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JOINT LIGHTCURVE OBSERVATIONS OF 10 NEAR-EARTH ASTEROIDS FROM MODRA AND ONDŘEJOV

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Abstract. The effort in photometry of near-Earth asteroids (NEAs) at Modra Observatory has been enhanced following a recent collaboration with Ondřejov Observatory. We present a part of our collaborative work on measuring rotation lightcurve data for 10 NEAs. We derived following synodic periods P and amplitudes of their composite lightcurves: (3553), 3.1944 h, 0.08 mag; (22753), 10.24 h, 0.11 mag; (31669), 5.807 h, 0.07–0.27 mag; (40267), 4.9568 h, 1.01–1.11 mag; (66146), 2.3774 h, 0.12–0.15 mag; (88188), 2.6906 h, 0.06 mag; (103067), 9.489 h, 0.49 mag; 2001 CB_{21}, 3.302 h, 0.19 mag; 2004 LJ_1, 2.7247 h, 0.17–0.59 mag; 2004 XO_{14}, 8.417 h, 0.19–0.25 mag. While the derived periods are unique (the reliability code $U=3$) for most of the objects, those of (3553), (22753) and 2001 CB_{21} are somewhat less reliable ($U=2$). We checked all the $U=3$ data for deviations from strict periodicity, but found no significant attenuation that would indicate the presence of a satellite. Absolute magnitudes in Cousins R band (H_R) were derived for (3553), 16.05; (40267), 15.59; (88188), 16.04; 2004 XO_{14}, 15.84; errors of the first three H_R estimates are 0.20 mag, but that of 2004 XO_{14} is <0.10 mag.

Keywords: Minor planets, asteroids, near-Earth asteroids, photometry

1. Introduction

After the initial efforts in asteroid photometry at Modra Observatory (Galád et al., 2004, and references therein), the collaboration with Ondřejov Observatory became a natural process that brought a higher efficiency to our work. The observatories are about 250 km distant; they have similar weather patterns and have used similar instruments:

– 0.6-m reflector, f/5.5, AP8p CCD camera since 2004 (ST8 before), relative photometry, mostly without filter in Modra,

– 0.65-m reflector, f/3.6, AP7p CCD camera since May 2001 (ST8 before), absolute photometry in Cousins R band in Ondřejov.

The instruments enabled us to study objects up to $V \sim 16.5$ with accuracy of 0.03 mag or better. The telescope in Modra suffered from poor guiding that allowed short integration times of up to 1 min only. We present results of a part of our collaborative work – rotation lightcurve data for 10 near-Earth asteroids (NEAs). Many other collaborative observations conducted with Ondřejov and other observatories have been obtained, and they were published in, e.g., Pravec et al. (2005), Higgins et al. (2006), Warner et al. (2006), Pray et al. (2006), Pravec et al. (2006), or they are prepared for future publications (see, e.g., prepublished results summary at *http://www.asu.cas.cz/~ppravec/newres.htm*).

2. Observations and Data Analysis

Standard calibration with dark frames and flatfield frames was applied to all images. Differential aperture photometry technique was applied. Data from Modra were processed using MaxIm DL software. The observational and reduction technique at Ondřejov was described in Pravec et al. (1998); only the ST8 CCD-camera was replaced by an AP7p one. Those data were absolutely calibrated in the Johnson–Cousins systems using Landolt (1992) standard stars to a level of 0.01–0.02 mag. Data from Modra were relative. The lightcurve analysis was performed with the ALC software developed by P. Pravec. All data presented in figures in the following section were light-time corrected.

3. Results for Individual NEAs

Table I contains basic aspect data for the studied NEAs. None of them had a synodic rotation period P published prior to our observations. In addition to P, we mention the reliability code U (Harris and Young, 1983) and the maximum synodic-sidereal period difference ΔP (Pravec et al., 2005) throughout the text. The latter is estimated from the motion of the phase angle bisector, and it is meant as the absolute value of the difference.

3.1. (3553) MERA

Photometrically, the most favourable conditions for this asteroid moving in an Amor-type orbit occurred during the discovery apparition in 1985 and then in 2004. In both apparitions, the asteroid's brightness was fainter than

TABLE I

The aspect data for 10 asteroids observed at Modra (M) and Ondřejov (O); *d* and *r* are the geocentric and heliocentric distances, respectively, α is the phase angle, L_{PAB} and B_{PAB} are the ecliptic coordinates of the phase angle bisector in J2000. The predicted brightness in the *V* band according to the MPC is in the last column

Time	*d* [AU]	*r* [AU]	α [°]	L_{PAB} [°]	B_{PAB} [°]	M/O	*V*
(3553) Mera							
2004 05 20.0	0.3980	1.3957	13.10	239.75	11.66	M	16.0
2004 05 20.9	0.4036	1.3997	13.76	239.65	12.31	M	16.1
2004 05 27.9	0.4556	1.4312	19.57	239.15	16.81	O	16.6
2004 05 30.0	0.4737	1.4406	21.24	239.10	17.96	M	16.7
2004 05 31.0	0.4826	1.4452	22.00	239.10	18.48	(M)	16.8
(22753) 1998 WT							
2002 10 27.8	0.1649	1.0844	52.93	02.56	13.47	(O)	15.9
2002 10 28.8	0.1744	1.0942	50.92	04.17	12.84	(O)	16.0
2002 11 06.8	0.2721	1.1792	41.30	14.33	9.16	O	16.8
2005 02 09.0	0.2876	1.2615	15.12	151.92	−2.53	M	16.3
2005 02 10.0	0.2768	1.2529	14.15	151.96	−2.68	M	16.2
(31669) 1999 JT_6							
2002 03 04.9	0.1937	0.9833	86.86	126.41	43.05	O	15.5
2002 03 05.9	0.1925	0.9888	85.38	129.03	43.12	O	15.4
2002 03 18.0	0.2002	1.0641	64.74	156.32	38.32	O	15.0
2002 03 30.0	0.2457	1.1515	46.55	172.77	29.75	M	15.0
2002 03 30.9	0.2505	1.1584	45.47	173.70	29.15	M	15.1
2002 04 04.0	0.2743	1.1904	41.08	177.51	26.53	M	15.2
2002 04 08.0	0.3007	1.2223	37.65	180.75	24.21	M	15.4
2002 04 08.9	0.3070	1.2295	36.99	181.43	23.72	M	15.4
(40267) 1999 GJ_4							
2000 02 06.1	0.6576	1.5713	21.03	160.85	2.39	O	16.4
2000 02 12.9	0.6780	1.6373	12.70	157.97	4.11	O	16.3
2000 02 13.9	0.6826	1.6467	11.55	157.54	4.34	O	16.3
2003 02 12.0	0.2618	1.2346	16.94	140.42	−12.69	M	13.7
2003 02 12.9	0.2724	1.2462	16.02	139.72	−11.72	M	13.8
2003 02 13.9	0.2847	1.2590	15.43	139.03	−10.71	M	13.9
2003 02 20.9	0.3848	1.3453	18.80	136.04	−5.31	M	14.8
2003 02 22.9	0.4167	1.3690	20.42	135.60	−4.17	M	15.1
2003 02 23.9	0.4330	1.3807	21.21	135.43	−3.65	M	15.2
(66146) 1998 TU_3							
2001 10 14.1	0.3190	1.0287	75.43	75.49	−13.11	M	14.9
2001 10 15.1	0.3131	1.0231	76.42	76.70	−13.26	M	14.9
2001 10 16.1	0.3074	1.0174	77.47	77.95	−13.40	M	14.9
2003 08 24.1	0.3166	1.1025	65.16	18.25	−13.03	O	14.7

TABLE I
Continued

Time	d [AU]	r [AU]	α [°]	L_{PAB} [°]	B_{PAB} [°]	M/O	V
2003 08 25.1	0.3127	1.1062	64.36	18.43	−13.20	(M)	14.7
2003 08 26.1	0.3089	1.1098	63.55	18.60	−13.37	O(M)	14.6
2003 08 27.1	0.3050	1.1132	62.72	18.76	−13.55	O(M)	14.6
2003 08 28.1	0.3010	1.1166	61.89	18.90	−13.73	O(M)	14.5
2003 09 01.1	0.2851	1.1290	58.42	19.31	−14.47	O(M)	14.3
2003 09 03.1	0.2771	1.1397	56.60	19.42	−14.86	O(M)	14.2
2003 09 05.1	0.2692	1.1397	54.70	19.46	−15.26	O(M)	14.1
2003 09 06.1	0.2652	1.1421	53.73	19.45	−15.46	(M)	14.1
2003 09 07.1	0.2613	1.1444	52.74	19.42	−15.66	(M)	14.0
(88188) 2000 XH_{44}							
2004 01 24.2	0.3880	1.3370	20.92	136.15	13.67	(O)	15.6
2004 02 12.0	0.2957	1.2748	11.67	143.58	9.26	O	14.6
2004 02 12.1	0.2953	1.2745	11.63	143.62	9.22	M	14.6
2004 02 12.8	0.2928	1.2725	11.33	143.89	8.99	(O)	14.6
2004 02 12.9	0.2924	1.2723	11.29	143.93	8.96	M	14.6
2004 02 17.1	0.2786	1.2613	9.92	145.56	7.45	O	14.4
2004 02 21.0	0.2681	1.2522	9.65	147.09	5.89	O	14.3
2004 03 14.9	0.2520	1.2201	23.65	157.69	−5.19	(M)	14.6
2004 03 28.9	0.2766	1.2203	32.60	166.26	−11.47	(O,M)	15.0
(103067) 1999 XA_{143}							
2005 01 11.1	0.4155	1.3511	23.35	131.44	5.80	O	16.5
2005 01 12.0	0.4046	1.3430	23.05	131.56	6.64	O	16.5
2005 01 12.1	0.4034	1.3421	23.02	131.58	6.73	M	16.5
2005 01 16.0	0.3604	1.3071	22.46	131.97	10.77	O	16.1
2005 01 16.1	0.3594	1.3062	22.47	131.98	10.89	M	16.1
2005 01 17.2	0.3486	1.2963	22.65	132.04	12.16	M	16.1
2001 CB_{21}							
2002 02 15.0	0.1274	1.0960	29.97	149.20	18.43	M	15.5
2002 02 15.1	0.1268	1.0955	30.01	149.20	18.45	O	15.5
2002 02 15.8	0.1226	1.0918	30.31	149.14	18.62	O(M)	15.4
2002 02 16.8	0.1168	1.0865	30.85	149.01	18.87	O	15.3
2002 02 17.1	0.1150	1.0850	31.04	148.97	18.95	M	15.3
2004 LJ_1							
2004 07 09.0	0.5236	1.3561	40.52	296.01	38.96	M	16.4
2004 07 10.9	0.5144	1.3402	41.85	296.77	40.01	M	16.3
2004 07 13.0	0.5050	1.3227	43.37	297.61	41.13	M	16.3
2004 07 14.9	0.4971	1.3069	44.81	298.50	42.24	M	16.3
2004 07 16.9	0.4894	1.2904	46.36	299.44	43.36	M	16.3

TABLE I
Continued

Time	d [AU]	r [AU]	α [°]	L_{PAB} [°]	B_{PAB} [°]	M/O	V
2004 07 17.0	0.4890	1.2896	46.44	299.49	43.42	O	16.3
2004 07 18.0	0.4853	1.2813	47.24	299.99	43.97	O(M)	16.3
2004 08 11.0	0.4264	1.0963	67.59	320.77	56.66	O	16.2
2004 08 15.9	0.4178	1.0631	71.67	328.51	58.75	O	16.2
2004 10 20.1	0.4045	0.9823	80.06	90.48	5.20	M	16.3
2004 XO_{14}							
2005 01 17.0	0.7436	1.6902	13.75	133.98	−2.37	O	17.4
2005 01 17.1	0.7439	1.6909	13.67	133.98	−2.33	M	17.4
2005 01 18.0	0.7462	1.6971	12.88	133.98	−2.03	O	17.4
2005 01 18.1	0.7464	1.6978	12.79	133.98	−2.00	M	17.4
2005 01 20.0	0.7520	1.7112	11.14	133.96	−1.37	M	17.3
2005 02 05.0	0.8403	1.8240	3.18	133.61	3.42	O	17.3
2005 02 06.0	0.8483	1.8311	3.80	133.60	3.69	O	17.4
2005 02 08.9	0.8731	1.8516	5.72	133.59	4.42	M	17.6
2005 02 09.9	0.8821	1.8586	6.39	133.59	4.67	M	17.7

$V = 16$. Our observations on four nights in May 2004 revealed a synodic rotation period $P = 3.1944 \pm 0.0004$ h (Figure 1) with the maximum synodic-sidereal period difference $\Delta P = 0.0008$ h. The data were fitted with the 4th-order Fourier series. Although the data were of a good quality (the rms residual of the fit was 0.02 mag), the small amplitude of the lightcurve, $A = 0.08$ mag, did not allow us to eliminate a few other possible period solutions. Thus, the reliability code is $U = 2$. The data from the fifth night were of a lower quality, but they were in agreement with the derived P. We estimated the mean absolute R magnitude $H_R = 16.05 \pm 0.20$ assuming the slope parameter $G = 0.15 \pm 0.20$.

3.2. (22753) 1998 WT

Very scarce lightcurve data are available for this potentially hazardous asteroid. Of the three sessions obtained in October–November 2002, only one is long enough to permit us to constrain P as being greater than 10 h. The two nights of February 2005 did not provide a unique solution as well. The most probable values were 10.24 ± 0.05 h and 13.05 ± 0.07 h. Thus, $U = 2$. Taking into account two short sessions of the previous apparition, we prefer the shorter solution for P (Figure 2). Using the 2nd Fourier order fit, we estimated amplitude $A = 0.11$ mag for both apparitions (the 13.05-h solution

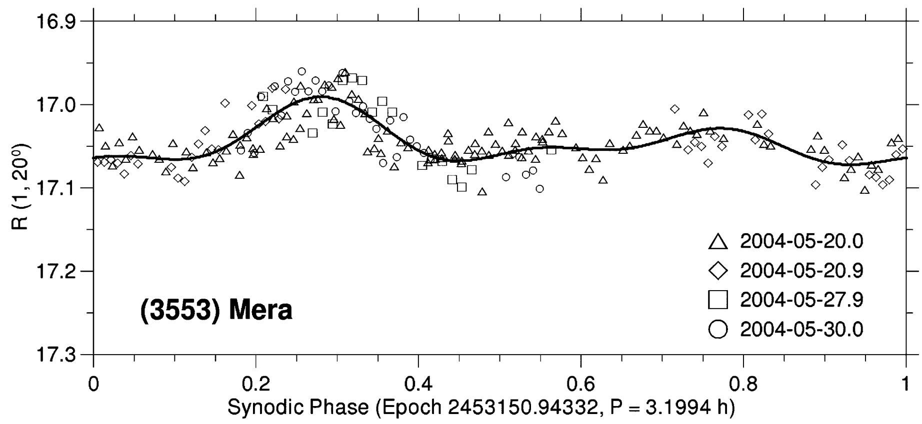

Figure 1. The composite lightcurve of (3553) Mera.

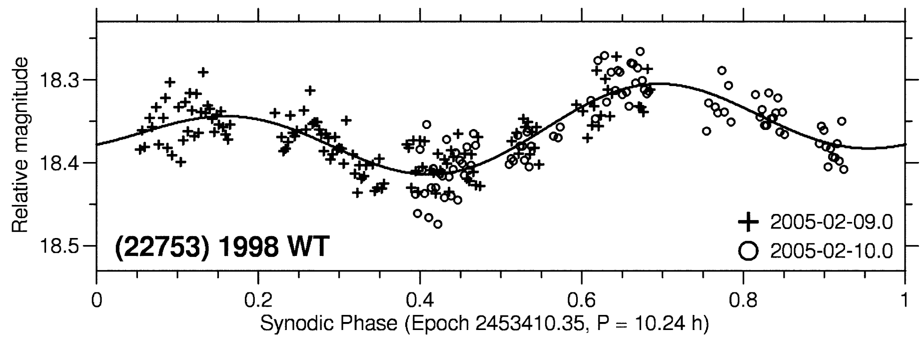

Figure 2. The composite lightcurve of (22753) 1998 WT.

has $A = 0.16$ mag). Radar observations (L. Benner, personal communication) suggest an upper limit of about 13 h on P that is consistent with the lightcurve data.

3.3. (31669) 1999 JT_6

This object in an Apollo-type orbit was observed in March–April 2002 during its best apparition since its discovery in 1999. It approached Earth within 0.2 AU, and it was a 15th-mag object. A similar opportunity will not occur before 2027. The first three calibrated observations obtained at large solar phases would formally require a very low value of $G < -0.2$. We assumed that it was rather an effect of changing aspect; otherwise, the asteroid would be much brighter at lower solar phases; this was not observed. A period solution (5.807 ± 0.002 h) became unique after additional data were obtained, though the amplitude decreased significantly and the new data were

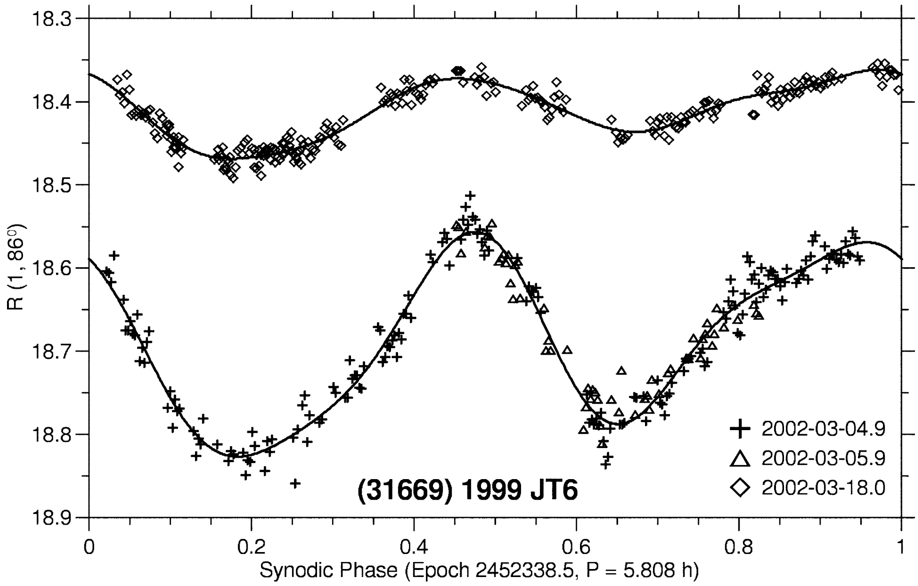

Figure 3. The composite lightcurve of (31669) 1999 JT_6 – the first 3 nights. $G = 0.15$ was assumed for the purpose of this plot.

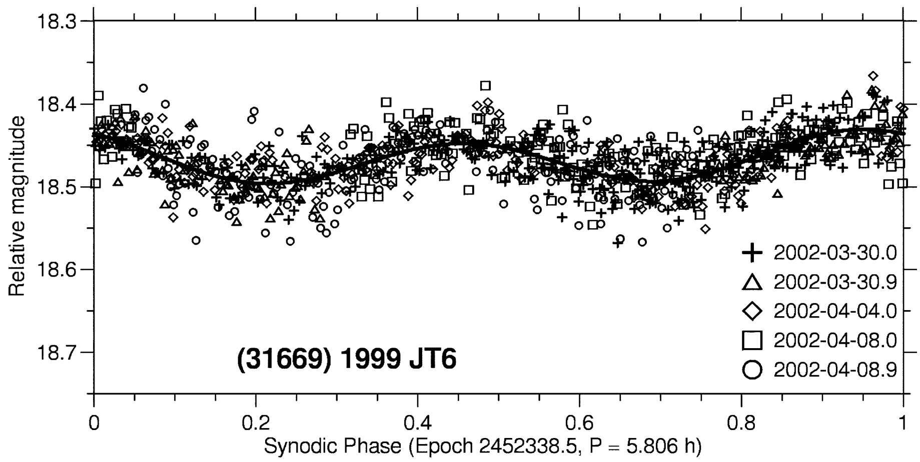

Figure 4. The composite lightcurve of (31669) 1999 JT_6 – the last 5 nights.

of lower quality (Figures 3 and 4); A decreased from 0.27 mag (on March 4 to 5) through 0.11 mag (March 18) down to 0.07 mag (during March 30 to April 8) as derived from the best Fourier fits to the data (the order $N = 4$, 5 and 2, respectively). It suggests an aspect close to pole-on during late March/early April 2002.

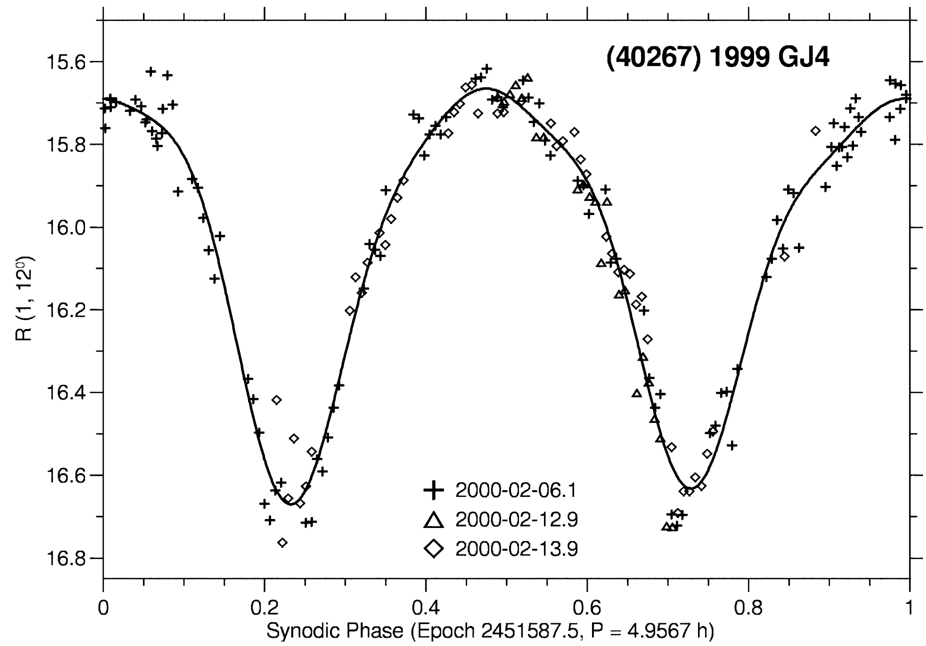

Figure 5. The composite lightcurve of (40267) 1999 GJ_4 in 2000.

3.4. (40267) 1999 GJ_4

This asteroid is in an Apollo-type orbit. In the apparitions of 2000 and 2003, high amplitudes of 1.01 and 1.11 mag, respectively, were observed. Estimated synodic periods are 4.9567 ± 0.0004 h and 4.95692 ± 0.00006 h, respectively. The data are presented in Figures 5 and 6. We estimated the following phase relation parameters: the mean absolute R magnitude $H_R = 15.59 \pm 0.20$ and $G = 0.5 \pm 0.2$.

3.5. (66146) 1998 TU_3

This is probably one of the largest Aten asteroids as it may be inferred from the MPC value of H.[1] Our observations during August–September 2003 revealed a unique solution for synodic period of $P = 2.37741 \pm 0.00004$ h (from calibrated data only), or $P = 2.37747 \pm 0.00006$ h (with relative data included). The observations of October 2001 did not bring a unique solution themselves, but a search around the 2003 value revealed a synodic period $P = 2.3767 \pm 0.0009$ h in the 2001 data (Figures 7 and 8). The observed

[1] The ranking of H for known Atens is 14.5 for 1999 HF_1, which is binary; 14.7 for (66146); 15.1 for (3753); 15.8 for (105140); and so on.

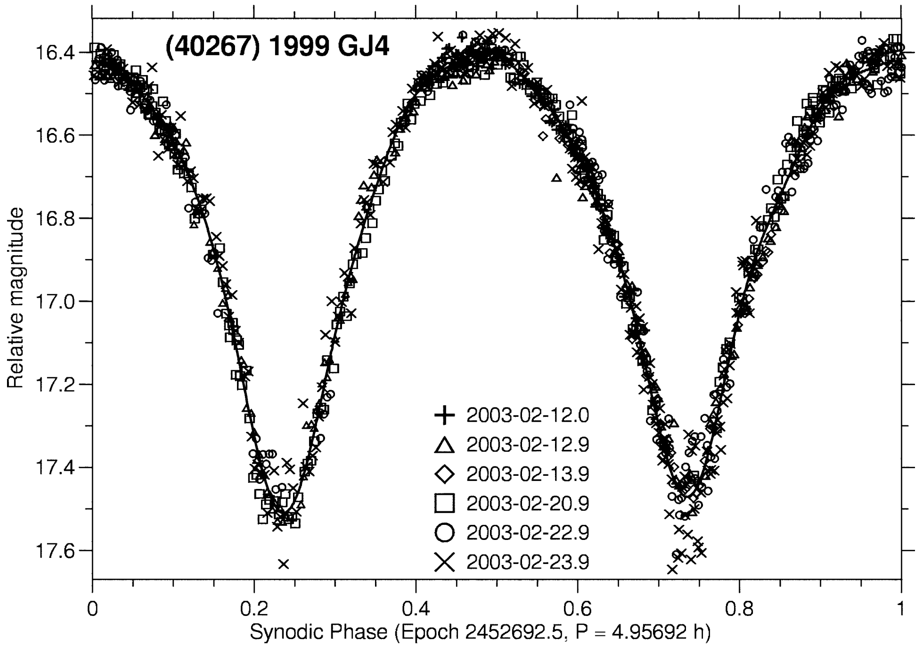

Figure 6. The composite lightcurve of (40267) 1999 GJ_4 in 2003.

amplitudes were 0.15 and 0.12 mag, respectively, in the 2001 and 2003 apparitions. Calibrated data fit best for $G = -0.01$.

3.6. (88188) 2000 XH_{44}

This Amor-type asteroid was observed in February–March 2004 during its best apparition since discovery. Despite its very low amplitude of 0.06 mag, the low-noise data obtained during four nights, February 12–21 (with errors of individual points of about 0.007 mag) allowed us to derive an apparently unique synodic period, $P = 2.6906 \pm 0.0002$ h (Figure 9). The best fit phase relations parameters to the data from January 24 to February 21 are $H_R = 16.04 \pm 0.20$ and $G = 0.35^{+0.20}_{-0.10}$ (realistic errors). The composite lightcurve from the four February nights' data is presented in Figure 10. The brighter mean R level of the last calibrated, isolated night of March 28 suggested a change of aspect; a formal fit with the *H–G* phase relation would require a very high *G* value.

3.7. (103067) 1999 XA_{143}

This Apollo-type asteroid is in an inclined orbit that does not bring it close to Earth. Our observations on four nights in January 2005 revealed a unique

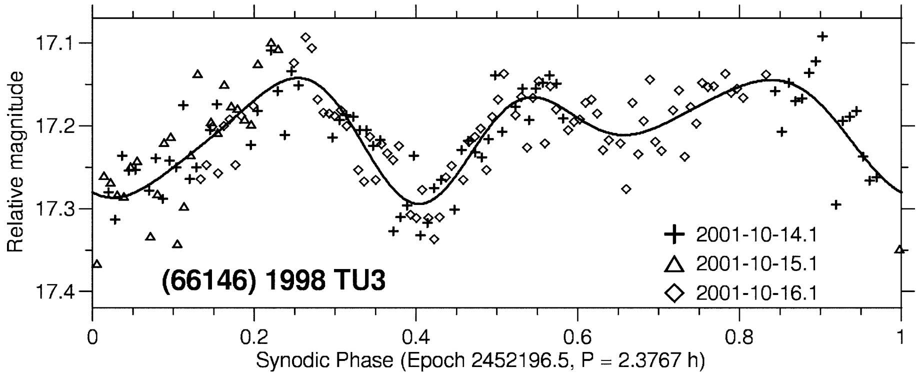

Figure 7. The composite lightcurve of (66146) 1998 TU_3 in 2001.

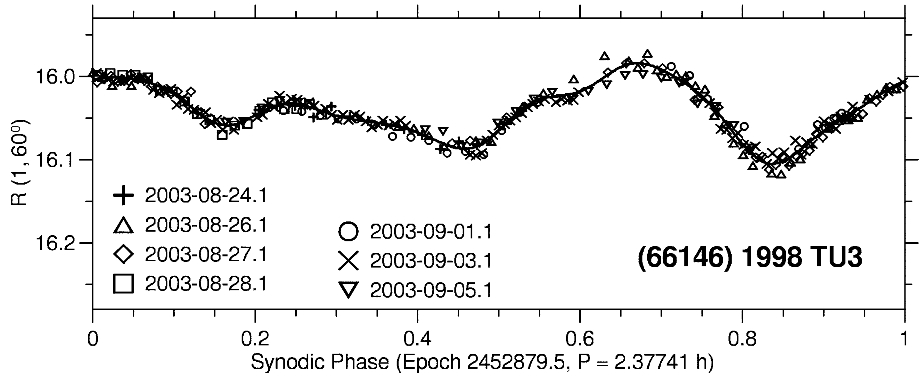

Figure 8. The composite lightcurve of (66146) 1998 TU_3 in 2003. $G = -0.01$ was used as it gave the formally best fit to the data.

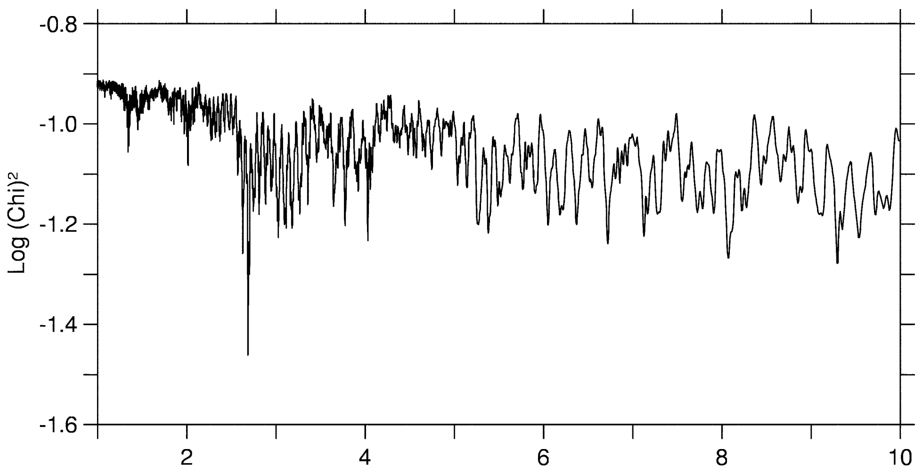

Figure 9. A plot of the sum of square residuals vs. period for (88188) 2000 XH_{44}.

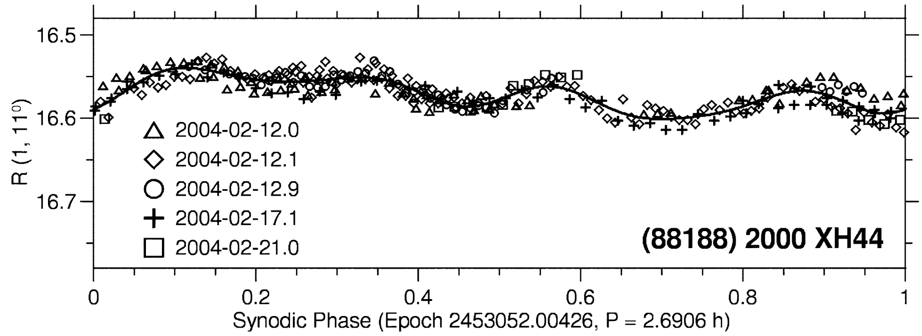

Figure 10. The composite lightcurve of (88188) 2000 XH_{44}.

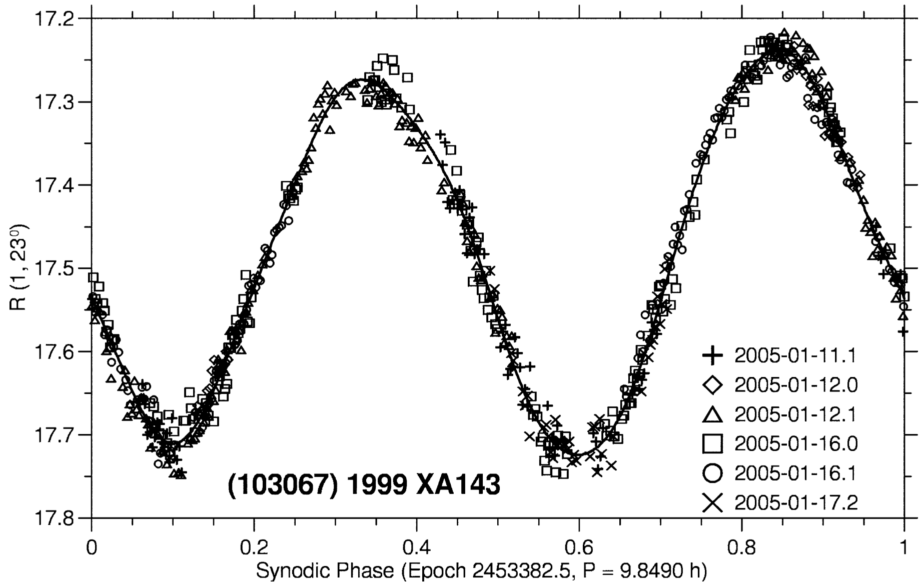

Figure 11. The composite lightcurve of (103067) 1999 XA_{143}.

solution of $P = 9.8490 \pm 0.0007$ h (the maximum synodic-sidereal period difference $\Delta P = 0.012$ h) and $A = 0.49$ mag (Figure 11).

3.8. 2001 CB_{21}

This object in an Apollo-type orbit was observed in February 2002 during its best apparition since discovery. The next similarly favorable approach to within 0.1 AU from Earth will occur in 2006, but after that it will not repeat until 2022. It was observed on three nights from both observatories. We have

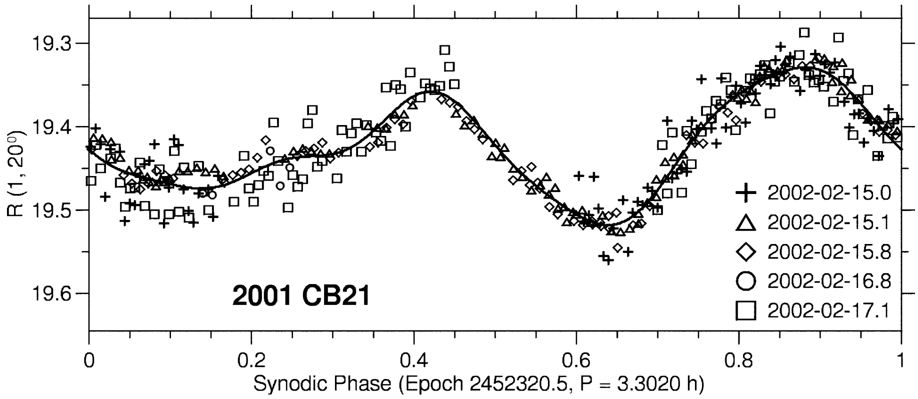

Figure 12. The composite lightcurve of 2001 CB_{21}.

found the most probable value of $P = 3.3020 \pm 0.0008$ h ($\Delta P = 0.0003$ h), but a value 1.5 times longer could not be ruled out, though it looked less likely, so this is $U = 2$ result. $A = 0.19$ mag (Figure 12). On February 16 we measured $V–R = 0.45 \pm 0.02$ mag.

3.9. 2004 LJ_1

This is a bright, potentially hazardous asteroid in an Apollo-type orbit. The discovery apparition provided a long window of observability; such favorable conditions will not repeat until 2021. Our observations from July 9 to 18 revealed a unique solution of $P = 2.7247 \pm 0.0002$ h ($\Delta P = 0.0006$ h) with $A = 0.21$ mag (Figure 13). The two nights of August 11 and 15 showed a

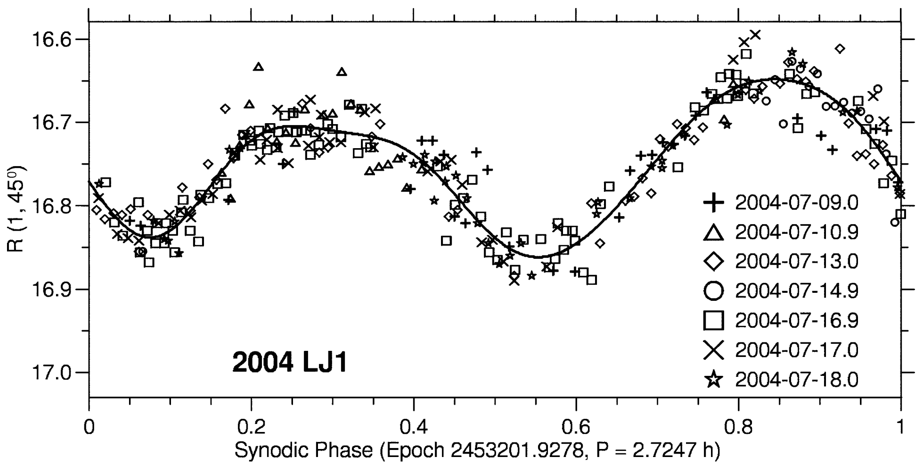

Figure 13. The composite lightcurve of 2004 LJ_1.

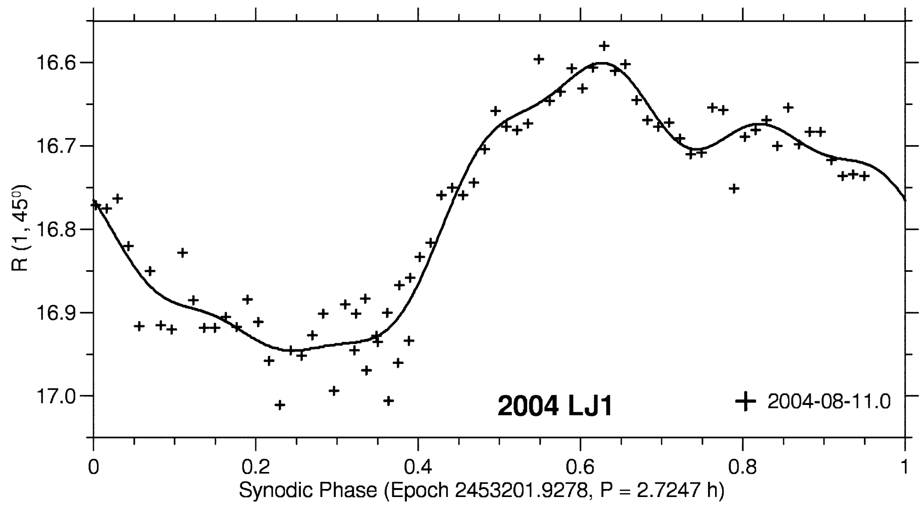

Figure 14. The composite lightcurve of 2004 LJ_1.

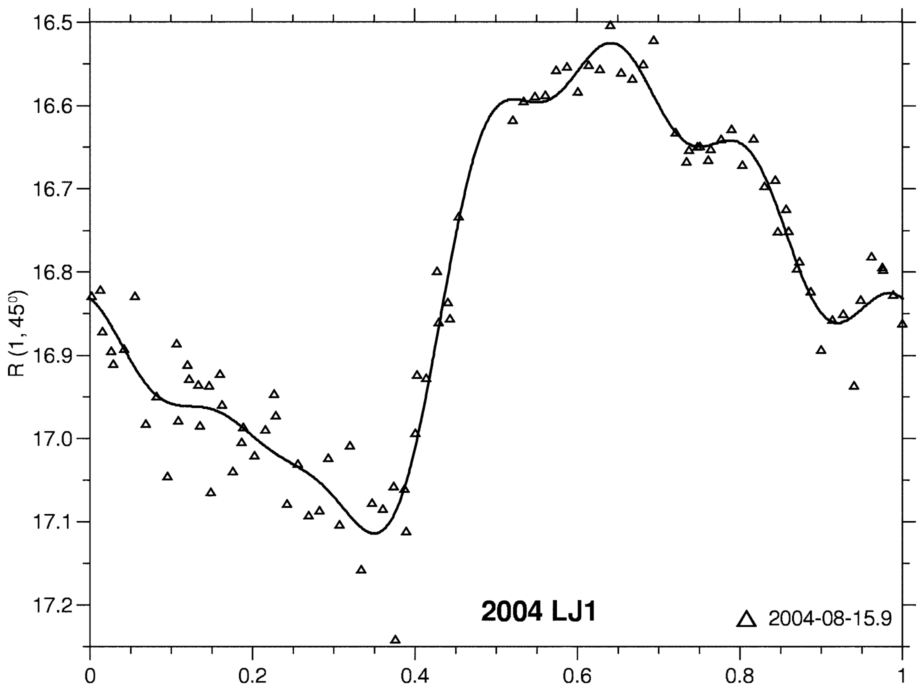

Figure 15. The composite lightcurve of 2004 LJ_1.

rapid evolution of the lightcurve with changing geometry, with A of 0.34 and 0.59 mag, respectively (Figures 14 and 15). The data of October 20 showed a lower amplitude of 0.17 mag again (Figure 16). Prominent changes in

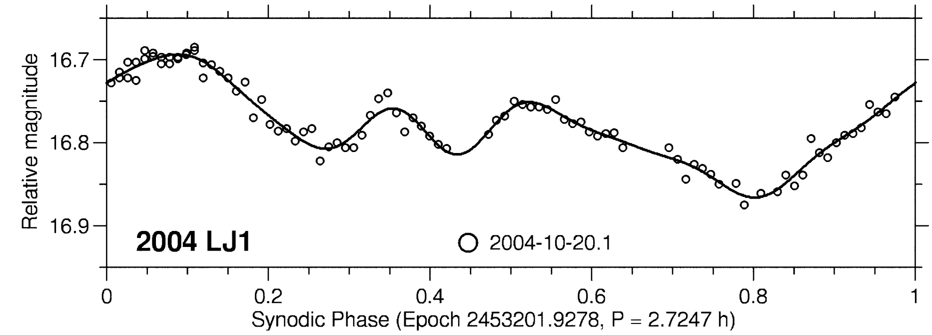

Figure 16. The composite lightcurve of 2004 LJ_1.

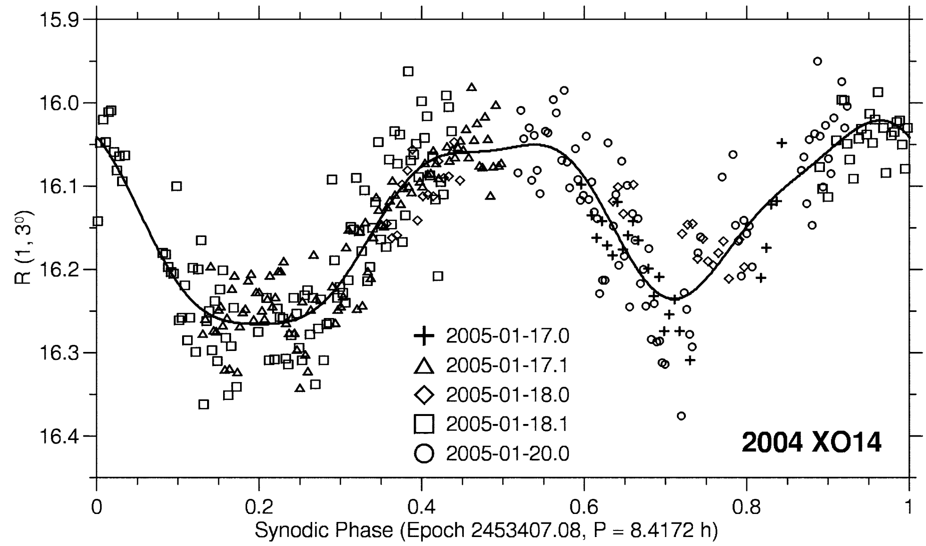

Figure 17. The composite lightcurve of 2004 XO_{14} – the first part.

viewing and illumination geometries were obviously responsible also for the fact that the calibrated July and August data could be formally fitted with G as low as -0.25.

3.10. 2004 XO_{14}

This Amor-type asteroid was the faintest of our targets ($V > 17$ mag); it was at the limit of our systems with photometric errors of about 0.04 mag. We derived a synodic period of 8.4172 ± 0.0006 h ($\Delta P = 0.0024$ mag) that is unique assuming 2 max/min per cycle; longer periods (1.5× and 2×) are formally possible, but they do not appear plausible, and we assigned $U = 3$ – to the

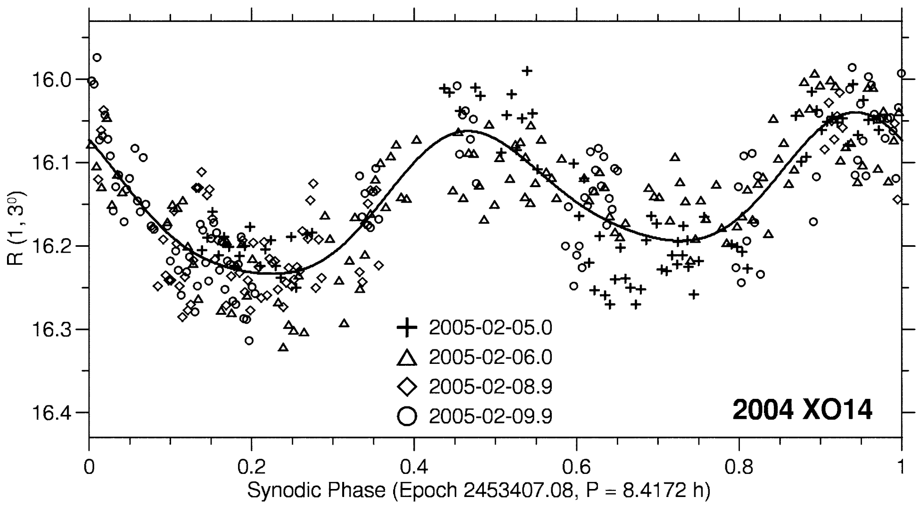

Figure 18. The composite lightcurve of 2004 XO_{14} – the second part.

period solution. Observed amplitudes were 0.25 and 0.19 mag in January and February 2005, respectively (Figures 17 and 18). We estimated the phase relation parameters $H_R = 15.84$ and $G = 0.16$ (formal errors of 0.02 in both, real errors probably within 0.10).

4. Discussion on *H* Values

In Table II, we summarize the derived lightcurve parameters: the synodic rotation period *P*, the maximum synodic-sidereal periods difference ΔP, the amplitude of the lightcurve *A*, the reliability code of the period solution *U*, the fitted Fourier order *N*, the rms residual of the fit δ, the slope parameter *G*, and the absolute R magnitude H_R. *G* and H_R values are presented only for 5 asteroids that have calibrated observations at solar phase angles $< 25°$.

A comparison of the H_R values with absolute magnitudes (*H*, in *V* band) of the Minor Planet Center (MPC) is useful. Most asteroids have *V–R* in the range 0.45 ± 0.10 (see, e.g., asteroid 2001 CB_{21}). We see that *H* and H_R values are mutually consistent for (3553), (103067) and 2004 XO_{14}. On the other hand, values for (40267) and (88188) show a discrepancy; the two asteroids were fainter than predicted by the MPC.

5. Conclusion

We have established a collaboration between our two stations for lightcurve observations of near-Earth asteroids. It has led to the determination of their

TABLE II

The main results of our observations. *P* is the synodic rotation period; ΔP is the maximum synodic-sidereal periods difference; *A* is the amplitude of the lightcurve from the Fourier fit; *U* is the reliability code of the period solution; *N* is the fitted Fourier order; δ is the rms residual of the fit; H_R and *G* are the best fit absolute R magnitude and slope parameter, respectively. *G* values in parentheses were assumed rather than derived. Absolute magnitude *H* according to the MPC (in *V* band) is in the last column for comparison. (Note that most asteroids have *V–R* in the range 0.45 ± 0.10.)

P [h]	ΔP [h]	*A* [mag]	*U*	*N*	δ [mag]	*G*	H_R	*H*
(3553) Mera								
3.1944 ± 0.0004	0.0008	0.08	2	4	0.02	$(0.15) \pm 0.20$	16.05 ± 0.20	16.5
(22753) 1998 WT								
10.24 ± 0.05	0.00	0.11	2	2	0.02			
(31669) 1999 JT_6 (first 3 nights)								
5.808 ± 0.002	0.007	0.11–0.27		4,5	0.02			
(last 5 nights)								
5.806 ± 0.001	0.004	0.07		2	0.03			
(all)								
5.807 ± 0.001	0.005	0.07–0.27	3					
(40267) 1999 GJ_4 (year 2000)								
4.9567 ± 0.0004	0.0014	1.01	3	6	0.06	0.5 ± 0.2	15.59 ± 0.20	15.3
(year 2003)								
4.95692 ± 0.00006	0.00250	1.11	3	10	0.04			
(66146) 1998 TU_3 (year 2001)								
2.3767 ± 0.0009	0.0008	0.15		5	0.02			
(year 2003 selected)								
2.37741 ± 0.00004	0.00014	0.12	3	9	0.01			
(year 2003 all)								
2.37747 ± 0.00006	0.00013	0.12	3	9	0.02			
(88188) 2000 XH_{44}								
2.6906 ± 0.0002	0.0005	0.06	3	6	0.01	$0.35^{+0.20}_{-0.10}$	16.04 ± 0.20	16.0
(103067) 1999 XA_{143}								
9.8490 ± 0.0007	0.012	0.49	3	7	0.02	(0.15)	16.4 ± 0.3	16.6
2001 CB_{21}								
3.3020 ± 0.0008	0.0003	0.19	2	6	0.02			
2004 LJ_1 (July)								
2.7247 ± 0.0002	0.0006	0.21	3	5	0.03			
(Aug & Oct)								
2.7247 assumed		0.17–0.59		6,8	0.01–0.04			
2004 XO_{14}								
8.4172 ± 0.0006	0.0024	0.19–0.25	3	5,4	0.05	$0.16 \pm < 0.10$	$15.84 \pm < 0.10$	16.1

rotation periods and potential detections of attenuations due to satellites. The collaborative work turned out to be particularly useful for cases with difficult conditions or parameters, leading to decreasing a bias against such objects (with certain periods, or orbits). Given the good experience and results for several NEAs presented in this and other papers, we are continuing the collaboration on a larger scale in the framework of the Photometric Survey of Asynchronous Binary Asteroids (see Pravec et al., 2006, and references therein).

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