 7	2001/08/29.91	1.930	0.988	14.97	10.93	27.32
3682 Welther	13 <sup>m</sup> 9	2001/10/06.91	1.888	1.003	20.05	17.01	25.19
5349 Paulharris	14 <sup>m</sup> 2	2002/10/16.08	1.721	0.775	15.60	27.72	27.14
5690 1992 EU	15 <sup>m</sup> 6	2000/10/12.95	1.776	1.218	32.77	89.85	36.29
6510 Tarry	15.m3	2002/06/12.95	1.853	1.010	23.68	73.61	42.14
7505 Furushu	14 <sup>m</sup> 3	2000/10/14.95	1.719	0.968	29.49	79.58	-6.77
11436 1969 QR	16.º9	1999/09/29.87	2.055	1.077	8.231	5.98	12.20

<sup>&</sup>lt;sup>a</sup> mid-time of observation

Table 2: The log of the observations

Asteroid	Date	Telescope*	Filter	Exp. time [sec]	Length [h]
469 Argentina	2002/01/28	a	X	40	6.0
109 mgentma	2002/01/20	a	X	40	9.8
	2002/02/01	a	X	40	7.4
531 Zerlina	2002/06/08	b	R	90	4.3
546 Herodias	2002/01/22	a	X	45	8.6
340 Herodias	2002/01/22	a	X	45	8.2
549 Jessonda	2002/01/25	a	X	30	2.2
697 Galilea	2003/02/18	b	R	90	1.7
756 Lilliana	2003/02/10	a	R	45	3.1
750 Limana	2001/07/10	a	R	45	6.5
	2001/07/11	a	R	45	4.8
	2001/07/23	a	R	45	5.0
894 Erda	2001/06/08	a	R	45	3.4
0)4 Liua	2001/07/17	a	R	45	7.0
	2001/07/19	a	R	45	6.5
1026 Ingrid	2001/07/19	b	X	90	3.6
1108 Demeter	2003/02/18		R	45	7.2
1106 Dellietei	2001/08/01	a	R	45	6.0
	2001/08/02	a a	R	45	6.0
1170 Siva	2001/06/27	b	R	60	3.6
1270 Datura	2001/10/00	b	R	60	3.6
1286 Banachiewicza	2000/10/13		X	40	1.2
1400 Tirela	2001/08/14	a	X		1.4
1400 Tireta	2001/08/08	a	X	45 45	7.0
	2001/08/09	a	X	45 45	7.0
	2001/08/13	a	X	45 45	6.5
1502 V		a b			
1503 Kuopio	2001/10/09 2001/10/10		R R	60 60	8.4 3.8
	2001/10/10	b b	R	60 60	2.2
1506 Xosa	2001/10/11		R	45	6.7
1300 A0sa	2001/07/30	a	R		
	2001/07/31	a	R	45 45	6.7 7.4
1695 Walbeck	2001/08/07	a	X	60	6.5
1095 Walveck	2001/08/28	a	X	60 60	6.5
	2001/08/29	a	X	60	1.7
2448 Sholokhov	2001/08/30	a b	X	90	3.6
3682 Welther	2003/02/18	-	X	60	2.4
3002 Weither	2001/08/29	a	X	60 60	7.0
	2001/08/30	a b	R	60 60	3.1
	2001/10/08	b	R	60 60	4.6
5349 Paulharris		b	R	90	0.7
5690 1992 EU	2002/10/15 2000/10/12	b		60	6.2
JUJU 1774 EU	2000/10/12	b b	R R	60 60	4.3
6510 Tarry	2000/10/13	b	R	120	5.3
U					
7505 Furushu	2000/10/14	b b	R	60 60	2.4
11/26 1060 OD	2000/10/15	b	R X	60	4.8
11436 1969 QR	1999/09/29	b	Λ	240	4.1

<sup>\*</sup>Used telescopes: (a) 0.4m Cassegrain (b) 0.6m Schmidt

Asteroid	Diameter [km]	P <sub>syn</sub> [h]	ampl.	P <sub>syn</sub> [h]	ampl.	Ref.
		this work	this work			
469 Argentina	129 ±3	12.3?	0º.14	3?	_	(a)
531 Zerlina	17.8±3.7	>3.84	>0 <sup>m</sup> 17	2.352	0º.12	(b)
546 Herodias	69.7±1.5	10.4?	0º:07			
549 Jessonda	20.5±2.1	_	>0 <sup>m</sup> 15	4.5	0º 1	(c)
697 Galilea	82.5±1.7	_	<0 <sup>m</sup> 1	$16.538 \pm 0.002$	0.º28	(d)
756 Lilliana	78.3±1.5	9.361±0.002	0 <sup>m</sup> 56	6.151	0 <u>.</u> .9	(b)
894 Erda	40.8±1.6	_	<0 <sup>m</sup> 1	$4.69 \pm 0.01$	0°.08	(e)
1026 Ingrid	14.4	5.3?	>0.º5			
1108 Demeter	27.4	_	0.m 15	$9.70 \pm 0.01$	0.º17	(e)
1170 Siva	12.3±0.6	3.5?	<0 <sup>m</sup> 1	5.215	0°.04	(b)
1270 Datura	9.5±0.5	$3.4 \pm 0.3$	0º.61	$3.2 \pm 0.1$	0.º41	(f)
1286 Banachiewicza	33.8±4.6	>1.2	>0.º4	8.631	0º.54	(b)
1400 Tirela	33.0	13.356±0.007	0 <sup>m</sup> 55	$10.3 \pm 5.8$	0 <sup>m</sup> 3	(b)
1503 Kuopio	23.0±1.7	9.98±0.03	0º.77	9.958	0.º69-1.º01	(b)
1506 Xosa	30.1	_	0°.22	$5.9 \pm 0.01$	0.º28	(g)
1695 Walbeck	21.0±0.7	5.3?	0°.34			
2448 Sholokhov	33.2±3.5	>14	>0 <sup>m</sup> 25			
3682 Welther	33.0	3.597±0.001	0.m35	3.5973±0.0003	0.º31	(h)
5349 Paulharris	19.0	>3	>0°.06			
5690 1992 EU	20.8	5?	>0 <sup>m</sup> 25			
6510 Tarry	18.2	7?	0.º54			
7505 Furushu	27.5	4.14±0.035	0.º75	$4.14\pm0.02$	0°.74	(i)
11436 1969 QR	7.8	$2.65 \pm 0.24$	0.º27			

References: (a) Wang (2003); (b) Behrend web site; (c) CALL web site; (d) Sheridan (2002); (e) Stephens (2002); (f) Wisniewski et al. (1997); (g) Robinson & Warner (2002); (h) Stephens et al. (2002); (i) Stephens (2001).