

LIGHTCURVE PHOTOMETRY OPPORTUNITIES: 2012 OCTOBER-DECEMBER

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We present lists of asteroid photometry opportunities for objects reaching a favorable apparition and have no or poorly-defined lightcurve parameters. Additional data on these objects will help with shape and spin axis modeling via lightcurve inversion. We also include lists of objects that will be the target of radar observations. Lightcurves for these objects can help constrain pole solutions and/or remove rotation period ambiguities that might not come from using radar data alone.

We present four lists of “targets of opportunity” for the period 2012 October-December. For background on the program details for each of the opportunity lists, refer to previous issues, e.g., *Minor Planet Bulletin* **36**, 188. In the first three sets of tables, “Dec” is the declination, “U” is the quality code of the lightcurve, and “ α ” is the solar phase angle. See the asteroid lightcurve data base (LCDB) documentation for an explanation of the U code:

<http://www.minorplanet.info/lightcurvedatabase.html>

Objects with $U = 1$ should be given higher priority over those rated $U = 2$ or $2+$ but not necessarily over those with no period. On the other hand, do not overlook asteroids with $U = 2/2+$ on the assumption that the period is sufficiently established. Regardless, do not let the existing period influence your analysis since even high quality ratings have been proven wrong at times. Note that the lightcurve amplitude in the tables could be more or less than what's given. Use the listing only as a guide.

The first list is an *abbreviated list* of those asteroids reaching $V < 14.5$ at brightest during the period and have either no or poorly-constrained lightcurve parameters. A ‘(F)’ after the name indicates that the asteroid is reaching one of its five brightest apparitions between the years 1995-2050.

The goal for these asteroids is to find a well-determined rotation rate. The target list generator on the CALL web site allows you to

create custom lists for objects reaching $V \leq 17.5$ during any month in the current year, e.g., limiting the results by magnitude and declination.

http://www.minorplanet.info/PHP/call_OppLCDBQuery.php

In a general note, small objects with periods up to 4 hours or even longer are possible binaries. The odds may be less but the bonus is that the size of the secondary, if it exists, is likely larger (see Pravec *et al.* (2010), *Nature* **466**, 1085-1088), thus eclipses, if they occur, will be deeper and easier to detect.

The Low Phase Angle list includes asteroids that reach very low phase angles. Getting accurate, calibrated measurements (usually V band) at or very near the day of opposition can provide important information for those studying the “opposition effect.” You will have the best chance of success working objects with low amplitude and periods that allow covering, e.g., a maximum, every night. Objects with large amplitudes and/or long periods are much more difficult for phase angle studies since, for proper analysis, the data have to be reduced to the average magnitude of the asteroid for each night. Without knowing the period and/or the amplitude at the time, that reduction becomes highly uncertain. As an aside, some use the maximum light to find the phase slope parameter (G). However, this can produce a significantly different value for both H and G versus using average light, which is the method used for values listed by the Minor Planet Center.

The third list is of those asteroids needing only a small number of lightcurves to allow spin axis and/or shape modeling. Those doing work for modeling should contact Josef Ďurech at the email address above and/or visit the Database of Asteroid Models from Inversion Techniques (DAMIT) web site for existing data and models:

<http://astro.troja.mff.cuni.cz/projects/asteroids3D>

The fourth list gives a brief ephemeris for planned radar targets. Supporting optical observations to determine the lightcurve period, amplitude, and shape are needed to supplement the radar data. *High-precision work, 0.01-0.02 mag, is preferred, especially if the object is a known or potential binary.* Those obtaining lightcurves in support of radar observations should contact Dr. Benner directly at the email given above.

Future radar targets:

<http://echo.jpl.nasa.gov/~lance/future.radar.nea.periods.html>

Past radar targets:

<http://echo.jpl.nasa.gov/~lance/radar.nea.periods.html>

Arecibo targets:

<http://www.naic.edu/~pradar/sched.shtml>

<http://www.naic.edu/~pradar>

Goldstone targets:

http://echo.jpl.nasa.gov/asteroids/goldstone_asteroid_schedule.html

As always, we encourage observations of asteroids even if they have well-established lightcurve parameters and especially if they are lacking good spin axis and/or shape model solutions. Every lightcurve of sufficient quality supports efforts to resolve a number of questions about the evolution of individual asteroids and the general population. For example, pole directions are known for only about 30 NEAs out of a population of 8000. This is hardly sufficient to make even the most general of statements about NEA pole alignments, including whether or not the thermal YORP effect

is forcing pole orientations into a limited number of preferred directions (see La Spina *et al.*, 2004, *Nature* **428**, 400-401). Data from many apparitions can help determine if an asteroid's rotation rate is being affected by YORP, which can also cause the rotation rate of a smaller, irregularly-shaped asteroid to increase or decrease. See Lowry *et al.* (2007) *Science* **316**, 272-274 and Kaasalainen *et al.* (2007) *Nature* **446**, 420-422.

The ephemeris listings for the optical-radar listings include lunar elongation and phase. Phase values range from 0.0 (new) to 1.0 (full). If the value is positive, the moon is waxing – between new and full. If the value is negative, the moon is waning – between full and new. The listing also includes the galactic latitude. When this value is near 0°, the asteroid is likely in rich star fields and so may be difficult to work. It is important to emphasize that the ephemerides that we provide are only guides for when you might observe a given asteroid. Obviously, you should use your discretion and experience to make your observing program as effective as possible.

Once you've analyzed your data, it's important to publish your results. Papers appearing in the *Minor Planet Bulletin* are indexed in the Astrophysical Data System (ADS) and so can be referenced by others in subsequent papers. It's also important to make the data available at least on a personal website or upon request.

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Lightcurve Opportunities

#	Name	Brightest			LCDB Data		
		Date	Mag	Dec	Period	Amp	U
1007	Pawlowia (F)	10 01.4	14.0	+7	8.23	0.02	1
973	Aralia	10 01.6	14.2	+11	7.29	0.25	2
673	Edda	10 02.2	13.9	+6	14.92	0.12	2
537	Pauly	10 04.1	12.4	-8	14.15	0.15-0.20	2+
876	Scott	10 04.4	14.5	-6	> 14.	0.3	1
231	Vindobona	10 06.9	13.3	+8	14.244	0.20-0.29	2+
2763	Jeans	10 07.3	13.8	+12			
3385	Bronnina	10 07.3	14.5	+6	2.996	0.25	2+
786	Bredichina	10 07.7	13.9	-12	18.61	0.60	2+
960	Birgit	10 08.2	14.4	+11	17.3558	0.25	1+
1604	Tombaugh	10 08.9	14.2	+19	7.047	0.16-0.20	2+
597	Bandusia (F)	10 09.1	11.9	-1	11.5	0.11	2
932	Hooveria (F)	10 12.9	12.3	+9	39.1	0.22	2+
2890	Vilyujsk (F)	10 16.9	14.4	+15	3.45	0.08	2
3478	Fanale (F)	10 17.0	13.9	+2			
460	Scania (F)	10 17.3	13.4	+10	9.56	0.05	2
279	Thule	10 18.5	14.4	+8	15.962	0.04-0.10	2+
1051	Merope	10 19.2	14.5	-4	27.2	0.20	2
1578	Kirkwood	10 20.7	14.5	+10	17.9	0.22	2
863	Benkoela	10 22.5	14.2	-22	7.03	0.05	2+
999	Zachia (F)	10 23.0	12.9	+13	22.77	0.3	2
1137	Raissa (F)	10 23.2	13.0	+6	37.	0.34	1
903	Nealley	10 23.7	14.4	-1	21.6	0.15	2
1694	Kaiser (F)	10 23.7	12.6	+20	13.23	0.13-0.25	2+
1086	Nata	10 24.3	14.1	+23	18.074	0.17	2
684	Hildburg	10 24.7	13.9	+19	11.92	0.23	2
1264	Letaba	10 29.4	14.0	+26	32.16	0.13	1
6991	Chichibu	10 29.8	14.5	+3			
1056	Azalea	10 31.9	13.8	+6	11.893	0.07-0.79	2+
5234	Sechenov (F)	11 01.6	14.5	+20	12.067	0.22	1
562	Salome	11 04.9	13.9	+8	6.3501	0.21-0.37	2
717	Wisibada	11 07.0	13.9	+19			
748	Simeisa	11 12.1	13.5	+20	11.919	0.22-0.36	2
897	Lysistrata	11 12.2	14.0	+28	11.26	0.11	2
464	Megaira	11 12.4	12.5	+5	12.726	0.08	2
1390	Abastumani	11 15.1	14.2	+30	17.1	0.15	2
1135	Colchis	11 18.7	13.5	+26	23.47	0.45	2
487	Venetia (F)	11 19.6	11.3	+6	13.28	0.03-0.30	2
850	Altona	11 21.4	14.5	+1	11.197	0.12	2
273	Atropos	11 21.6	14.3	-10	23.928	0.60-0.65	2
4352	Kyoto (F)	11 21.6	13.9	+17			
882	Swetlana (F)	11 21.8	13.4	+23	> 20.	0.17	2-
1064	Aethusa	11 23.0	14.2	+30	8.621	0.18	2
783	Nora	11 23.3	14.5	+6	34.4	0.08-0.2	2
538	Friederike	11 23.9	13.3	+11	27.	0.12	1

738	Alagasta	11 26.4	14.3	+16	17.83	0.20	2
227	Philosophia	11 26.8	14.5	+33	18.048	0.06-0.20	2
4369	Seifert	11 27.3	14.3	+39	30.3	0.28	2
964	Subamara	11 29.2	14.3	+30	6.864	0.11	2
1066	Lobelia	11 29.7	14.5	+31			
858	El Djezair	11 30.0	14.4	+22	22.31	0.1	2
1549	Mikko (F)	11 30.6	14.2	+19	11.49	0.03	1+
1605	Milankovitch	12 02.1	14.1	+6	11.6	0.12	2
1166	Sakuntala	12 02.2	14.3	+5	6.3	0.40	2
396	Aeolia	12 02.8	14.1	+22	22.2	0.30	2-
2052	Tamriko	12 04.4	14.2	+13	7.462	0.11	2
845	Naema	12 07.5	14.3	+33	20.892	0.16	2
1052	Belgica (F)	12 07.7	13.6	+19			
891	Gunhild	12 09.2	13.7	+13	7.93	0.18	2
906	Repsolda	12 09.3	13.4	+34	15.36	0.20	2
644	Cosima	12 09.6	13.7	+22	15.13	0.16	1
1197	Rhodesia	12 15.0	13.6	+21	16.062	0.22-0.32	2
521	Brixia (F)	12 15.5	10.2	+21	9.78	0.11	2-
308	Polyxo	12 15.7	12.0	+17	12.032	0.08-0.15	2+
392	Wilhelmina	12 25.3	13.6	+3	17.96	0.04-0.70	2
987	Wallia	12 25.6	14.2	+33	10.082	0.16-0.36	2
2034	Bernoulli	12 25.7	14.0	+41			
1016	Anitra	12 26.1	13.8	+35	5.93	0.30-0.50	2

Low Phase Angle Opportunities

#	Name	Date	α	V	Dec	Period	Amp	U
35	Leukothea	09 04.0	0.72	13.1	-09	31.900	0.07-0.43	3
1346	Gotha	09 06.1	0.44	14.0	-05	11.19	0.12	2
76	Freia	09 06.4	0.55	12.8	-04	9.969	0.10-0.33	3
277	Elvira	09 08.3	0.65	13.1	-04	29.69	0.34-0.59	3
601	Nerthus	09 09.6	0.44	13.3	-04	13.59	0.29	3
	2010 GT12	09 10.8	0.20	7.0	-04			
1332	Marconia	09 15.7	0.53	13.6	-04			
658	Asteria	09 20.5	0.19	14.0	-01	21.034	0.22-0.32	3
236	Honorio	09 20.8	0.86	10.7	+01	12.333	0.05-0.18	3
313	Chaldaea	09 22.0	0.32	12.1	-01	8.392	0.08-0.24	3
492	Gismonda	10 01.9	0.61	13.1	+02	6.488	0.10	3
673	Edda	10 02.2	0.97	13.9	+06	14.92	0.12	2
359	Georgia	10 03.3	0.37	11.4	+05	5.537	0.15-0.54	3
1542	Schalen	10 04.0	0.57	13.9	+06			
60	Echo	10 06.0	0.07	10.6	+05	25.208	0.07-0.22	3
231	Vindobona	10 07.1	0.98	13.3	+08	14.244	0.29	2+
85	Io	10 11.5	0.85	10.1	+09	6.875	0.05-0.17	3
222	Lucia	10 12.7	0.81	13.7	+05	7.780	0.25-0.33	3
932	Hooveria	10 12.8	0.53	12.4	+09	39.1	0.22	2+
834	Burnhamia	10 15.8	0.57	13.9	+07	13.875	0.15-0.22	3
460	Scania	10 17.3	0.17	13.4	+10	9.56	0.05	2
32	Pomona	10 20.5	0.71	11.2	+12	9.448	0.13-0.30	3
518	Halawe	10 21.0	0.35	13.3	+10			
999	Zachia	10 23.1	0.77	13.3	+13	22.77	0.3	2
73	Klytia	10 30.3	0.76	12.1	+16	8.297	0.26-0.35	3
178	Belisana	10 30.6	0.32	12.4	+13	12.323	0.12-0.26	3
499	Venusia	11 05.1	0.51	13.8	+17	13.48	0.33	3
717	Wisibada	11 07.2	0.99	14.0	+19			
91	Aegina	11 08.9	0.90	11.5	+19	6.025	0.15	3
208	Lacrimosa	11 11.1	0.64	12.8	+19	14.085	0.15-0.33	3
748	Simeisa	11 12.0	0.56	13.5	+20	11.88	0.22	2
663	Gerlinde	11 19.7	0.65	13.7	+18	10.251	0.19-0.35	3
184	Dejopeja	11 22.5	0.50	12.8	+22	6.455	0.25-0.3	3
90	Antiope	11 27.8	0.11	12.7	+21	16.509	0.08-0.90	3
3322	Lidiya	12 01.2	0.77	14.0	+23			
24	Themis	12 02.0	0.21	11.0	+23	8.374	0.09-0.14	3
352	Gisela	12 02.8	0.25	11.4	+22	7.490	0.31-0.58	3
122	Gerda	12 04.5	0.71	12.2	+20	10.685	0.11-0.26	3
197	Arete	12 09.5	0.35	12.8	+22	6.6084	0.10-0.15	3
644	Cosima	12 09.6	0.42	13.7	+22	15.13	0.16	1
1197	Rhodesia	12 14.8	0.95	13.6	+21	16.062	0.22-0.32	2
43	Ariadne	12 17.0	0.03	11.0	+23	5.762	0.08-0.66	3
1	Ceres	12 18.3	0.69	6.7	+25	9.074170	0.02-0.06	3
21	Lutetia	12 23.1	0.35	10.5	+24	8.1655	0.06-0.25	3
972	Cohnia	12 23.5	0.81	13.0	+26	18.472	0.20-0.30	3
486	Cremona	12 27.0	0.17	13.7	+24	65.15	0.80-1.00	3-

Shape/Spin Modeling Opportunities

There are two lists here. The first is for objects for which good occultation profiles are available. These are used to constrain the models obtained from lightcurve inversion, eliminating ambiguous solutions and fixing the size of asteroid. Lightcurves are needed for modeling and/or to establish the rotation phase angle at the time the profile was obtained. The second list is of those objects for

which another set of lightcurves from one more apparitions will allow either an initial or a refined solution.

Occultation Profiles Available

#	Name	Brightest			Period	LCDB DATA		U
		Date	Mag	Dec		Amp		
51	Nemusa	09 02.2	10.4	-04	7.783	0.10-0.25	3	
76	Freia	09 06.5	12.7	-04	9.969	0.10-0.33	3	
638	Moirá	09 17.0	14.0	-12	9.875	0.31	3	
366	Vincentina	09 20.7	12.6	+02	15.5	0.08	1	
522	Helga	09 29.1	13.6	-03	8.129	0.17-0.30	3	
120	Lachesis	10 16.9	12.3	+16	46.551	0.14-0.22	3	
381	Myrrha	10 26.8	13.2	-04	6.572	0.36	3	
704	Interamnia	11 14.9	9.8	+38	8.727	0.03-0.11	3	
914	Palisana	11 18.5	12.1	+33	15.922	0.04-0.18	3	
154	Bertha	12 14.3	12.4	+45	22.30	0.04-0.20	2	
308	Polyxo	12 15.7	12.0	+17	12.032	0.08-0.15	2+	
105	Artemis	12 31.	12.8	-13	37.15506	0.09-0.17	3	
976	Benjamina	12 31.	14.2	+05	9.746	0.18	3-	
102	Miriam	12 31.	13.3	+12	23.613	0.04-0.14	3	

Inversion Modeling Candidates

#	Name	Brightest			Period	LCDB Data		U
		Date	Mag	Dec		Amp		
770	Bali	09 04.5	13.1	-14	5.9513	0.40-0.55	3	
484	Pittsburghia	09 05.2	13.2	-18	10.63	0.37	3	
277	Elvira	09 08.3	13.1	-04	29.69	0.34-0.59	3	
601	Nerthus	09 09.6	13.3	-04	13.59	0.29	3	
1368	Numidia	09 11.8	14.1	-16	3.64	0.35	3	
787	Moskva	09 17.5	12.4	+02	6.056	0.47-0.60	3	
313	Chaldaea	09 22.0	12.1	-01	8.392	0.08-0.24	3	
733	Mocia	09 28.6	14.2	+14	11.374	0.29	3	
567	Eleutheria	09 28.7	14.0	-07	7.71	0.26-0.50	3	
2111	Tselina	10 09.5	14.1	-01	6.563	0.17	3	
226	Weringia	10 10.2	13.6	-13	11.240	0.08-0.15	3-	
2332	Kalm	10 11.6	14.9	-07	22.8	0.39	2	
292	Ludovica	10 15.2	12.6	+00	8.93	0.45	3	
1245	Calvinia	10 16.4	13.3	+06	4.84	0.37-0.63	3	
550	Senta	10 23.6	12.3	+26	20.555	0.3	3	
692	Hippodamia	10 27.0	14.0	-08	8.98	0.50	3	
889	Erynia	10 27.5	13.0	-02	9.89	0.67	3	
312	Pierretta	10 28.6	13.0	+20	10.282	0.32	3	
502	Sigune	11 03.0	14.6	-24	10.922	0.35-0.44	3	
1002	Olbersia	11 06.2	14.6	+31	10.244	0.38	3	
782	Montefiore	11 17.4	13.8	+15	4.08	0.43	3	
809	Lundia	11 23.8	14.0	+08	15.4142	0.18-1.12	3	
1088	Mitaka	11 26.9	12.7	+24	3.049	0.23-0.40	3	
486	Cremona	12 27.1	13.6	+24	65.15	0.80-1.00	3-	
934	Thuringia	12 31.	13.5	+40	8.166	0.52-0.66	3	
299	Thora	12 31.	14.1	+21				
351	Yrsa	12 31.	12.8	+18	13.29	0.42	3	
1350	Rosselia	12 31.	14.6	+20	8.140	0.53	3	
187	Lamberta	12 31.	12.3	+31	10.670	0.23-0.32	3	

Radar-Optical Opportunities

Use the ephemerides below as a guide to your best chances for observing, but remember that photometry may be possible before and/or after the ephemerides given below. Some of the targets may be too faint to do accurate photometry with backyard telescopes. However, accurate astrometry using techniques such as “stack and track” is still possible and can be helpful for those asteroids where the position uncertainties are significant. Note that the intervals in the ephemerides are not always the same and that *geocentric* positions are given. Use these web sites to generate updated and *topocentric* positions:

MPC: <http://www.minorplanetcenter.org/iau/MPEph/MPEph.html>
JPL: <http://ssd.jpl.nasa.gov/?horizons>

In the ephemerides below, ED and SD are, respectively, the Earth and Sun distances (AU), V is the estimated Johnson V magnitude, and α is the phase angle. SE and ME are the great circles distances (in degrees) of the Sun and Moon from the asteroid. MP is the lunar phase and GB is the galactic latitude. “PHA” in the header indicates that the object is a “potentially hazardous asteroid”,

meaning that at some (long distant) time, its orbit might take it very close to Earth.

Some of the objects below are repeats from the previous issue of the *Minor Planet Bulletin* and those with opportunities extending into the next quarter may be featured again in the next issue of the MPB.

1620 Geographos (2012 Sep-Nov, H = 16.8, PHA)

The rotation period (5.22 h) and shape for this famous NEA are well-established. A good reason for observing this and any NEA under such circumstances is to build a data set that can be used to determine if the asteroid’s spin rate is being changed by the YORP effect. This thermal process can cause an asteroid’s spin rate to increase or decrease slowly, but perceptibly, over time. The strength of the YORP is dependent on many factors, but chief among them is distance from the Sun. Therefore, NEAs are the best candidates for checking on YORP. That all said, Durech *et al.* (2008, *Astron. Astrophys.* **489**, L25) have detected YORP spin-up for Geographos (0.0027 s/year!). However, more data can be used to confirm and/or refine those findings.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
09/10	15 46.8	-28 04	0.45	0.98	16.6	80.6	73	146	-0.36	+21
09/20	17 05.2	-25 51	0.45	1.03	16.5	74.0	80	28	+0.20	+9
09/30	18 15.3	-21 32	0.48	1.08	16.6	67.1	87	92	+1.00	-2
10/10	19 13.1	-16 31	0.54	1.14	16.7	61.2	91	161	-0.34	-12
10/20	19 59.9	-11 44	0.61	1.19	17.0	56.4	93	31	+0.27	-20
10/30	20 38.6	-07 30	0.70	1.25	17.2	52.7	93	88	-1.00	-27
11/09	21 11.9	-03 51	0.80	1.30	17.5	49.7	92	158	-0.30	-33
11/19	21 41.5	-00 39	0.90	1.34	17.8	47.3	91	22	+0.33	-37

(68216) 2001 CV26 (2012 Sep-Oct, H = 16.2, PHA)

The rotation period for 2001 CV26 is about 2.4 h. This and its size make it a potential binary candidate so higher-precision observations are encouraged. The estimated size is 1.2 km, or the approximate average of the diameters found by the WISE (Mainzer *et al.*, $p_V = 0.27$) and AKARI (Usui *et al.*, $p_V = 0.41$) surveys.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
09/20	20 30.3	-62 57	0.27	1.12	15.8	58.7	108	69	+0.20	-35
09/25	20 08.5	-59 09	0.25	1.09	15.7	62.9	104	43	+0.74	-33
09/30	19 51.3	-54 25	0.23	1.07	15.7	67.6	100	81	+1.00	-30
10/05	19 37.9	-48 45	0.22	1.04	15.6	72.7	95	131	-0.79	-27
10/10	19 27.0	-42 07	0.20	1.02	15.6	78.3	90	149	-0.34	-24
10/15	19 17.8	-34 29	0.19	1.00	15.7	84.3	85	90	+0.00	-20
10/20	19 09.3	-25 53	0.18	0.98	15.8	90.6	79	18	+0.27	-15
10/25	19 00.9	-16 31	0.18	0.96	15.9	96.9	73	52	+0.79	-9

(137032) 1998 UO1 (2012 Oct-Nov, H = 16.6)

This NEA has an estimated diameter of 1.4 km. The rotation period has been given as from 2.9 to 4.4 h. The amplitude has tended to be small, $A < 0.15$ mag, which can make finding an unambiguous period more difficult. However, those previous attempts were at solar phases angles $< 35^\circ$. The amplitude of a lightcurve increases with phase angle, so it’s possible that the amplitude this time around will be larger and help with period analysis.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/05	17 17.0	-08 09	0.15	0.95	16.2	103.5	68	161	-0.79	+17
10/10	19 13.9	+01 30	0.19	1.03	15.7	76.6	93	156	-0.34	-4
10/15	20 24.9	+07 18	0.25	1.10	15.9	60.6	107	114	+0.00	-17
10/20	21 06.6	+10 18	0.33	1.16	16.4	52.0	113	56	+0.27	-24
10/25	21 33.5	+11 59	0.41	1.23	16.9	47.0	115	21	+0.79	-28
10/30	21 52.6	+13 03	0.50	1.29	17.3	43.8	116	65	-1.00	-31
11/04	22 07.5	+13 47	0.59	1.35	17.7	41.6	115	118	-0.78	-33
11/09	22 19.8	+14 21	0.69	1.41	18.1	40.0	113	162	-0.30	-35

(66146) 1998 TU3 (2012 Sep-Nov, H = 14.6, PHA)

There is no lack of previous work on this NEA. The period is well established at 2.377 h. Here is another case where additional lightcurves are most beneficial for YORP and shape/spin axis modeling. There have been no reported indications of the asteroid being binary. However, its rotation rate and size make it good candidate.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
09/20	19 08.7	-44 04	0.25	1.10	14.0	62.3	105	56	+0.20	-21
09/30	19 51.5	-38 57	0.33	1.13	14.6	59.0	105	75	+1.00	-28
10/10	20 20.3	-34 56	0.41	1.15	15.0	57.9	102	159	-0.34	-32
10/20	20 43.6	-31 34	0.48	1.17	15.4	57.8	98	39	+0.27	-37
10/30	21 04.4	-28 35	0.56	1.17	15.8	58.1	93	89	-1.00	-40
11/09	21 23.9	-25 48	0.63	1.16	16.0	58.7	88	151	-0.30	-44
11/19	21 42.9	-23 07	0.69	1.14	16.2	59.5	83	19	+0.33	-47
11/29	22 01.5	-20 28	0.74	1.11	16.3	60.6	78	106	-1.00	-51

(136993) 1998 ST49 (2012 Sep-Oct, H = 17.6)

Galad (2007) reported a period of 2.3 h for this NEA. The diameter is a little under a kilometer.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
09/20	01 26.8	-35 23	0.29	1.24	16.8	32.1	139	121	+0.20	-79
09/25	01 17.6	-34 14	0.24	1.20	16.3	31.4	141	71	+0.74	-81
09/30	01 03.1	-31 55	0.20	1.17	15.7	30.2	144	40	+1.00	-85
10/05	00 40.4	-27 21	0.15	1.13	15.0	28.1	148	71	-0.79	-88
10/10	00 04.0	-18 01	0.11	1.10	14.2	25.8	151	128	-0.34	-76
10/15	23 04.4	+01 10	0.08	1.06	13.6	32.3	145	152	+0.00	-52
10/20	21 31.7	+29 27	0.08	1.03	14.1	56.9	119	72	+0.27	-16
10/25	19 39.9	+47 52	0.10	1.01	15.3	78.6	96	64	+0.79	+12

(163364) 2002 OD20 (2012 Oct-Nov, H = 18.8, PHA)

There are no entries in the lightcurve database (LCDB, Warner *et al.*) for 2002 OD20. The estimated size is 0.5 km. This is fainter than we normally include but it's a rare opportunity to observe this PHA.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/20	03 24.0	+25 36	0.67	1.61	19.9	17.4	151	145	+0.27	-26
10/25	03 17.4	+25 15	0.63	1.59	19.6	14.0	157	76	+0.79	-27
10/30	03 09.1	+24 43	0.60	1.57	19.3	10.2	164	14	-1.00	-28
11/04	02 59.5	+23 59	0.57	1.55	19.0	6.4	170	50	-0.78	-30
11/09	02 48.8	+23 03	0.54	1.53	18.8	4.2	173	114	-0.30	-32
11/14	02 37.5	+21 56	0.52	1.51	18.8	6.6	170	169	+0.00	-35
11/19	02 26.1	+20 38	0.51	1.48	18.9	11.3	163	93	+0.33	-37
11/24	02 15.1	+19 15	0.50	1.46	19.0	16.3	155	26	+0.82	-39

(144411) 2004 EW9 (2012 Sep-Nov, H = 16.6)

Pravec *et al.* (2004) found a period of 49.94 h for this asteroid along with an amplitude at least 0.9 magnitude. The estimated size is 1.4 km. Given the long period, this a target best suited to a campaign among several observers at different longitudes.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
09/20	03 06.8	+49 22	0.36	1.20	16.6	50.0	114	149	+0.20	-8
09/30	02 40.3	+47 23	0.39	1.27	16.6	39.1	127	52	+1.00	-12
10/10	02 14.0	+44 13	0.42	1.35	16.7	28.9	139	83	-0.34	-16
10/20	01 51.6	+40 07	0.47	1.43	16.8	20.3	150	125	+0.27	-21
10/30	01 35.7	+35 42	0.54	1.50	17.0	15.5	156	22	-1.00	-26
11/09	01 26.6	+31 36	0.63	1.58	17.4	15.5	155	128	-0.30	-31
11/19	01 23.3	+28 10	0.73	1.66	18.0	18.4	148	82	+0.33	-34
11/29	01 24.7	+25 31	0.86	1.73	18.5	21.7	140	45	-1.00	-37

3200 Phaethon (2012 Oct-Nov, H = 14.6, PHA)

This is a relatively large target among this quarter's offerings: about 5 km. It makes the closest approach to the Sun of all the named asteroids, only 0.14 AU, and its orbit resembles more one of a comet. However, there have been no obvious cometary signs

observed over the years. This object is considered to be the parent body of the Geminid meteor shower. The rotation period is about 3.6 h.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/01	03 36.7	+45 11	1.41	2.12	18.1	23.8	121	48	-0.99	-8
10/06	03 25.3	+45 19	1.38	2.14	18.0	21.8	127	32	-0.71	-10
10/11	03 12.3	+45 15	1.36	2.17	17.9	19.7	133	84	-0.24	-11
10/16	02 58.2	+44 55	1.34	2.19	17.9	17.5	139	145	+0.00	-12
10/21	02 43.4	+44 19	1.33	2.21	17.8	15.3	144	122	+0.38	-14
10/26	02 28.3	+43 26	1.32	2.23	17.7	13.4	149	61	+0.86	-16
10/31	02 13.6	+42 16	1.33	2.25	17.7	12.0	152	27	-0.99	-18
11/05	01 59.7	+40 53	1.34	2.27	17.7	11.3	153	72	-0.69	-20

(214869) 2007 PA8 (2012 Oct and 2012 Jan, H = 16.2, PHA)

2007 PA8 is an NEA with an estimated diameter of 1.6 km. There are no entries in the LCDB. This asteroid has two good apparitions in late 2012 and early 2013, the gap being when the asteroid gets too close to the Sun in 2012 November-December. An ephemeris for before and after conjunction are included below.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/01	00 54.5	-01 52	0.25	1.25	14.3	6.4	172	12	-0.99	-65
10/06	00 59.8	-03 02	0.21	1.21	13.9	7.2	171	65	-0.71	-66
10/11	01 07.1	-04 35	0.18	1.17	13.5	9.9	168	123	-0.24	-67
10/16	01 18.2	-06 39	0.14	1.13	13.1	13.7	164	158	+0.00	-69
10/21	01 36.2	-09 36	0.11	1.10	12.6	18.4	160	96	+0.38	-70
10/26	02 09.0	-14 11	0.08	1.07	12.1	24.7	153	45	+0.86	-68
10/31	03 17.5	-21 36	0.06	1.04	11.6	36.3	142	40	-0.99	-56
11/05	05 44.4	-29 17	0.04	1.01	11.7	60.8	117	53	-0.69	-27

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
01/01	12 09.1	-04 14	0.30	1.06	16.2	66.7	97	43	-0.88	+57
01/06	12 10.8	-03 43	0.32	1.09	16.2	61.6	102	22	-0.41	+58
01/11	12 11.2	-03 06	0.34	1.13	16.3	56.4	107	96	-0.01	+58
01/16	12 10.0	-02 23	0.35	1.17	16.3	51.1	113	168	+0.22	+59
01/21	12 07.2	-01 32	0.37	1.21	16.3	45.8	119	129	+0.69	+59
01/26	12 03.1	-00 35	0.38	1.25	16.3	40.3	125	68	+0.99	+60
01/31	11 57.6	+00 29	0.40	1.29	16.3	34.8	132	5	-0.85	+60
02/05	11 51.1	+01 38	0.42	1.33	16.3	29.2	139	68	-0.34	+61

2006 VB14 (2012 Dec, H = 18.6)

The rotation period for this 0.6 km NEA has yet to be determined. It will be moving across the sky fairly rapidly, so numerous shorter exposures to "beat down the noise" may be required. Fortunately for Northern Hemisphere observers, it's fairly bright the first part of December.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
12/01	05 37.5	+65 11	0.14	1.09	15.9	39.7	135	46	-0.95	+17
12/06	03 52.7	+52 28	0.11	1.08	15.2	28.8	148	91	-0.57	-1
12/11	02 49.0	+31 15	0.11	1.08	15.1	29.8	147	166	-0.08	-25
12/16	02 14.0	+10 10	0.12	1.07	15.8	44.7	130	94	+0.10	-48
12/21	01 54.2	-04 49	0.15	1.05	16.6	58.2	114	25	+0.58	-63
12/26	01 42.4	-14 26	0.18	1.04	17.3	67.6	103	53	+0.95	-73
12/31	01 35.0	-20 44	0.22	1.02	17.8	74.1	93	109	-0.94	-78
01/05	01 30.1	-25 07	0.26	1.00	18.3	78.9	86	145	-0.52	-81

(33342) 1998 WT24 (2012 Nov-Dec, H = 17.9)

Based on LCDB entries, the last period determination (3.69 h) was based on observations in 2001, more than a decade ago. That's because favorable apparitions are rare. The next "highly favorable" one is not until 2015 December (V ~ 11.3) and the one after that is 2029, so work this one now if possible. The estimated diameter is 400 meters.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/15	09 51.4	+08 30	0.33	1.02	18.1	75.6	86	101	+0.02	+44
11/20	10 09.2	+08 10	0.30	1.02	18.0	76.3	87	169	+0.44	+47
11/25	10 29.9	+07 46	0.27	1.01	17.8	77.6	87	132	+0.89	+51
11/30	10 54.4	+07 15	0.25	1.00	17.7	79.6	86	79	-0.98	+56
12/05	11 23.7	+06 32	0.23	0.99	17.5	82.8	84	27	-0.67	+61
12/10	11 59.1	+05 31	0.21	0.97	17.5	87.3	81	34	-0.16	+65
12/15	12 41.6	+04 07	0.19	0.95	17.5	93.5	75	98	+0.04	+67
12/20	13 31.1	+02 14	0.18	0.93	17.7	101.1	69	151	+0.48	+63

(203471) 2002 AU4 (2012 Dec, H = 18.7)

Here is a good opportunity to get a phase curve for an asteroid. The phase angle changes dramatically during the apparition and reaches a minimum of 8.5°. For best estimates of H-G, it would better if the phase angle was at least < 3°, but this may be “good enough.” There are no entries in the LCDB for the 0.5 km NEA.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
12/05	09 47.9	-35 51	0.15	0.99	17.7	83.3	88	45	-0.67	+14
12/10	09 10.6	-29 56	0.13	1.02	17.0	71.5	101	67	-0.16	+12
12/15	08 25.7	-20 51	0.11	1.04	16.2	56.0	119	137	+0.04	+10
12/20	07 35.0	-08 11	0.10	1.06	15.6	36.7	140	119	+0.48	+6
12/25	06 43.8	+05 58	0.11	1.08	15.1	17.0	161	47	+0.90	+1
12/30	05 58.3	+17 58	0.12	1.10	15.1	9.3	170	26	-0.98	-3
01/04	05 22.0	+26 21	0.14	1.12	15.9	19.5	158	98	-0.62	-6
01/09	04 55.2	+31 47	0.17	1.13	16.6	28.8	146	168	-0.11	-7

1994 XD (2012 Nov-Dec, H = 19.1, PHA, Binary)

Radar observations in 2005 (Benner *et al.*) determined that this NEA is a binary. The primary size was estimated at 600 meters with a lower bound size of 150 meters for the secondary. This implies mutual event depths of about 0.07 mag, if total. These should be observable in higher-precision data.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/25	11 45.7	-41 46	0.06	0.96	17.7	119.4	58	143	+0.89	+19
11/30	07 46.2	-13 59	0.06	1.02	15.1	57.9	119	48	-0.98	+5
12/05	06 15.3	+06 25	0.10	1.08	15.4	24.3	153	50	-0.67	-5
12/10	05 40.5	+13 59	0.16	1.14	16.0	10.1	168	125	-0.16	-9
12/15	05 22.9	+17 33	0.21	1.20	16.6	4.9	174	155	+0.04	-10
12/20	05 12.9	+19 35	0.28	1.26	17.4	7.8	170	83	+0.48	-11
12/25	05 07.0	+20 53	0.34	1.32	18.1	11.8	164	21	+0.90	-12
12/30	05 03.7	+21 47	0.41	1.37	18.7	15.3	158	39	-0.98	-12

2062 Aten (2012 Nov-Dec, H = 16.8)

This namesake for the Aten NEA group (semi-major axis < 1.0 AU) has only one period determination in the LCDB: 40.8 h (Mottola *et al.*, 1995). This apparition could provide an excellent opportunity for a campaign involving observers at different longitudes to confirm and/or refine those results.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/01	05 45.8	-55 08	0.34	1.10	16.9	63.6	99	78	-0.96	-31
11/11	05 06.0	-54 16	0.32	1.11	16.7	59.7	104	96	-0.12	-37
11/21	04 21.7	-50 57	0.31	1.13	16.6	56.1	109	87	+0.55	-44
12/01	03 41.1	-44 35	0.30	1.14	16.4	53.2	113	74	-0.95	-52
12/11	03 10.3	-35 24	0.30	1.14	16.4	51.5	115	127	-0.08	-59
12/21	02 50.9	-24 26	0.31	1.14	16.4	51.7	114	47	+0.58	-63
12/31	02 41.4	-13 03	0.32	1.14	16.6	53.5	111	92	-0.94	-61
01/10	02 39.5	-02 22	0.35	1.13	16.9	56.4	106	131	-0.05	-54

3908 Nyx (2012 Nov-Dec, H = 17.4)

The LCDB lists a rotation period of 4.426 h along with shape and spin axis models based on lightcurve inversion and/or radar. As mentioned before, new lightcurve observations can be used to study YORP as well as help analysis using new radar data. Go to echo.jpl.nasa.gov/asteroids/benner.etal.2002.nyx.pdf to download a paper by Benner *et al.* showing the derived shape.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/01	20 34.1	-12 49	0.35	1.05	17.6	71.4	89	115	-0.96	-28
11/11	21 17.4	-10 10	0.33	1.04	17.5	71.6	90	130	-0.12	-37
11/21	22 08.1	-06 31	0.32	1.05	17.4	69.7	93	2	+0.55	-46
12/01	23 04.7	-01 57	0.31	1.07	17.3	65.7	97	109	-0.95	-54
12/11	00 04.0	+03 04	0.33	1.10	17.2	60.3	103	136	-0.08	-58
12/21	01 01.8	+07 50	0.36	1.15	17.4	54.8	108	9	+0.58	-55
12/31	01 54.7	+11 49	0.41	1.19	17.6	50.2	111	98	-0.94	-48
01/10	02 41.2	+14 52	0.48	1.25	17.9	46.6	113	138	-0.05	-40

(137924) 2000 BD19 (2012 Dec – 2013 Jan, H = 17.1)

What makes this NEA particularly interesting is that has among the smallest perihelion distances of any numbered asteroid and also has one of largest aphelion distances among the Atens (the orbital eccentricity is almost 0.9). The estimated diameter is 1 km. There are no entries in the LCDB.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
12/01	13 40.7	+31 08	0.56	0.92	18.5	79.3	67	96	-0.95	+79
12/11	13 28.1	+42 55	0.52	1.06	18.3	66.9	84	64	-0.08	+73
12/21	13 02.2	+56 26	0.50	1.19	18.1	54.6	101	116	+0.58	+61
12/31	11 48.2	+70 00	0.51	1.29	17.9	43.2	116	64	-0.94	+46
01/10	08 25.5	+75 59	0.55	1.38	18.1	35.6	125	121	-0.05	+32
01/20	05 50.2	+69 31	0.63	1.45	18.4	33.1	126	61	+0.60	+20
01/30	05 03.9	+61 07	0.74	1.51	18.9	33.8	121	86	-0.92	+12
02/09	04 51.9	+54 19	0.88	1.56	19.3	35.3	114	124	-0.02	+6

(153958) 2002 AM31 (2012 Nov-Dec, H = 18.1, PHA)

There are no lightcurve parameters in the LCDB for 2002 AM31, an NEA with estimated size of 0.7 km. The asteroid made a close flyby in July. It becomes a photometry target the final two months of the year, when it might be possible for those with larger instruments (1-meter or so) to get a good rotation period.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/01	07 02.5	+08 45	0.41	1.21	18.5	49.5	112	45	-0.96	+6
11/11	06 53.1	+08 46	0.42	1.27	18.4	40.1	124	84	-0.12	+4
11/21	06 37.4	+09 13	0.43	1.34	18.3	29.9	137	126	+0.55	+1
12/01	06 17.2	+10 05	0.46	1.41	18.2	19.5	152	10	-0.95	-3
12/11	05 55.6	+11 16	0.50	1.47	18.2	10.3	164	135	-0.08	-7
12/21	05 36.3	+12 36	0.56	1.54	18.4	7.6	168	77	+0.58	-10
12/31	05 22.0	+13 57	0.64	1.60	19.0	12.7	159	47	-0.94	-13
01/10	05 13.3	+15 15	0.74	1.66	19.6	18.2	148	172	-0.05	-14

2003 UC20 (2012 Nov-Dec, H = 18.7, PHA)

2003 UC20 is an NEA with an estimated effective diameter of 0.7 km. There are no entries in the LCDB for the asteroid.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/20	08 47.7	-01 17	0.19	1.04	16.9	67.5	102	166	+0.44	+25
11/25	08 50.6	-04 41	0.17	1.04	16.6	65.8	105	112	+0.89	+24
11/30	08 52.8	-08 48	0.15	1.04	16.3	64.6	108	58	-0.98	+22
12/05	08 53.9	-13 58	0.13	1.04	16.0	63.9	109	25	-0.67	+19
12/10	08 53.6	-20 39	0.11	1.03	15.6	64.2	110	71	-0.16	+15
12/15	08 51.1	-29 34	0.09	1.02	15.3	66.5	109	126	+0.04	+9
12/20	08 44.6	-41 40	0.08	1.01	15.1	71.9	104	125	+0.48	+1
12/25	08 28.6	-57 39	0.07	0.99	15.1	81.7	94	98	+0.90	-11

4179 Toutatis (2012 Jul-Sep, H = 15.3, PHA, NPA)

This 2.6 km NEA is one of the prime examples of a “tumbler”, an asteroid in non-principal axis rotation (see Pravec *et al.*, 2005). The lightcurve will be anything from regular and so don’t expect it to repeat itself. The two periods (rotation and precession) are 178 and 130 h. The amplitude has ranged from 0.15 to 1.0 mag or more.

The asteroid has a close approach in December (0.046 AU), when it will be as bright as V ~ 10.4. It was a good photometric target earlier this year. Comparisons between any lightcurves obtained at

that time and during the December apparition could be very interesting. As noted in this article in 39-3, the wide range of phase angles might allow finding a good phase curve (G). However, the complex lightcurve of a tumbler may make it hard to determine a good average magnitude value for a given night.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
12/01	21 37.5	-18 34	0.09	0.96	13.9	103.3	72	134	-0.95	-45
12/11	00 45.1	-02 45	0.05	1.00	11.2	67.5	110	143	-0.08	-66
12/21	04 48.3	+18 47	0.08	1.06	10.8	15.5	163	65	+0.58	-17
12/31	06 03.9	+21 55	0.14	1.12	11.9	7.6	171	38	-0.94	+0
01/10	06 32.1	+22 32	0.22	1.20	13.1	10.1	168	167	-0.05	+6
01/20	06 47.5	+22 43	0.31	1.28	14.2	14.4	161	60	+0.60	+9
01/30	06 59.1	+22 42	0.41	1.37	15.1	18.7	154	60	-0.92	+12
02/09	07 09.9	+22 34	0.53	1.45	15.9	22.4	146	163	-0.02	+14

2010 BB (2012 Dec – 2013 Jan, H = 20.0, PHA)

This small (0.3 km) NEA has no entries in the LCDB. The observing window extends into 2013 January, assuming good photometry can still be obtained at V ~ 18.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
12/20	20 22.7	+20 09	0.06	0.95	18.8	119.8	57	51	+0.48	-10
12/23	21 24.0	+20 49	0.06	0.96	18.0	111.4	65	65	+0.76	-21
12/26	22 34.8	+19 46	0.06	0.97	17.3	101.1	76	81	+0.95	-33
12/29	23 43.8	+16 57	0.06	0.98	17.0	90.7	86	101	-1.00	-43
01/01	00 41.3	+13 23	0.06	0.99	16.9	82.1	94	126	-0.88	-49
01/04	01 25.0	+10 03	0.07	1.00	17.0	76.0	100	156	-0.62	-52
01/07	01 57.6	+07 20	0.08	1.01	17.2	72.0	103	168	-0.30	-52
01/10	02 22.3	+05 13	0.10	1.01	17.4	69.5	105	131	-0.05	-51

(52762) 1998 MT24 (2012 Dec, H = 14.6)

Pravec et al. (1998) reported a period of 12.07 h for this asteroid. This begs for a collaboration among at least two observers who are well-separated in longitude. Pravec et al. (2012) report a size of 6.7 km based on an assumed albedo of 0.05, which was based on their derived value of $G = 0.0$, implying a dark asteroid.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
12/01	10 13.4	+37 15	1.06	1.64	17.3	35.4	106	53	-0.95	+55
12/06	10 22.0	+36 06	0.97	1.59	17.1	36.0	109	32	-0.57	+57
12/11	10 30.3	+34 45	0.88	1.54	16.9	36.5	111	81	-0.08	+59
12/16	10 38.3	+33 10	0.80	1.50	16.6	37.0	114	142	+0.10	+61
12/21	10 46.0	+31 16	0.71	1.45	16.3	37.5	116	135	+0.58	+62
12/26	10 53.4	+28 55	0.63	1.40	15.9	37.9	119	86	+0.95	+64
12/31	11 00.6	+25 55	0.55	1.35	15.6	38.2	122	36	-0.94	+65
01/05	11 07.6	+22 00	0.47	1.31	15.2	38.6	124	38	-0.52	+66

2002 AY1 (2012 Dec, H = 20.9, PHA)

There are no entries in the LCDB for this NEA of about 0.2 km size. The semi-major axis is only 0.78 AU. With an orbital eccentricity of 0.44, the asteroid distance from the Sun ranges from about 0.44 to 1.12 AU, or almost entirely within the Earth's orbit.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
12/20	11 40.1	+59 54	0.19	1.07	19.5	58.7	112	118	+0.48	+55
12/23	11 39.5	+61 56	0.16	1.06	19.1	58.2	114	99	+0.76	+53
12/26	11 36.3	+64 51	0.14	1.05	18.6	57.7	116	79	+0.95	+50
12/29	11 27.3	+69 19	0.11	1.04	18.1	57.3	117	64	-1.00	+46
01/01	10 54.4	+76 44	0.08	1.02	17.4	57.4	119	68	-0.88	+38
01/04	04 22.7	+84 04	0.06	1.01	16.7	59.9	117	96	-0.62	+23
01/07	00 54.9	+54 37	0.04	0.99	16.3	72.1	106	137	-0.30	-8
01/10	00 31.0	+12 31	0.04	0.98	17.3	95.0	82	107	-0.05	-50

(99942) Apophis (2012 Dec – 2013 Feb, H = 19.3, PHA)

This is probably the most famous and debated NEA of recent times. The rotation period for the 400 meter NEA is about 30.4 h, based on observations in 2005 analyzed by Behrend. Again, such a period is best confirmed and refined by several observers at multiple longitudes, in this case, those south of the equator.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
12/10	11 38.1	-26 13	0.11	0.96	17.9	99.9	74	34	-0.16	+34
12/20	10 56.7	-27 13	0.10	0.99	17.2	83.1	91	153	+0.48	+29
12/30	10 09.4	-27 11	0.10	1.02	16.6	66.5	108	55	-0.98	+23
01/09	09 13.6	-24 52	0.10	1.04	16.1	50.0	126	98	-0.11	+16
01/19	08 16.0	-19 16	0.10	1.06	15.8	36.3	140	101	+0.50	+9
01/29	07 29.7	-11 32	0.11	1.08	16.0	31.6	145	42	-0.96	+3
02/08	07 00.4	-03 55	0.13	1.09	16.5	36.3	139	158	-0.07	+0
02/18	06 46.7	+02 23	0.16	1.10	17.1	43.8	130	45	+0.52	+0