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LIGHTCURVE PHOTOMETRY OPPORTUNITIES: 2022 APRIL-JUNE

Brian D. Warner
Center for Solar System Studies (CS3)
446 Sycamore Ave.
Eaton, CO 80615 USA
brian@MinorPlanetObserver.com

Alan W. Harris
Center for Solar System Studies (CS3)
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 using lightcurve inversion. The "Radar-Optical Opportunities" section includes a list of potential radar targets as well as some that might be in critical need of astrometric data.

We present several lists of asteroids that are prime targets for photometry and/or astrometry during the period 2022 April through June. The "Radar-Optical Opportunities" section provides an expanded list of potential NEA targets, many of which are planned for radar observations.

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

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

The ephemeris generator on the MinorPlanet.info web site allows creating custom lists for objects reaching $V \leq 18.0$ during any month in the current year and up to five years in the future, e.g., limiting the results by magnitude and declination, family, and more.

https://www.minorplanet.info/php/callopplcdbquery.php

We refer you to past articles, e.g., Warner et al. (2021a; 2021b) 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*

The database contains more than 3.9 million observations for 15,000+ objects, making it one of the more useful sources for raw data of dense time-series asteroid photometry.

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 highly-rated result 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 bold italics is a near-Earth asteroid (NEA).

Number	Name	Brightest Date	Mag	Dec	LCDB Data Period	Amp	U
795	Fini	04 09.2	12.9	-8	9.292	0.02-0.06	1+
2328	Robeson	04 09.9	15.0	-2	18.632	0.20	2+
2689	Bruxelles	04 10.7	15.0	-6	8.71	0.05	2
5237	Yoshikawa	04 13.0	15.2	-6	3.47	0.33	2
3224	Irkutsk	04 16.5	14.3	-13	33.14	0.51	2
4544	Xanthus	04 20.2	14.9	-19	37.65	0.27	2
3580	Avery	04 22.6	15.5	-16	24.226	0.17-0.33	2
36731	2000 RR50	05 04.8	15.5	-18	7.494	0.10	1
5009	Sethos	05 05.2	15.4	-16	2.691	0.08	2
17567	Hoshinoyakata	05 08.5	15.4	-18	19.882	0.34-0.40	2
4639	Minox	05 10.6	15.5	-21	12.993	0.40	2
10212	1997 RA7	05 16.0	15.5	-20	9.154	0.88-1.05	2
3469	Bulgakov	05 16.6	14.9	-15	6.48	0.05-0.09	1
5557	Chimikeppuko	05 24.2	15.2	-29	4.168	0.35-0.46	2
5693	1993 EA	05 24.2	13.7	+15	2.496	0.05-0.13	2
3901	Nanjingdaxue	05 28.8	14.5	-45	21.4	0.21-0.28	2+
7134	Ikeuchisatoru	05 30.0	15.0	-13	20	0.15	2
3466	Ritina	05 31.4	15.0	-20	5.253	0.51	2
9900	Llull	06 02.6	14.5	-14	183.319	0.88	2
3909	Gladys	06 03.5	14.8	-9	6.83	0.04-0.15	1
30810	1990 FM	06 04.4	15.4	-16	82.259	0.48-0.55	2
10922	1998 BG2	06 06.9	14.9	-22	7.92	0.12	2
11354	1997 XY9	06 08.1	15.5	-24	6.192		2-
3326	Agafonikov	06 09.1	15.0	-29	8.118		2
2492	Kutuzov	06 14.3	15.1	-24	15.099		2-
1109	Tata	06 19.3	13.7	-23	8.277	0.06	2
6481	Tenzing	06 21.0	15.0	-35	6.517	0.13	2
7899	Joya	06 23.1	15.3	-25	85.658		2
783	Nora	06 25.4	12.7	-8	55.53	0.08-0.13	2
10347	Murom	06 30.7	15.2	-21	35.3	0.45	2-

Low Phase Angle Opportunities

The Low Phase Angle list includes asteroids that reach very low phase angles ($\alpha < 1°$). 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.

https://www.minorplanet.info/php/callopplcdbquery.php

The best chance of success comes with covering at least half a cycle a night, meaning periods generally < 16 h, when working objects with low amplitude. 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. Refer to Harris et al. (1989) for the details of the analysis procedure.

As an aside, it is arguably better for physical interpretation (e.g., *G* value versus albedo) to use the maximum light rather than mean level to find the phase slope parameter (*G*). Maximum light better models the behavior of a spherical object of the same albedo, but it can produce significantly different values for both *H* and *G* versus using average light level, which is the method used for values listed by the Minor Planet Center. Using and reporting the results of both methods can provide additional insights into the physical properties of an asteroid.

The International Astronomical Union (IAU) has adopted a new system, H-G_{12}, introduced by Muinonen et al. (2010). It will be some years before H-G_{12} becomes widely used, and hopefully not until a discontinuity flaw in the G_{12} function has been fixed. This discontinuity results in false "clusters" or "holes" in the solution density and makes it impossible to draw accurate conclusions.

We strongly encourage obtaining data as close to 0° as possible, then every 1-2° out to 7°, below which the curve tends to be non-linear due to the opposition effect. From 7° out to about 30°, observations at 3-6° intervals should be sufficient. Coverage beyond 50° or so is not generally helpful since the H-G system is best defined with data from 0-30°.

It's important to emphasize that all observations should (must) be made using high-quality catalogs to set the comparison star magnitudes. These include ATLAS, Pan-STARRS, SkyMapper, and Gaia2/3. Catalogs such as CMC-15, APASS, or the MPOSC from *MPO Canopus* have too high of significant systematic errors.

Also important is that that there are sufficient data from each observing run such that their location can be found on a combined, phased lightcurve derived from two or more nights obtained *near the same phase angle.* If necessary, the magnitudes for a given run should be adjusted so that they correspond to mid-light of the combined lightcurve. This goes back to the H-G system being based on average, not maximum or minimum light.

The asteroid magnitudes are brighter than in others lists because higher precision is required and the asteroid may be a full magnitude or fainter when it reaches phase angles out to 20-30°.

Num	Name	Date	α	V	Dec	Period	Amp	U
340	Eduarda	04 02.7	0.62	13.7	-03	8.006	0.17-0.32	3
431	Nephele	04 07.2	0.72	13.7	-04	13.530	0.03-0.23	3
578	Happelia	04 08.1	0.73	12.8	-05	10.061	0.11-0.16	3
104	Klymene	04 08.5	0.47	13.0	-06	8.984	0.2 -0.3	3
176	Iduna	04 09.0	0.27	13.3	-08	11.288	0.14-0.43	3
795	Fini	04 09.2	0.43	12.9	-08	9.292	0.02-0.06	1+
135	Hertha	04 11.7	0.88	11.5	-10	8.403	0.12-0.30	3
720	Bohlinia	04 15.5	0.27	13.3	-09	8.919	0.16-0.46	3
79	Eurynome	04 16.0	0.04	11.6	-10	5.978	0.05-0.25	3
82	Alkmene	04 18.9	0.14	11.0	-11	12.999	0.18-0.54	3
76	Freia	04 19.7	0.13	12.8	-11	9.973	0.05-0.33	3
13	Egeria	05 04.9	0.18	9.9	-16	7.045	0.12-0.47	3
342	Endymion	05 11.1	0.19	13.8	-18	6.319	0.15-0.23	3
240	Vanadis	05 16.5	0.83	13.5	-17	10.64	0.08-0.34	3
332	Siri	05 16.5	0.67	13.3	-21	8.007	0.10-0.35	3
368	Haidea	05 16.7	0.67	13.7	-17	9.823	0.15-0.23	3
26	Proserpina	05 21.7	0.65	10.3	-22	13.110	0.08-0.21	3
534	Nassovia	05 26.8	0.79	13.7	-19	9.382	0.15-0.37	3
596	Scheila	05 28.9	0.64	11.8	-20	15.848	0.06-0.10	3
367	Amicitia	05 29.7	0.64	13.1	-20	5.055	0.25-0.90	3
3873	Roddy	05 30.8	0.61	13.9	-23	2.478	0.05-0.11	3
144	Vibilia	06 01.3	0.28	11.8	-21	13.819	0.13-0.20	3
492	Gismonda	06 03.6	0.38	14.0	-23	6.488	0.10-0.14	3
350	Ornamenta	06 17.4	0.79	13.4	-21	9.178	0.10-0.3	3
149	Medusa	06 18.0	0.72	12.9	-22	26.023	0.33-0.56	3
563	Suleika	06 18.5	0.19	12.8	-24	5.69	0.13-0.28	3
1109	Tata	06 19.3	0.14	13.8	-23	8.277	0.06	2
182	Elsa	06 21.3	0.36	12.6	-22	80.088	0.60-0.72	3
583	Klotilde	06 22.7	0.81	13.8	-21	9.213	0.17-0.30	3
222	Lucia	06 27.0	0.33	13.0	-24	7.837	0.25-0.41	3
786	Bredichina	06 28.2	0.95	12.6	-26	29.434	0.05-0.60	3-

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

https://astro.troja.mff.cuni.cz/projects/damit/

Additional lightcurves 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 ≥ 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.

		Brightest			LCDB Data		
Num	Name	Date	Mag	Dec	Period	Amp	U
811	Nauheima	04 01.6	14.8	-1	4.001	0.11-0.20	3
2093	Genichesk	04 02.3	15.4	+2	11.028	0.23-0.27	3
1005	Arago	04 05.1	15.0	-18	8.789	0.22-0.25	3
547	Praxedis	04 05.2	14.4	-5	9.105	0.04-0.12	3
213	Lilaea	04 05.6	12.6	+4	12.042	0.07-0.20	3
4375	**Kiyomori**	**04 06.2**	**15.3**	**+3**	**6.471**	**0.15-0.16**	**3**
431	Nephele	04 07.3	13.8	-4	13.53	0.03-0.23	3
1242	Zambesia	04 07.4	14.9	-13	17.315	0.11-0.24	3
445	Edna	04 09.4	15.0	-33	19.959	0.21-0.27	3
5484	**Inoda**	**04 11.2**	**15.3**	**+2**	**14.148**	**0.09-0.16**	**3**
4221	**Picasso**	**04 12.2**	**15.4**	**-2**	**3.111**	**0.27-0.31**	**3**
612	Veronika	04 16.4	15.4	-8	8.243	0.09-0.14	3
4029	Bridges	04 18.9	15.0	-12	3.575	0.18-0.29	3
2103	Laverna	04 19.2	14.6	-23	9.249	0.15-0.22	3
414	Liriope	04 19.3	14.9	+1	11.005	0.10-0.16	3
1656	Suomi	04 20.7	15.3	+16	2.588	0.08-0.20	3
1765	Wrubel	04 21.2	15.1	+7	5.26	0.11-0.33	3
773	Irmintraud	04 22.2	13.3	-34	6.751	0.05-0.25	3
275	Sapientia	04 23.1	11.9	-5	14.931	0.05-0.12	3-
5168	Jenner	04 23.8	15.3	-54	3.258	0.24-0.35	3
109	Felicitas	04 24.4	13.7	-19	13.191	0.06-0.17	3
1866	Sisyphus	04 25.0	14.3	+1	2.4	0.02-0.17	3
1018	Arnolda	04 25.1	14.9	-19	14.617	0.28-0.39	3
1129	Neujmina	04 25.2	15.0	-23	5.084	0.06-0.20	3
633	Zelima	04 26.3	14.6	+1	11.73	0.14-0.49	3
1416	Renauxa	04 26.5	15.4	-23	8.7	0.09-0.40	3
768	Struveana	04 26.7	15.4	-13	10.753	0.26-0.54	3-
1961	Dufour	04 28.8	15.5	-16	15.79	0.17-0.35	3-
25332	1999 KK6	04 29.0	15.5	-16	2.453	0.06-0.11	3
1262	Sniadeckia	04 30.0	14.7	+4	17.57	0.06-0.16	3
1319	**Disa**	**05 02.1**	**13.4**	**-18**	**7.08**	**0.24-0.27**	**3**
971	Alsatia	05 03.5	14.2	-3	9.614	0.17-0.29	3
948	Jucunda	05 05.5	15.4	-26	26.24	0.14-0.35	3
3306	**Byron**	**05 06.5**	**14.5**	**-15**	**7.321**	**0.18-0.84**	**3-**
323	Brucia	05 08.1	14.2	+12	9.463	0.15-0.36	3
42701	**1998 MD13**	**05 11.2**	**15.3**	**-3**	**2.603**	**0.09-0.19**	**3**
834	Burnhamia	05 12.0	12.9	-13	13.875	0.15-0.22	3
677	Aaltje	05 13.8	13.5	-27	16.608	0.10-0.37	3
240	Vanadis	05 16.5	13.6	-17	10.64	0.13-0.34	3
341	California	05 17.6	13.3	-24	18	0.43-0.92	3
2504	Gaviola	05 18.2	15.4	-24	8.738	0.25-0.31	3-
1369	Ostanina	05 18.4	14.8	-1	8.4	0.73-1.11	3
1567	Alikoski	05 21.8	14.1	-24	16.374	0.08-0.16	3
2764	Moeller	05 22.3	15.4	-23	5.953	0.24-0.51	3
2650	Elinor	05 25.6	15.2	-41	2.762	0.02-0.18	3
429	Lotis	05 26.8	13.9	-15	13.577	0.09-0.24	3
26471	Tracybecker	05 29.6	15.1	-38	2.687	0.18-0.25	3
3873	**Roddy**	**05 30.7**	**14.0**	**-23**	**2.478**	**0.05-0.11**	**3**
309	Fraternitas	05 31.0	13.8	-28	22.398	0.10-0.35	3
3800	Karayusuf	05 31.4	15.2	+0	2.232	0.10-0.19	3
4730	**Xingmingzhou**	**06 01.5**	**15.5**	**-19**	**3.396**	**0.15-0.23**	**3**
4159	Freeman	06 03.5	14.9	-14	4.402	0.23-0.40	3
1149	Volga	06 04.7	14.6	-25	27.262	0.14-0.26	3-
854	**Frostia**	**06 06.0**	**13.8**	**-11**	**37.56**	**0.33-0.38**	**3**
2729	Urumqi	06 06.8	15.2	-24	3.127	0.19-0.35	3
2166	Handahl	06 08.4	14.7	-12	7.226	0.11-0.13	3
542	Susanna	06 09.3	13.8	-5	10.069	0.11-0.30	3
2114	**Wallenquist**	**06 10.0**	**15.5**	**-24**	**5.51**	**0.22-0.30**	**3**
81	Terpsichore	06 11.9	13.5	-34	10.943	0.06-0.15	3
475	Ocllo	06 12.1	14.2	-47	7.315	0.19-0.81	3
298	Baptistina	06 14.0	14.2	-34	16.23	0.10-0.25	3
498	Tokio	06 14.9	11.7	-19	41.85	0.08-0.36	3
711	Marmulla	06 15.2	13.2	-37	2.721	0.03-0.18	3
1342	Brabantia	06 15.3	14.1	-53	4.175	0.17-0.23	3
973	Aralia	06 17.8	15.4	-45	7.366	0.20-0.25	3
1277	**Dolores**	**06 18.3**	**13.3**	**-19**	**12.676**	**0.42-0.45**	**3**
5144	Achates	06 18.7	14.6	-33	5.958	0.18-0.35	3
715	Transvaalia	06 20.0	13.9	-38	11.83	0.14-0.32	3
862	Franzia	06 21.0	14.1	-34	7.523	0.07-0.13	3
318	Magdalena	06 21.6	14.5	-9	42.65	0.06-0.11	3
643	Scheherezade	06 24.3	14.8	-17	14.161	0.23-0.37	3
70	**Panopaea**	**06 24.4**	**10.7**	**-39**	**15.805**	**0.07-0.18**	**3**
786	**Bredichina**	**06 28.0**	**12.6**	**-26**	**29.434**	**0.04-0.60**	**3-**
766	Moguntia	06 28.1	14.7	-38	4.816	0.06-0.23	3
1305	Pongola	06 30.4	14.5	-25	8.335	0.14-0.19	3-

Radar-Optical Opportunities

Table I below gives a list of near-Earth asteroids reaching maximum brightness for the current quarter-year based on calculations by Warner. We switched to this presentation in lieu of ephemerides for reasons outlined in the 2021 October-December opportunities paper (Warner et al., 2021b), which centered on the potential problems with ephemerides generated several months before publication.

The initial list of targets started using the planning tool at

https://www.minorplanet.info/php/callopplcdbquery.php

where the search was limited to near-Earth asteroids only that were V ≤ 18 for at least part of the quarter.

The list was then filtered to include objects that might be targets for the Goldstone radar facility or, if it were still operational, the Arecibo radar. This was based on the calculated radar SNR using

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

and assuming a rotation period of 4 hours (2 hours if $D \leq 200$ m) if a period was not given in the asteroid lightcurve database (LCDB; Warner et al., 2009). The SNR values are estimates only and assume that the radar is fully functional.

If an asteroid was on the list but failed the SNR test, we checked if it might be a suitable target for radar and/or photometry sometime through 2050. If so, it was kept on the list to encourage physical and astrometric observations during the current apparition. In most of those cases, the SNR values in the “A” and “G” columns are not for the current quarter but the year given in the Notes column. If a better apparition is forthcoming through 2050, the Notes column in Table I contains SNR values for that time.

The final step was to cross-reference our list with that found on the Goldstone planned targets schedule at

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

It's important to note that the final list in Table I is based on *known* targets and orbital elements when it was prepared. It is common for newly discovered objects to move in or out of the list. We recommend that you keep up with the latest discoveries by using 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 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.

For observation planning, use these two sites

MPC: *http://www.minorplanetcenter.net/iau/MPEph/MPEph.html*
JPL: *http://ssd.jpl.nasa.gov/?horizons*

Cross-check the ephemerides from the two sites just in case there is discrepancy that might have you imaging an empty sky.

About YORP Acceleration

Near-Earth asteroids are particularly sensitive to YORP acceleration. YORP (Yarkovsky-O'Keefe-Radzievskii-Paddack; Rubincam, 2000) 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 an asteroid that already has a well-known period remains 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.

The Quarterly Target List Table

The Table I columns are

Num	Asteroid number, if any.
Name	Name assigned by the MPC.
H	Absolute magnitude from MPCOrb.
Dkm	Diameter (km) assuming $p_V = 0.2$.
Date	Date (mm dd.d) of brightest magnitude.
V	Approximate V magnitude at brightest.
Dec	Approximate declination at brightest.
Period	Synodic rotation period from summary line in the LCDB summary table.
Amp	Amplitude range (or single value) of reported lightcurves.
U	LCDB U (solution quality) from 1 (probably wrong) to 3 (secure).
A	Approximate SNR for Arecibo (if operational and at full power).
G	Approximate SNR for Goldstone radar at full power.
Notes	Comments about the object.

"PHA" is a potentially hazardous asteroid. For good measure, consider that astrometry and photometry have been requested to support Goldstone observations. The sources for the rotation period are given in the Notes column. If none are qualified with a specific period, then the periods from multiple sources were in general agreement. Higher priority should be given to those where the current apparition is the last one V ≤ 18 through 2050 or several years to come.

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Num	Name	H	D	Date	V	Dec	Period	Amp	U	A	G	Notes
474585	2004 HC2	19.46	0.381	04 03.6	17.0	-3				10	-	
363599	2004 FG11	21.03	0.185	04 09.8	17.1	37	7.021	0.3	2	75	20	PHA, Binary. Taylor et al. (2012). Dumitru et al. (2018).
	2015 TX143	19.76	0.332	04 17.0	17.8	63				12	–	
4544	Xanthus	17.21	1.070	04 20.2	14.9	-19	37.65	0.27	2	10	–	Behrend (2007web).
175706	1996 FG3	18.32	0.644	04 21.7	15.0	-20	3.5942	0.04 0.2	3	100	30	PHA, Binary, NHATS Mottola and Lahulla (2000). Pravec et al. (2000).
	2009 CC3	19.12	0.446	04 26.8	16.8	56				30	10	
418135	2008 AG33	19.40	0.392	05 02.5	15.8	-54				6900	1980	
467460	2006 JF42	19.20	0.430	05 10.3	13.4	-45				990	280	PHA
388945	2008 TZ3	20.46	0.240	05 10.9	16.2	-3	39.15	0.47 0.56	2+	1280	370	PHA. Pravec et al. (2019web).
	2017 VV	20.40	0.247	05 13.1	16.8	-16				55	15	
	2013 UX	22.00	0.118	05 14.8	17.7	-81				75	20	
163692	2003 CY18	18.16	0.693	05 18.2	16.0	54				60	15	
	2018 KM1	20.80	0.206	05 22.0	17.6	36				15	–	
5693	1993 EA	16.69	1.360	05 24.2	13.7	15	2.496	0.13	2	425	120	PHA. Warner and Stephens (2019b).
7335	1989 JA	17.52	0.931	05 25.8	11.1	-29	12			20200	5800	PHA. Mahapatra et al. (2002).
	2018 XR	18.58	0.571	06 17.8	15.8	-60	15.27	0.53	3	525	150	PHA. Warner and Stephens (2019a).
	2011 MU	20.28	0.261	06 19.8	16.6	8				40	10	
10302	1989 ML	19.40	0.392	06 23.6	15.9	-9	19.164	1.00 1.13	2+	40	10	Pravec et al. (2019web).
66400	1999 LT7	19.28	0.414	06 27.5	16.6	-39				45	15	

Table I. A list of near-Earth asteroids reaching brightest in the fourth quarter of 2021. * Favorable apparition. PHA: potentially hazardous asteroid. Diameters are based on p_V = 0.20. The Date, V, and Dec columns are the mm/dd.d, approximate magnitude, and declination when at brightest. Amp is the single or range of amplitudes. The A and G columns are the approximate SNRs for an assumed full-power Arecibo (not operational) and Goldstone radars. The references in the Notes column are those for the reported periods and amplitudes.