

LIGHTCURVE PHOTOMETRY OPPORTUNITIES: 2018 OCTOBER-DECEMBER

Brian D. Warner
Center for Solar System Studies / MoreData!
446 Sycamore Ave.
Eaton, CO 80615 USA
brian@MinorPlanetObserver.com

Alan W. Harris
MoreData!
La Cañada, CA 91011-3364 USA

Josef Ďurech
Astronomical Institute
Charles University
18000 Prague, CZECH REPUBLIC
durech@sirrah.troja.mff.cuni.cz

Lance A.M. Benner
Jet Propulsion Laboratory
Pasadena, CA 91109-8099 USA
lance.benner@jpl.nasa.gov

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 or might be radar targets. 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 several lists of asteroids that are prime targets for photometry during the period 2018 October-December.

In the first three sets of tables, “Dec” is the declination and “U” is the quality code of the lightcurve. See the asteroid lightcurve data base (LCDB; Warner et al., 2009) documentation for an explanation of the U code:

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

The ephemeris generator on the CALL web site allows you to create custom lists for objects reaching $V \leq 18.0$ during any month in the current year, e.g., limiting the results by magnitude and declination.

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

We refer you to past articles, e.g., *Minor Planet Bulletin* **36**, 188, for more detailed discussions about the individual lists and points of advice regarding observations for objects in each list.

Once you’ve obtained and 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. We urge you to consider submitting your raw data to the ALCDEF database. This can be accessed for uploading and downloading data at

<http://www.alcdef.org>

Containing almost 3.2 million observations for more than 13380 objects, we believe this to be the largest publicly available database of raw asteroid time-series lightcurve data.

Now that many backyard astronomers and small colleges have access to larger telescopes, we have expanded the photometry opportunities and spin axis lists to include asteroids reaching $V = 15.5$ and brighter (sometimes 15.0 when the list has more than 100 objects).

Lightcurve/Photometry Opportunities

Objects with $U = 3-$ or 3 are excluded from this list since they will likely appear in the list for shape and spin axis modeling. Those asteroids rated $U = 1$ 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.

An entry in italics is a near-Earth asteroid (NEA).

Number	Name	Brightest			Period	LCDB Data		U
		Date	Mag	Dec		Amp		
4025	Ridley	10	01.2	15.1	-1			
2487	Juhani	10	01.8	14.6	+5			
2835	Ryoma	10	03.1	15.0	+4	18.234	0.17	2
3844	Lujiaxi	10	04.1	14.7	+0	13.33	0.34	2+
14510	1996 ES2	10	07.3	15.0	+12			
917	Lyka	10	07.4	13.1	+11	7.92	0.10-0.14	2
5321	Jagras	10	09.3	14.6	+12			
1236	Thais	10	10.3	13.6	-8	>72.	0.08	1
2056	Nancy	10	10.4	13.8	+10	>15.	0.08	1
7230	Lutz	10	11.0	14.7	+6			
2010	Chebyshev	10	12.1	14.6	+8			
2070	Humason	10	12.1	14.7	+9			
3994	Ayashi	10	12.5	14.7	+4		0.1	
1707	Chantal	10	14.1	13.8	+10	>10.	0.2	1
1053	Vigdis	10	15.6	14.9	+10			
2244	Tesla	10	17.6	14.7	-4			
3381	Mikkola	10	18.0	14.9	+16			
55567	2002 CS6	10	19.2	15.0	+12	6.646	0.48	2
6582	Flagsymphony	10	19.9	14.4	+10			
3069	Heyrovsky	10	21.8	15.0	+11	6.6	0.23	2
1390	Abastumani	10	22.9	13.9	+11	17.1	0.15	2
1033	Simona	10	23.2	14.6	+6	10.07	0.04	1+
2178	Kazakhstania	10	26.6	14.9	+15			
4467	Kaidanovskij	10	29.2	14.6	+14	>12.	0.03	1
16529	Dangoldin	10	31.4	15.0	-8			
6801	Strekov	11	01.0	14.9	+13	6.173	0.17	2
5703	Hevelius	11	01.1	15.0	+15			
2413	van de Hulst	11	01.2	15.0	+2			
7485	Changchun	11	01.9	14.9	-3			
1112	Polonia	11	04.4	13.8	+29	82.5	0.20	2
6540	Stepling	11	06.2	14.9	+11			
1385	Gelria	11	07.4	14.0	+6		0.36	
6608	Davidecrespi	11	09.3	14.9	+15	>20.	0.3	2
1839	Ragazza	11	15.9	14.6	+19			
1475	Yalta	11	17.2	14.4	+14			
37306	2001 KW46	11	18.0	14.7	+19	5.621	0.10	2
2290	Helffrich	11	18.4	14.7	-2		0.10	
1079	Mimosa	11	19.1	14.5	+21	64.6	0.07-0.13	2-
7409	1990 BS	11	19.6	14.7	+19	31.61	0.20	2
2946	Muchachos	11	21.3	15.0	+21			
3769	Arthurmiller	11	24.7	15.0	+21			
1965	van de Kamp	11	27.6	14.5	+20	>36.	0.5	1
2245	Hekatostos	11	29.9	14.3	+15	20.61	0.21	2+
3204	Lindgren	11	30.3	14.7	+19	5.614	0.15	2
2678	Aavasaksa	12	04.5	14.4	+24	>24.	0.4	1
2085	Henan	12	07.0	14.9	+18	>24.	0.25	1
1544	Vinterhansenia	12	07.9	14.0	+24	13.77	0.15-0.18	2
1826	Miller	12	10.4	14.7	+27	30.049	0.08	2
4807	Noboru	12	20.1	14.8	+24			
5522	De Rop	12	20.5	14.9	+24			
2872	Gentelec	12	23.6	15.0	+21	10.624	0.16	2
72396	2001 CU20	12	24.9	14.9	+25	8.0467	0.1	2
1553	Bauersfelda	12	30.1	14.8	+22	51.191	0.26	2

Low Phase Angle Opportunities

The Low Phase Angle list includes asteroids that reach very low phase angles. The “ α ” column is the minimum solar phase angle for the asteroid. 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.” Use the on-line query form for the LCDB to get more details about a specific asteroid.

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

You will have the best chance of success working objects with low amplitude and periods that allow covering at least half a cycle every night. Objects with large amplitudes and/or long periods are much more difficult for phase angle studies since, for proper analysis, the data must be reduced to the average magnitude of the asteroid for each night. This reduction requires that you determine the period and the amplitude of the lightcurve; for long period objects that can be difficult. Refer to Harris *et al.* (1989; *Icarus* **81**, 365-374) for the details of the analysis procedure.

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 when using average light, which is the method used for values listed by the Minor Planet Center.

The International Astronomical Union (IAU) has adopted a new system, H-G₁₂, introduced by Muinonen *et al.* (2010; *Icarus* **209**, 542-555). It will be some years before H-G₁₂ becomes the standard. Furthermore, it still needs refinement. That can be done mostly by having data for more asteroids, but only if at very low and moderate phase angles. We strongly encourage obtaining data every degree between 0° to 7°, the non-linear part of the curve that is due to the opposition effect. At angles $\alpha > 7^\circ$, well-calibrated data every 2° or so out to about 25-30°, if possible, should be sufficient. Coverage beyond about 50° is not generally helpful since the H-G system is best defined with data from 0-30°.

Num	Name	Date	α	V	Dec	Period	Amp	U
66	Maja	10 06.7	0.28	11.7	+06	9.7351	0.21-0.45	3
83	Beatrice	10 07.7	0.72	11.9	+04	10.16	0.18	3
766	Moguntia	10 08.0	0.63	13.9	+07	4.816	0.06-0.23	3
485	Genua	10 08.4	0.25	11.7	+05	17.59	0.12-0.16	3
160	Una	10 09.5	0.33	12.2	+07	11.033	0.10-0.18	3
569	Misa	10 16.9	0.93	12.8	+11	11.595	0.09-0.25	3
968	Petunia	10 22.1	0.09	14.0	+11	61.280	0.30-0.38	3
1390	Abastumani	10 22.9	0.06	13.9	+11	17.100	0.15	2
767	Bondia	10 30.0	0.96	13.6	+11	>60.	0.1	2
368	Haidea	11 08.4	0.15	13.7	+17	9.823	0.15-0.23	3
222	Lucia	11 09.5	0.48	13.9	+15	7.837	0.25-0.41	3
425	Cornelia	11 13.4	0.37	13.8	+17	17.505	0.19-0.21	3
508	Princeton	11 13.6	0.72	12.8	+20	52.8	0.40	3
447	Valentine	11 17.9	0.73	12.8	+17	9.651	0.18	3
456	Abnoba	11 17.9	0.67	13.7	+17	18.281	0.2	-0.32 3
293	Brasilia	11 18.1	0.89	13.7	+17	8.17	0.20-0.30	3-
278	Paulina	11 20.9	0.25	13.5	+19	6.497	0.32-0.51	3
12	Victoria	11 22.3	0.45	10.1	+19	8.660	0.04-0.42	3
492	Gismonda	11 24.2	0.24	13.7	+21	6.488	0.10-0.14	3
1307	Cimmeria	11 28.1	0.75	14.0	+20	2.820	0.29-0.31	3
419	Aurelia	11 29.6	0.56	12.7	+20	16.784	0.07-0.18	3
153	Hilda	12 02.0	0.80	13.6	+18	5.959	0.04-0.20	2+
128	Nemesis	12 04.2	0.33	10.5	+21	77.81	0.08-0.10	3-
1303	Luthera	12 08.7	0.68	13.9	+25	5.878	0.05-0.06	3
455	Bruchsalia	12 11.3	0.44	11.8	+24	11.85	0.10-0.35	2+
847	Agnia	12 11.5	0.35	13.4	+24	14.827	0.05-0.51	3
241	Germania	12 13.2	0.44	11.6	+24	15.51	0.05-0.17	3
184	Dejopeja	12 15.4	0.48	12.7	+25	6.455	0.25-0.3	3
901	Brunsia	12 19.9	0.14	13.9	+23	3.136	0.09-0.28	3
700	Auravictrix	12 20.2	0.79	13.6	+22	6.075	0.18-0.43	3
122	Gerda	12 21.4	0.74	12.2	+21	10.685	0.10-0.26	3
90	Antiope	12 24.5	0.34	13.1	+25	16.509	0.05-0.88	3
548	Kressida	12 31.1	0.68	12.6	+22	11.940	0.44	2

Shape/Spin Modeling Opportunities

Those doing work for modeling should contact Josef Ďurech at the email address above. If looking to add lightcurves for objects with existing models, visit the Database of Asteroid Models from Inversion Techniques (DAMIT) web site

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

An additional dense lightcurve, along with sparse data, could lead to the asteroid being added to or improving one in DAMIT, thus increasing the total number of asteroids with spin axis and shape models.

Included in the list below are objects that:

1. Are rated U = 3– or 3 in the LCDB
2. Do not have reported pole in the LCDB Summary table
3. Have at least three entries in the Details table of the LCDB where the lightcurve is rated U $\geq$ 2.

The caveat for condition #3 is that no check was made to see if the lightcurves are from the same apparition or if the phase angle bisector longitudes differ significantly from the upcoming apparition. The last check is often not possible because the LCDB does not list the approximate date of observations for all details records. Including that information is an on-going project.

Favorable apparitions are in bold text. NEAs are in italics.

Num	Name	Brightest			LCDB Data		U
		Date	Mag	Dec	Period	Amp	
1376	Michelle	10 02.1	13.7	+1	5.9748	0.03-0.20	3
2017	Wesson	10 03.6	14.5	+1	3.4158	0.38-0.60	3
1225	Ariane	10 05.7	14.3	+5	5.5068	0.30-0.36	3
766	Moguntia	10 08.0	13.9	+7	4.8164	0.06-0.23	3
78	Diana	10 08.3	11.8	+14	7.2991	0.02-0.30	3
256	Walpurga	10 11.0	14.2	+2	16.664	0.25-0.58	3
5080	Oja	10 11.3	14.6	+12	7.222	0.31-0.39	3
656	Beagle	10 14.4	14.6	+8	7.035	0.57-1.20	3
5985	1942 RJ	10 16.8	14.6	+22	9.7212	0.11-0.18	3
2151	Hadwiger	10 18.0	14.1	+8	5.872	0.07-0.38	3
3223	Forsius	10 19.4	14.4	+0	2.343	0.20-0.28	3
465	Alekto	10 21.3	15.0	+17	10.936	0.12-0.18	3
1660	Wood	10 21.9	14.3	+14	6.809	0.14-0.26	3
3447	Burckhalter	10 24.9	14.6	+33	59.8	0.10-0.39	3
1845	Helewalda	10 25.5	15.3	-2	7.2786	0.15-0.34	3-
654	Zelinda	10 29.4	11.7	+37	31.735	0.08- 0.3	3
195	Eurykleia	11 04.1	12.9	+21	16.521	0.10-0.24	3
619	Triberga	11 04.1	13.0	+3	29.311	0.30-0.45	3
2903	Zhuhai	11 04.2	14.8	+20	5.263	0.32-0.54	3
1523	Pieksamaki	11 04.5	15.1	+23	5.3202	0.28- 0.5	3
834	Burnhamia	11 04.6	14.2	+12	13.875	0.15-0.22	3
860	Ursina	11 06.5	14.1	+36	9.386	0.22-0.50	3
205	Martha	11 07.7	12.7	+13	14.911	0.10-0.50	3
368	Haidea	11 08.3	13.7	+17	9.823	0.15-0.23	3
4910	Kawasato	11 09.8	15.2	+10	4.662	0.10-0.22	3
4451	Grieve	11 10.9	14.6	+7	6.864	0.56-0.80	3
1830	Pogson	11 11.3	14.8	+10	2.57	0.10-0.18	3
1369	Ostanina	11 12.8	15.2	+3	8.4001	0.3 -1.11	3
545	Messalina	11 13.8	13.7	+34	7.2	0.22-0.27	3
2004	Lexell	11 14.3	14.5	+22	5.4429	0.42-0.51	3
755	Quintilla	11 16.0	14.8	+15	4.552	0.08-0.45	3
643	Scheherezade	11 17.2	14.3	+25	14.161	0.23-0.37	3
456	Abnoba	11 17.9	13.7	+17	18.281	0.2- 0.32	3
4497	Taguchi	11 18.2	13.9	+6	3.563	0.11-0.21	3
2642	Vesale	11 19.3	15.2	+4	5.566	0.12-0.39	3
1308	Halleria	11 20.5	14.8	+27	6.028	0.14-0.17	3
750	Oskar	11 21.9	14.8	+19	6.2584	0.07-0.20	3
261	Prymno	11 25.6	12.2	+17	8.002	0.13-0.20	3
101	Helena	11 25.8	11.7	+37	23.08	0.09-0.13	3
267	Tirza	11 26.9	14.2	+20	7.648	0.18- 0.4	3
8345	Ulmerspatz	11 27.2	14.6	+48	17.13	0.47-1.05	3-
3397	Leyla	11 30.8	15.2	+53	3.098	0.29-0.40	3
124	Alkeste	12 03.0	11.9	+18	9.906	0.08-0.30	3
939	Isberga	12 05.6	14.6	+27	2.9173	0.20-0.25	3
839	Valborg	12 08.8	14.6	+42	10.366	0.14-0.19	3
477	Italia	12 17.9	13.5	+32	19.413	0.15-0.32	3
1604	Tombaugh	12 19.0	14.7	+33	7.24	0.16-0.35	3-

Num	Name	Brightest			LCDB Data		U
		Date	Mag	Dec	Period	Amp	
901	Brunsia	12 19.9	13.9	+23	3.1363	0.09-0.28	3
453	Tea	12 22.2	13.3	+33	6.812	0.03-0.37	3
524	Fidelio	12 27.4	12.9	+34	14.198	0.18-0.22	3
913	Otila	12 30.4	15.0	+24	4.872	0.09-0.45	3

Radar-Optical Opportunities

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

These are based on *known* targets at the time the list was prepared. It is very common for newly discovered objects to move up the list and become radar targets on short notice. We recommend that you keep up with the latest discoveries the Minor Planet Center observing tools

In particular, monitor NEAs and be flexible with your observing program. In some cases, you may have only 1-3 days when the asteroid is within reach of your equipment. Be sure to keep in touch with the radar team (through Dr. Benner's email or their Facebook or Twitter accounts) if you get data. The team may not always be observing the target but your initial results may change their plans. In all cases, your efforts are greatly appreciated.

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. Note that *geocentric* positions are given. Use these web sites to generate updated and *topocentric* positions:

MPC: <http://www.minorplanetcenter.net/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" 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.

About YORP Acceleration

Many, if not all, of the targets in this section are near-Earth asteroids. These objects are particularly sensitive to YORP acceleration. YORP (Yarkovsky-O'Keefe-Radzievskii-Paddack) is the asymmetric thermal re-radiation of sunlight that can cause an asteroid's rotation period to increase or decrease. High precision lightcurves at multiple apparitions can be used to model the asteroid's *sidereal* rotation period and see if it's changing.

It usually takes four apparitions to have sufficient data to determine if the asteroid rotation rate is changing under the influence of YORP. This is why observing asteroids that already have well-known periods is still a valuable use of telescope time. It is even more so when considering the BYORP (binary-YORP) effect among binary asteroids that has stabilized the spin so that

acceleration of the primary body is not the same as if it would be if there were no satellite.

To help focus efforts in YORP detection, Table I gives a quick summary of this quarter's radar-optical targets. The family or group for the asteroid is given under the number name. Also under the name will be additional flags such as "PHA" for Potentially Hazardous Asteroid, NPAR for a tumbler, and/or "Bin" to indicate the asteroid is a binary (or multiple) system. If "Bin" is followed by "?" it means that the asteroid is a suspected but not confirmed binary. The period is in hours and, in the case of binary, for the primary. The Amp column gives the known range of lightcurve amplitudes. The App columns gives the number of different apparitions at which a lightcurve period was reported while the Last column gives the year for the last reported period. The R SNR column indicates the estimated radar SNR using the tool at

<http://www.naic.edu/~eriverav/scripts/index.php>

The "A" is for Arecibo and "G" is for Goldstone. Note that this calculator assumes full power at Arecibo.

Asteroid	Period	Amp	App	Last	R SNR
2018 EB NEA	1.221	0.54	1	2018	A 1540 G 88
(475534) 2006 TS7 NEA	-	-	-	-	A 1210 G 686
2002 VE68 NEA PHA	13.50	0.9	2	2010	A 4360 G 248
(65733) 1993 PC NEA	4.184	0.76 0.97	1	2013	A 172 G 10
(410088) 2007 EJ NEA	4.781	0.09 0.16	1	2015	A 236 G 55
(54660) 2000 UJ NEA	5.43	1.15	1	2009	A 116 G -
(162687) 2000 UH1 NEA	-	-	-	-	A 22 G -
(4953) 1990 MU NEA	14.218	0.68	1	1994?	A - G 22
(163899) 2003 SD220 NEA PHA NHATS	285	2.2	1	2015	A * G *
(141053) 2001 XT1 NEA	-	-	-	-	A 14 G -
(418884) 2008 WM64 NEA	-	-	-	-	A 1590 G 90

Table I. Summary of radar-optical opportunities in 2018 July-October. Data from the asteroid lightcurve database (Warner *et al.*, 2009; *Icarus* **202**, 134-146). *The SNRs for 2003 SD220 will be enormous: A: 1.76E+6, G: 96800.

The estimated SNR uses the current MPCORB absolute magnitude (H), a period of 4 hours (2 hours if $D \leq 170$ m) if it's not known, and the approximate minimum Earth distance during the current quarter. If the estimated diameter is, a period of 2 hours was used

If the SNR value is in bold text, the object was found on the radar planning pages listed above. Otherwise, the planning tool at

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

was used to find known NEAs that were $V < 18.0$ during the quarter. An object is usually placed on the list only if the estimated Arecibo SNR > 10 . This would produce a marginal signal, not enough for imaging, but might allow improving orbital parameters.

2018 EB (Oct, $H = 21.8$)

Warner (2018) found the period for this 130-meter NEA to be 1.2208 h. Even though the amplitude was 0.51 mag, the asteroid was at a large phase angle ($\sim 54^\circ$), and so there is a possibility that the period could be wrong. Rapid sky motion will require short exposures.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/04	06 10.5	+42 39	0.05	1.01	18.0	79.3	98	35	-0.32	+11
10/05	06 08.1	+33 04	0.04	1.01	17.7	77.9	100	45	-0.22	+6
10/06	06 05.9	+21 46	0.04	1.01	17.5	76.6	101	59	-0.13	+0
10/07	06 03.7	+09 21	0.04	1.01	17.4	75.6	102	75	-0.06	-6
10/08	06 01.6	-03 08	0.04	1.01	17.5	75.2	103	91	-0.02	-13
10/09	05 59.6	-14 36	0.04	1.01	17.6	75.4	102	104	+0.00	-18
10/10	05 57.6	-24 24	0.05	1.01	17.8	75.9	101	112	+0.01	-22
10/11	05 55.7	-32 26	0.05	1.01	18.1	76.5	101	117	+0.04	-25

(475534) 2006 TS7 (Oct, $H = 21.2$)

This is another strong radar target, easily within the reach of Arecibo and Goldstone. The period for the 170 meter NEA is not known. The size is just at the point where the asteroid is likely a super-fast rotator ($P < 2$ h). Keep exposures as short as practical until you have an idea of the period.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/20	03 51.2	+36 38	0.10	1.08	17.9	36.6	140	92	+0.79	-14
10/21	03 54.5	+37 46	0.09	1.07	17.6	37.2	140	82	+0.86	-12
10/22	03 58.8	+39 10	0.08	1.06	17.4	38.1	139	72	+0.92	-11
10/23	04 04.4	+40 57	0.07	1.05	17.1	39.4	138	62	+0.97	-9
10/24	04 12.3	+43 17	0.06	1.04	16.8	41.4	136	53	+0.99	-6
10/25	04 24.1	+46 27	0.05	1.03	16.5	44.4	134	46	-1.00	-2
10/26	04 44.1	+50 56	0.04	1.02	16.2	49.1	129	42	-0.98	+3
10/27	05 24.0	+57 23	0.03	1.01	15.8	56.9	122	43	-0.94	+12
10/28	07 07.0	+65 20	0.02	1.00	15.7	70.5	108	50	-0.87	+26
10/29	10 53.9	+63 01	0.02	0.99	16.0	93.5	85	64	-0.79	+49

2002 VE68 (Oct-Nov, $H = 20.5$, PHA)

The better chances for photometry come at the first of November, when the moon is near new. Then again, the NEA will be nearly at the galactic plane in dense star fields. Pravec et al. (2002) and Hicks et al. (2010) found a period of 13.5 h with a large amplitude lightcurve. The estimated size is 240 meters.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/20	09 44.0	+58 42	0.09	0.99	18.4	91.8	83	134	+0.79	+45
10/23	09 26.9	+63 12	0.07	1.00	17.9	86.3	89	108	+0.97	+41
10/26	08 51.8	+69 11	0.06	1.00	17.2	79.5	97	76	-0.98	+36
10/29	07 11.8	+76 15	0.05	1.01	16.5	70.7	106	56	-0.79	+27
11/01	02 50.4	+75 54	0.04	1.01	15.8	59.6	118	73	-0.46	+15
11/04	00 30.3	+59 32	0.04	1.02	15.2	48.2	130	114	-0.16	-3
11/07	23 46.4	+38 18	0.04	1.02	15.2	43.7	135	134	-0.01	-23
11/10	23 27.6	+20 16	0.05	1.02	15.6	48.0	130	103	+0.06	-38
11/13	23 17.9	+07 36	0.06	1.02	16.3	55.0	122	62	+0.27	-49
11/16	23 12.4	-00 54	0.07	1.02	16.9	61.2	115	22	+0.54	-55

(65733) 1993 PC (Oct-Nov, $H = 15.4$)

Warner (2014) observed this NEA twice in 2013 October, at phase angles of 12° and 34° . The better solution was 4.184 h (vs. 4.28 h). The ambiguity needs to be removed. The estimated diameter is 620 meters.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/05	01 52.4	+23 45	0.30	1.27	17.3	19.9	154	101	-0.22	-37
10/08	01 45.6	+24 36	0.27	1.25	17.0	17.9	157	142	-0.02	-37
10/11	01 36.9	+25 29	0.25	1.23	16.7	16.3	160	159	+0.04	-36
10/14	01 26.0	+26 25	0.22	1.21	16.4	15.3	161	127	+0.25	-36
10/17	01 12.4	+27 22	0.20	1.19	16.2	15.5	161	91	+0.53	-35
10/20	00 55.5	+28 20	0.18	1.17	16.0	17.5	159	56	+0.79	-35
10/23	00 34.4	+29 14	0.16	1.14	15.8	21.6	155	30	+0.97	-34
10/26	00 08.4	+29 57	0.15	1.12	15.7	27.5	149	45	-0.98	-32
10/29	23 36.5	+30 20	0.13	1.10	15.6	35.2	140	85	-0.79	-30
11/01	22 58.3	+30 05	0.12	1.07	15.7	44.8	130	124	-0.46	-27

(410088) 2007 EJ (Oct, Dec-Jan, $H = 18.1$)

There are two chances to observe this 700-meter NEA. Southern Hemisphere observers get first try in October while Northern Hemisphere observers are favored in December. Warner (2015) found a period of 4.78 h. Vaduvescu et al. (2017) found 2.38 h, or the half-period of Warner's result. Here's another case where the ambiguity needs to be resolved.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/01	22 40.4	-43 12	0.29	1.20	17.4	41.0	128	110	-0.65	-59
10/04	22 33.7	-44 05	0.28	1.18	17.4	44.5	124	142	-0.32	-58
10/07	22 26.7	-44 53	0.26	1.16	17.3	48.1	121	143	-0.06	-56
10/10	22 19.3	-45 37	0.25	1.13	17.3	51.9	117	110	+0.01	-55
10/13	22 11.7	-46 17	0.24	1.11	17.2	55.8	113	75	+0.17	-53
10/16	22 03.6	-46 52	0.22	1.09	17.2	59.9	109	45	+0.43	-52
10/19	21 55.1	-47 24	0.21	1.07	17.1	64.1	105	31	+0.71	-50
10/22	21 45.8	-47 54	0.19	1.05	17.0	68.6	101	51	+0.92	-49
10/25	21 35.5	-48 21	0.18	1.03	17.0	73.3	97	84	-1.00	-47
10/28	21 23.5	-48 46	0.16	1.01	16.9	78.5	92	120	-0.87	-45

12/15	13 12.0	+21 09	0.15	0.96	17.3	94.6	77	150	+0.46	+82
12/18	13 06.2	+22 42	0.17	0.97	17.3	89.0	81	151	+0.74	+84
12/21	13 01.4	+23 57	0.18	0.99	17.3	83.9	85	117	+0.96	+86
12/24	12 57.2	+25 01	0.20	1.00	17.3	79.1	90	75	-0.98	+88
12/27	12 53.4	+25 56	0.21	1.02	17.4	74.7	93	37	-0.76	+89
12/30	12 49.8	+26 46	0.23	1.04	17.4	70.4	97	29	-0.43	+89
01/02	12 46.1	+27 32	0.24	1.05	17.5	66.3	101	59	-0.15	+89
01/05	12 42.3	+28 15	0.25	1.07	17.5	62.4	104	93	+0.01	+88
01/08	12 38.2	+28 57	0.27	1.10	17.5	58.6	108	126	+0.03	+87
01/11	12 33.8	+29 36	0.28	1.12	17.6	54.8	112	152	+0.21	+85

(54660) 2000 UJ (Oct-Nov, $H = 18.0$)

No period is reported in the asteroid lightcurve database (LCDB; Warner et al., 2009) for this 750-meter NEA. Given the estimated size, the period is almost certainly $P > 2$ h. The asteroid will always be at large phase angles from mid-October to mid-November, which could mean unusual lightcurves due to shadowing effects.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/20	07 24.2	+68 14	0.24	1.07	17.4	66.7	101	118	+0.79	+28
10/23	06 58.1	+62 45	0.20	1.07	16.9	63.8	106	93	+0.97	+25
10/26	06 33.6	+54 45	0.17	1.07	16.4	59.1	112	57	-0.98	+19
10/29	06 10.9	+43 05	0.14	1.07	15.9	52.4	121	22	-0.79	+11
11/01	05 50.2	+26 54	0.13	1.08	15.4	44.5	130	45	-0.46	+0
11/04	05 31.4	+07 36	0.12	1.08	15.2	39.3	136	93	-0.16	-14
11/07	05 14.4	-10 42	0.13	1.09	15.4	40.3	135	133	-0.01	-26
11/10	04 59.2	-24 49	0.16	1.09	15.9	44.7	129	136	+0.06	-35
11/13	04 45.7	-34 42	0.18	1.10	16.4	49.0	123	111	+0.27	-40
11/16	04 33.7	-41 27	0.22	1.11	16.8	52.1	118	86	+0.54	-43

(162687) 2000 UH1 (Nov, $H = 19.2$)

There's no period reported in the LCDB for this NEA. The estimated size is about 430 meters, so it's very likely that the period will be greater than 2 hours. Here again, the asteroid will always be at large phase angles, which could mean unusual lightcurves due to shadowing effects.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/01	05 24.1	-18 10	0.24	1.15	18.1	45.1	125	64	-0.46	-27
11/04	05 39.5	-18 49	0.22	1.12	17.9	47.4	123	94	-0.16	-24
11/07	05 58.3	-19 26	0.19	1.10	17.7	50.3	121	120	-0.01	-20
11/10	06 21.9	-19 55	0.17	1.08	17.5	54.0	118	136	+0.06	-15
11/13	06 52.0	-20 08	0.15	1.06	17.3	58.8	114	138	+0.27	-9
11/16	07 30.6	-19 51	0.13	1.04	17.1	64.9	108	129	+0.54	-1
11/19	08 19.5	-18 38	0.11	1.02	17.1	72.8	101	117	+0.81	+10
11/22	09 17.7	-16 04	0.11	1.00	17.2	82.4	92	99	+0.98	+23
11/25	10 20.0	-12 07	0.10	0.98	17.5	92.5	81	75	-0.96	+36
11/28	11 18.4	-07 31	0.11	0.96	18.0	101.5	72	46	-0.72	+49

(4953) 1990 MU (Nov, $H = 14.1$)

The summary table above shows a somewhat unusual case where the asteroid can just be observed with radar at Goldstone but not at Arecibo. This is because Arecibo's range of declinations is about -1° to $+38^\circ$. The combination of distance and size when 1990 MU is within that range produces $\text{SNR} < 10$ at Arecibo.

The asteroid position dives into the Sun at the end of November and stays in the vicinity until 2019 July.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/01	04 34.2	-15 21	0.83	1.56	16.1	35.1	116	36	-0.65	-37
10/11	04 44.4	-18 16	0.68	1.47	15.6	36.1	120	138	+0.04	-36
10/21	04 53.0	-22 06	0.54	1.37	15.0	37.8	123	83	+0.86	-35
10/31	05 00.2	-27 27	0.41	1.26	14.3	41.2	123	65	-0.58	-35
11/10	05 06.4	-36 07	0.28	1.15	13.5	48.8	119	125	+0.06	-36
11/20	05 16.4	-54 57	0.16	1.04	12.7	68.4	103	76	+0.88	-35

(163899) 2003 SD220 (Nov-Dec, $H = 17.3$, PHA, NHATS)

NHATS is the acronym for *Near-Earth Object Human Space Flight Accessible Targets Study*. In other words, this asteroid is on a list of possible targets to which to send a human mission. Because of the enormous radar SNR values expected, almost 2 million for Arecibo(!), expect an abundance of news stories about the asteroid.

Part of the reason for the large SNRs is the rotation period, which has been reported to range from 175 to 285 hours (respectively, Aznar et al., 2018; Warner, 2016). This requires a good campaign involving observers over a wide range of longitudes *and* well-calibrated data. With such long period objects, often the approach is to get a limited number of data points each night. While improving telescope time efficiency, the requirements on the quality of the data go up significantly.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/01	10 35.8	+56 29	0.16	0.99	16.3	85.6	85	42	-0.46	+52
11/07	10 46.1	+56 28	0.15	1.00	16.0	83.4	88	79	-0.01	+53
11/13	10 58.2	+56 25	0.13	1.00	15.7	81.4	91	129	+0.27	+54
11/19	11 12.6	+56 21	0.11	1.00	15.4	80.0	94	124	+0.81	+56
11/25	11 30.8	+56 13	0.09	1.00	14.9	79.1	95	71	-0.96	+57
12/01	11 55.9	+55 52	0.08	1.00	14.5	79.4	96	49	-0.39	+60
12/07	12 34.7	+54 52	0.06	0.99	13.9	81.8	95	90	+0.00	+62
12/13	13 43.3	+50 57	0.04	0.98	13.3	89.8	88	122	+0.28	+64

(141053) 2001 XT1 (Dec-Jan, $H = 18.7$)

There's apparently no reported period for this 500-meter NEA. This will be a weak target at best for Arecibo but it looks to be a strong candidate for photometrists who want to find its phase (H-G) curve. During December to early January, the phase angle drops from 72° to less than 5° .

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
12/01	10 31.7	+22 49	0.19	1.03	17.7	72.2	97	22	-0.39	+58
12/07	09 42.5	+26 03	0.20	1.09	17.4	55.4	115	111	+0.00	+48
12/13	08 56.2	+28 02	0.22	1.15	17.3	40.3	131	163	+0.28	+38
12/19	08 15.1	+28 56	0.25	1.20	17.3	27.1	146	82	+0.83	+30
12/25	07 40.5	+29 03	0.29	1.26	17.4	15.9	160	14	-0.93	+23
12/31	07 12.9	+28 41	0.33	1.31	17.4	7.0	171	103	-0.33	+17
01/06	06 51.7	+28 05	0.39	1.37	17.7	4.5	174	173	+0.00	+12
01/12	06 36.3	+27 26	0.45	1.42	18.3	9.5	166	103	+0.29	+9
01/18	06 25.7	+26 48	0.51	1.47	18.9	14.4	158	23	+0.86	+7

(418849) 2008 WM64 (Dec-Jan, $H = 20.6$)

Both Rowe (2018) and Warner (2018) found a period of 2.4 h based on observations in mid- to late-December of 2017. This makes it a potential binary candidate, so careful observations are in order.

Unfortunately, as the asteroid brightens, the moon waxes towards full. It should still be possible to get good data since the asteroid is reasonably bright and asteroid-moon elongation (sky distance) stays above 45° .

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
12/15	06 32.0	-58 52	0.10	1.00	18.2	77.7	97	92	+0.46	-25
12/17	06 00.4	-54 03	0.08	1.00	17.6	73.1	102	83	+0.65	-29
12/19	05 24.3	-45 48	0.06	1.01	16.9	66.0	111	68	+0.83	-34
12/21	04 44.8	-31 32	0.05	1.01	16.1	55.1	123	49	+0.96	-40
12/23	04 04.3	-09 24	0.04	1.01	15.4	42.2	136	45	-1.00	-41
12/25	03 25.3	+15 24	0.05	1.02	15.5	38.4	140	72	-0.93	-33
12/27	02 49.9	+33 57	0.06	1.02	16.1	44.8	133	102	-0.76	-23
12/29	02 19.2	+45 17	0.07	1.03	16.8	51.5	125	124	-0.54	-15
12/31	01 53.5	+52 04	0.09	1.03	17.4	56.4	119	134	-0.33	-10