LIGHTCURVE PHOTOMETRY OPPORTUNITIES: 2021 APRIL-JUNE

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 using 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 come from using radar data alone.

We present several lists of asteroids that are prime targets for photometry during the period 2021 April-June.

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 CALL web site allows creating custom lists for objects reaching V ≤ 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.

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

We refer you to past articles, e.g., Warner et al. (2021) 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 almost 3.8 million observations for 15,000+ objects, making it one of the more useful sources for raw asteroid *time-series* lightcurve data.

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, d*o 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).

		Brightest				LCDB Data		
Number	Name	Date	Mag	Dec		Period	Amp	U
1669	Dagmar	04 04.9	14.4	-6	>	12	0.15	1
1027	Aesculapia	04 07.0	14.5	-6		13.529	0.09-0.19	2
1340	Yvette	04 08.0	14.7	-7		3.525	0.16	2
2841	Puijo	04 09.4	15.2	+1		3.545	0.03	1+
27225	1999 GB17	04 11.5	15.2	-9		3.853	0.57	2
1796	Riga	04 12.7	14.4	+0		22.226	0.06-0.40	2
163243	***2002 FB3***	***04 12.7***	***14.8***	***+9***		***6.231***	***0.19***	***2***
6785	1990 VA7	04 13.9	15.4	+2		6.417	0.16	2
4362	Carlisle	04 15.2	14.8	-8				
2738	Viracocha	04 19.0	15.4	-13				
15427	Shabas	04 24.7	15.2	-12				
3181	Ahnert	04 24.9	14.6	-14				
4899	Candace	04 30.8	15.2	+7		40.7	0.15	2
6764	Kirillavrov	05 03.1	15.0	-21		4.74	0.07-0.19	2+
5776	1989 UT2	05 03.6	15.5	-16	S	4.341		2
14007	1993 TH14	05 04.9	15.5	-10				
9870	Maehata	05 05.1	15.5	-18				
7309	Shinkawakami	05 09.3	15.1	-19				
11682	Shiwaku	05 09.9	15.5	-15	S	4.019		2
3815	Konig	05 11.7	15.2	-10		6.239	0.14	2
6914	Becquerel	05 14.8	14.6	-22				
5529	Perry	05 16.5	15.5	-26				
14191	1998 XR28	05 19.1	15.5	-23				
13832	1999 XR13	05 20.0	15.1	-9				
3353	Jarvis	05 20.8	14.6	-26		202	0.10-0.50	2+
3648	Raffinetti	05 21.1	15.4	-13				
2779	Mary	05 29.9	15.3	-20		3.36	0.10	2
12375	1994 NO1	06 02.2	15.3	-24	S	39.504		2
11277	Ballard	06 03.4	14.6	-24	>	10	0.25	2-
2359	Debehogne	06 08.3	15.3	-17				
2038	Bistro	06 09.5	14.3	-26		95.667	0.06-0.12	2
8817	Roytraver	06 11.8	15.2	-21		68.79	0.53-0.55	2
12194	1979 KO1	06 15.2	15.0	-24				
34886	2001 VH12	06 17.9	15.3	-49				
4894	Ask	06 18.1	14.4	-23		3.636	0.17-0.23	2+
1834	Palach	06 19.9	14.9	-23		3.139	0.13-0.16	2
450263	***2003 WD158***	***06 20.0***	***14.0***	***-9***				
7851	Azumino	06 21.1	14.8	-29				
3774	Megumi	06 22.6	15.2	-29				
12225	Yanfernandez	06 22.7	15.3	-14				
31498	1999 CX61	06 22.9	15.0	-25				
5042	Colpa	06 23.8	15.3	-25		169.64	0.93	2+
4562	Poleungkuk	06 24.0	15.1	-22		9.477	0.73-0.77	2
3044	Saltykov	06 24.3	15.2	-12		35.357	0.34	2
21313	Xiuyanyu	06 24.7	15.4	-26		4.432		2-
4798	Mercator	06 25.8	14.9	-23				
14665	1999 CC5	06 30.2	15.1	-17		3.009	0.14	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.

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) for the details of the analysis procedure.

As an aside, some use the maximum light to find the phase slope parameter (*G*). Even though the results better resemble the behavior of a spherical object of the same albedo, it can produce significantly different values 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-G_{12}, introduced by Muinonen et al. (2010). It will be some years before H-G_{12} becomes widely used, but not until a discontinuity flaw in the G_{12} function has be resolved. 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 about 50° 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. Catalogs such as CMC-15, APASS, or the MPOSC from *MPO Canopus* should not be used due to 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.* This is so that the lightcurve amplitude isn't significantly different. If necessary, the magnitudes for the 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.

For this table, the asteroid magnitudes are brighter than in others. This is because higher precision is required for this work and the asteroid may be a full magnitude or more fainter when it reaches phase angles out to 20-30°.

Num	Name	Date	α	V	Dec	Period	Amp	U
656	Beagle	04 14.3	0.16	13.8	-09	7.035	0.57-1.20	3
755	Quintilla	04 17.3	0.95	13.3	-08	4.552	0.08-0.45	3
90	Antiope	04 18.7	0.66	12.5	-09	16.509	0.05-0.88	3
127	Johanna	04 23.8	0.22	12.0	-13	12.7988	0.18-0.21	3
509	Iolanda	04 29.4	0.21	12.9	-14	12.306	0.35-0.45	3
210	Isabella	05 04.0	0.49	13.6	-17	6.672	0.09-0.38	3
731	Sorga	05 05.4	0.18	13.8	-16	8.184	0.19-0.72	3
770	Bali	05 07.2	0.15	13.9	-17	5.8190	0.21-0.65	3
397	Vienna	05 11.0	0.27	13.4	-17	15.48	0.16-0.20	3
118	Peitho	05 15.6	0.56	12.5	-20	7.8055	0.11-0.33	3
230	Athamantis	05 22.1	0.15	10.2	-20	24.0055	0.10-0.26	3
95	Arethusa	05 23.1	0.11	12.7	-21	8.705	0.24-0.35	3
128	Nemesis	05 26.8	0.61	11.6	-19	77.81	0.08-0.10	3-
122	Gerda	05 28.1	0.69	12.1	-19	10.685	0.10-0.26	3
378	Holmia	05 29.2	0.93	13.9	-19	4.450	0.10-0.21	3
248	Lameia	05 29.4	0.20	12.7	-22	11.912	0.10-0.17	3
562	Salome	05 29.6	0.27	13.9	-21	6.351	0.17-0.37	3-
425	Cornelia	05 30.1	0.30	13.4	-23	17.505	0.19-0.21	3
503	Evelyn	06 01.6	0.16	13.3	-22	38.780	0.30-0.5	3-
267	Tirza	06 01.7	0.23	13.1	-22	7.648	0.18-0.4	3
184	Dejopeja	06 04.7	0.54	12.6	-24	6.4416	0.22-0.3	3
1303	Luthera	06 05.4	0.46	13.7	-24	5.878	0.05-0.06	3
420	Bertholda	06 08.6	0.72	13.2	-20	11.04	0.24-0.29	3
277	Elvira	06 13.8	0.33	13.7	-22	29.69	0.34-0.59	3
758	Mancunia	06 14.1	0.86	13.4	-20	12.7253	0.15-0.27	3
30	Urania	06 14.7	0.97	10.6	-26	13.686	0.11-0.45	3
895	Helio	06 19.8	0.72	13.5	-21	9.347	0.10-0.23	3
1248	Jugurtha	06 21.2	0.98	13.5	-26	12.910	0.70-1.40	3

<u>Shape/Spin Modeling Opportunities</u>

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
459	Signe	04 01.8	14.5	-1	5.536	0.25-0.54	3
536	Merapi	04 03.8	13.8	+13	8.791	0.23-0.38	3
1591	Baize	04 05.6	14.7	+37	7.794	0.19-0.37	3-
198	Ampella	04 06.1	12.8	-18	10.379	0.11-0.22	3
2150	**Nyctimene**	**04 08.1**	**14.9**	**-10**	**6.131**	**0.56-0.90**	**3**
598	Octavia	04 08.6	14.8	+8	10.89	0.28-0.40	3
81	Terpsichore	04 10.1	13.3	-11	10.943	0.06-0.15	3
318	Magdalena	04 11.3	14.1	+1	42.65	0.06-0.11	3
363	Padua	04 12.7	13.1	-3	8.401	0.08- 0.3	3
973	Aralia	04 12.9	15.0	-21	7.366	0.20-0.25	3
1563	**Noel**	**04 13.0**	**14.4**	**-3**	**3.55**	**0.14-0.18**	**3**
123	Brunhild	04 13.9	12.9	-18	9.873	0.14-0.21	3
656	Beagle	04 14.2	13.7	-9	7.035	0.57-1.20	3
563	Suleika	04 14.3	12.9	+2	5.69	0.13-0.28	3
339	Dorothea	04 14.5	14.0	-2	5.974	0.06-0.10	3
766	Moguntia	04 15.9	14.4	-14	4.816	0.06-0.23	3
3031	**Houston**	**04 17.8**	**14.8**	**-18**	**11.218**	**0.11-0.17**	**3**
541	Deborah	04 18.0	13.9	-18	29.368	0.07-0.10	3
1266	Tone	04 18.0	14.3	-32	15.605	0.06-0.19	3
643	Scheherezade	04 18.4	14.6	-24	14.161	0.23-0.37	3
1153	Wallenbergia	04 20.0	14.6	-17	4.096	0.23-0.33	3
412	Elisabetha	04 21.4	13.0	+8	19.635	0.08-0.20	3
860	Ursina	04 22.3	14.3	-30	9.386	0.15-0.50	3
1509	Esclangona	04 25.0	14.8	-51	3.253	0.11-0.35	3
346	Hermentaria	04 25.8	11.7	-3	28.523	0.07-0.20	3
3385	**Bronnina**	**04 26.4**	**14.7**	**-10**	**2.959**	**0.12-0.35**	**3**
1609	Brenda	04 28.0	14.8	+14	19.776	0.16-0.27	3
481	Emita	05 01.0	13.2	-9	14.412	0.13-0.30	3
5189	***1990 UQ***	***05 01.0***	***14.5***	***+32***	***6.653***	***0.62-1.02***	***3***
987	Wallia	05 04.6	14.3	-27	10.081	0.11-0.36	3
1806	Derice	05 05.0	14.8	-21	3.224	0.07-0.19	3

		Brightest			LCDB Data		
Num	Name	Date	Mag	Dec	Period	Amp	U
3760	Poutanen	05 06.8	15.0	+1	2.956	0.13-0.21	3
307	Nike	05 09.1	14.8	-11	11.857	0.15-0.23	3
1086	Nata	05 10.0	14.3	-29	18.061	0.17-0.18	3-
397	Vienna	05 11.1	13.4	-17	15.48	0.15-0.20	3
1385	Gelria	05 12.0	15.0	-9	4.624	0.08-0.23	3
680	**Genoveva**	**05 14.0**	**12.5**	**-26**	**11.089**	**0.21-0.25**	**3**
1254	Erfordia	05 14.7	14.9	-27	12.287	0.33-0.47	3
1292	Luce	05 17.4	14.4	-21	6.954	0.17-0.26	3
815	Coppelia	05 18.1	14.3	-20	4.421	0.13-0.24	3
917	Lyka	05 18.6	14.7	-27	7.867	0.10-0.26	3
195	Eurykleia	05 18.9	13.2	-28	16.521	0.10-0.24	3
1132	Hollandia	05 19.7	13.6	-26	5.322	0.15-0.35	3
799	Gudula	05 22.7	13.7	-12	14.814	0.27-0.30	3
1308	Halleria	05 23.3	14.9	-28	6.028	0.14-0.17	3
5081	**Sanguin**	**05 27.5**	**14.8**	**-13**	**10.26**	**0.40-0.53**	**3**
909	Ulla	05 27.9	14.4	+4	8.716	0.08-0.24	3
1184	Gaea	05 30.5	14.7	-39	2.871	0.09-0.15	3-
1052	Belgica	05 31.3	15.0	-18	2.71	0.06-0.08	3
929	**Algunde**	**05 31.9**	**13.3**	**-19**	**3.31**	**0.11-0.17**	**3**
503	Evelyn	06 01.6	13.4	-22	38.78	0.30- 0.5	3-
267	**Tirza**	**06 01.7**	**13.2**	**-22**	**7.648**	**0.18- 0.4**	**3**
972	Cohnia	06 02.5	14.3	-28	18.472	0.16-0.21	3
2411	**Zellner**	**06 03.4**	**14.5**	**-20**	**2.975**	**0.31-0.34**	**3**
101	Helena	06 04.0	11.5	-39	23.08	0.09-0.13	3
1303	**Luthera**	**06 05.3**	**13.7**	**-24**	**8.328**	**0.05-0.11**	**3**
5978	**Kaminokuni**	**06 05.6**	**14.8**	**-26**	**7.063**	**0.43-0.50**	**3**
420	Bertholda	06 08.6	13.2	-20	11.04	0.22-0.29	3
456	**Abnoba**	**06 09.5**	**12.1**	**-10**	**18.281**	**0.23-0.32**	**3**
300	Geraldina	06 10.8	14.2	-24	6.842	0.04-0.32	3
1028	Lydina	06 11.0	14.6	-27	11.68	0.22- 0.7	3
1602	Indiana	06 11.7	14.8	-24	2.601	0.12-0.19	3
569	Misa	06 13.1	14.3	-24	11.595	0.09-0.25	3
479	Caprera	06 13.4	14.3	-13	9.454	0.05-0.25	3
1684	**Iguassu**	**06 14.3**	**14.4**	**-21**	**6.416**	**0.15-1.11**	**3**
839	Valborg	06 15.5	13.9	-44	10.366	0.14-0.19	3
619	Triberga	06 16.6	13.5	-1	29.311	0.25-0.45	3
2151	Hadwiger	06 17.1	14.9	-45	5.872	0.07-0.38	3
1967	Menzel	06 17.7	15.0	-27	2.835	0.16-0.39	3
1246	Chaka	06 17.9	13.7	-36	25.462	0.18-0.25	3
1200	Imperatrix	06 18.6	14.6	-17	17.769	0.21-0.25	3
895	Helio	06 19.8	13.5	-21	9.347	0.10-0.23	3
3416	Dorrit	06 19.8	15.0	-73	2.574	0.21-0.27	3
12008	**Kandrup**	**06 19.8**	**13.6**	**+6**	**32.903**	**0.61-0.85**	**3**
1376	Michelle	06 21.6	14.0	-16	5.975	0.03-0.20	3
1867	**Deiphobus**	**06 23.0**	**15.0**	**-31**	**58.66**	**0.10-0.27**	**3-**
2017	Wesson	06 23.3	14.4	-13	3.416	0.38-0.60	3
3996	**Fugaku**	**06 25.6**	**14.8**	**-24**	**7.193**	**0.57-0.86**	**3**
1224	Fantasia	06 28.7	14.4	-19	4.995	0.06-0.47	3
1603	Neva	06 30.2	14.8	-16	6.426	0.16-0.25	3-

Radar-Optical Opportunities

The loss of the Arecibo Observatory in late 2020 leaves a large gap in the study of NEAs and other solar system objects as well as atmospheric research. Since Arecibo is no longer available, we have modified our approach to this listing.

For one, the list of potential radar targets is much smaller since the Goldstone facility, while able to cover more of the sky, achieves a much lower SNR for an asteroid than would Arecibo. This means, broadly speaking, that potential targets must come closer to Earth to achieve useable SNRs.

As before, we will present a list of targets that are within reach of radar, but considering only Goldstone. This allows continued coordination between the optical and radar communities. We will also provide of list that might be called “What Might Have Been”, i.e., those objects that would have been considered if Arecibo were still in service. Detailed discussions and ephemerides will not be provided for these objects, unless there is a particular reason to do so.

We hope that this second listing will encourage observations despite being out of Goldstone radar range *for this apparition*. The data can still be important for future Earth encounters that do come within reach of the facilities in operation at that time.

Past radar targets:
http://echo.jpl.nasa.gov/~lance/radar.nea.periods.html

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

These lists are based on *known* targets at the time they were prepared. It is very common for newly discovered objects to move into, out of, or 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 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 better chances for observing, but remember that photometry may be possible before and/or after the dates in the ephemerides. 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 circle 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 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.

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 line. Also, underneath the first list 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. “BIN?” 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” column 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 SNRs were calculated using the current MPCORB absolute magnitude (H), a period of 4 hours (2 hours if $D \leq 200$ m) if it's not known, and the approximate minimum Earth distance during the current quarter. These are estimates only and assume that the radars are fully functional.

If the row 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.

Asteroid	Period	Amp	App	Last	R SNR
1997 GL3 NEA PHA	**7.572**	**0.28**	**1**	**1997**	**35**
2004 TP1 NEA PHA	**-**	**-**	**-**	**-**	**15**
(5189) 1990 UQ NEA	**6.676**	**0.62 1.02**	**3**	**2020**	**100**
(494690) 2004 JQ1 NEA	-	-	-	-	13
(450263) 2003 WD158 NEA PHA	**-**	**-**	**-**	**-**	**100**
(441987) 2010 NY65 NEA PHA	**4.9706**	**0.16 0.32**	**5**	**2020**	**30**

Table I. Summary of Goldstone-optical opportunities for the current quarter. Period and amplitude data are from the asteroid lightcurve database (LCDB; Warner et al., 2009). SNR values are *estimates* and are given for relative comparisons among the objects in the list.

Asteroid	Period	Amp	App	Last	R SNR
(142464) 2002 TC9 NEA Apr 01 16.0 +2°	2.320	0.13	1	2017	10
(66400) 2008 JO NEA Apr 21 17.3 30°	-	-	-	-	3
(467351) 2003 KO2 NEA May 01 17.9 +16°	6.48	1.28	1	2016	7
(495615) 2015 PQ291 NEA May 11 15.3 -30°	13.763	0.66	1	2020	5
(408752) 1991 TB2 NEA May 21 15.7 -53°	-	-	-	-	7
(374267) 2005 LW NEA Jun 01 17.2 +15°	-	-	-	-	13
(387505) 1998 KN3 NEA Jun 01 17.1 -20°	-	-	-	-	2
(154330) 2002 VX94 NEA Jun 01 16.2 -72°	8.932	0.65	1	2011	25

Table II. This list includes only those objects that would have been within reach of Arecibo but not Goldstone (assuming SNR > 10 for the latter). The columns are the same as for Table I. In the "R SNR" column, the estimated SNR is for Arecibo.

In Table II, the third line in the first column gives the approximate date when the asteroid is brightest along with the V magnitude and declination at the time.

It's rarely the case, especially for shape/spin axis modeling, that there are too many observations. Remember that the best set for modeling includes data not just from multiple apparitions but from as wide a range of phase angles during each apparition as well.

Unless otherwise said, the estimated diameters given below are based on an albedo of $p_V = 0.20$, the approximate average of the S taxonomic class that dominates the NEA region (Warner et al., 2009).

1997 GL3 (H = 19.1, PHA)

Pravec et al. (1998) reported a period of 7.572 h for this 300-m NEA. The asteroid is favorably placed for the second half of April. The presumed diameter makes it unlikely that the period is < 2 h.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
04/10	07 12.5	+25 18	0.07	1.00	16.5	89.7	86	110	-0.04	+16
04/12	08 52.4	+23 09	0.08	1.03	16.1	68.7	107	108	+0.00	+36
04/14	10 00.5	+19 16	0.10	1.06	16.1	54.2	121	101	+0.03	+50
04/16	10 43.0	+15 53	0.12	1.08	16.4	45.2	130	88	+0.13	+58
04/18	11 10.5	+13 20	0.15	1.11	16.7	39.6	135	71	+0.28	+63
04/20	11 29.3	+11 26	0.17	1.14	17.1	36.1	138	52	+0.47	+65
04/22	11 42.9	+09 59	0.20	1.17	17.4	33.8	140	29	+0.68	+66
04/24	11 53.2	+08 51	0.23	1.19	17.7	32.3	141	5	+0.86	+67
04/26	12 01.4	+07 55	0.26	1.22	18.0	31.3	141	23	+0.98	+67
04/28	12 08.0	+07 08	0.29	1.25	18.2	30.7	141	51	-0.99	+68

2004 TP1 (H = 20.7, PHA)

At 220 meters, the period for this NEA is also likely to be $P > 2$ h. The earlier days of the ephemeris are better, mostly because the moon is near new and well away from the asteroid's sky position.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
04/07	08 05.5	+59 55	0.06	1.00	17.2	84.9	92	137	-0.24	+32
04/10	09 56.7	+45 39	0.06	1.02	16.6	66.3	111	133	-0.04	+51
04/13	10 52.1	+29 50	0.06	1.04	16.5	50.6	127	119	+0.01	+64
04/16	11 22.2	+17 32	0.08	1.06	16.7	40.2	137	96	+0.13	+67
04/19	11 40.8	+08 54	0.09	1.08	16.9	34.2	143	68	+0.38	+65
04/22	11 53.6	+02 51	0.11	1.10	17.3	31.1	146	35	+0.68	+62
04/25	12 03.1	-01 29	0.13	1.12	17.6	29.7	147	7	+0.93	+59
04/28	12 10.6	-04 43	0.15	1.14	18.0	29.2	147	46	-0.99	+57

(5189) 1990 UQ (H = 17.8)

Warner (2018) reported a period of 6.676 h based on observations in 2017. Follow-up work in 2019 found a period of 6.640 h (Warner and Stephens, 2019). Oey (2020) followed the asteroid in 2017 over a range of phase angles of 60° and greater. Over that time, the amplitude of the lightcurve ranges from 0.75 to 0.92 mag.

This time around, the phase starts at 23° and increases to nearly 90° over the period covered by the ephemeris. This makes it a good project for seeing how the amplitude changes with phase angle. There's also the potential of providing extremely useful data for modeling. The inversion process wants data not only from different viewing aspects but over a good range of phase angles within a given apparition.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
04/10	14 59.8	+01 42	0.23	1.21	16.1	22.9	152	134	-0.04	+50
04/13	15 06.5	+03 31	0.20	1.19	15.8	23.5	152	160	+0.01	+50
04/16	15 14.5	+05 46	0.18	1.16	15.5	24.8	151	147	+0.13	+50
04/19	15 24.5	+08 37	0.16	1.14	15.3	27.1	149	117	+0.38	+49
04/22	15 37.6	+12 15	0.13	1.12	15.0	30.7	145	84	+0.68	+48
04/25	15 55.4	+17 02	0.11	1.10	14.7	36.0	140	54	+0.93	+46
04/28	16 21.3	+23 23	0.10	1.07	14.5	43.8	132	43	-0.99	+43
05/01	17 01.6	+31 39	0.08	1.05	14.5	55.0	121	60	-0.79	+36
05/04	18 07.3	+41 06	0.07	1.03	14.6	70.0	106	76	-0.48	+25
05/07	19 48.0	+48 17	0.07	1.01	15.1	87.8	88	76	-0.20	+11

(494690) 2004 JQ1 (H = 20.0)

The LCDB had no rotation period entries for this 300-m NEA, which will be a difficult target because of the large phase angles, relatively small solar elongations, and low galactic latitudes. Given the diameter, the period should be more than 2 hours, but it's wise to expect the unexpected.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
05/24	20 09.6	+25 25	0.15	1.06	18.4	67.7	104	98	+0.91	-4
05/25	20 21.5	+25 27	0.14	1.05	18.3	69.8	103	90	+0.97	-6
05/26	20 35.5	+25 25	0.13	1.04	18.2	72.3	101	83	+1.00	-9
05/27	20 51.9	+25 15	0.12	1.04	18.0	75.3	98	76	-1.00	-12
05/28	21 11.3	+24 55	0.11	1.03	18.0	78.8	95	69	-0.96	-16
05/29	21 34.4	+24 18	0.10	1.02	17.9	82.9	92	63	-0.91	-20
05/30	22 01.6	+23 18	0.09	1.01	17.9	87.8	87	56	-0.83	-25
05/31	22 33.2	+21 43	0.08	1.01	17.9	93.7	82	49	-0.73	-31
06/01	23 09.0	+19 27	0.08	1.00	18.1	100.3	75	41	-0.63	-37
06/02	23 47.8	+16 24	0.07	0.99	18.3	107.5	68	33	-0.53	-44

(450263) 2003 WD158 (H = 18.8, PHA)

This NEA has an estimated diameter of about 500 m. There were no previously reported rotation periods in the LCDB. Observations will likely be hampered by the low galactic latitudes, i.e., potentially rich star fields.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
06/10	20 40.7	+60 10	0.07	1.01	16.1	89.5	87	85	+0.00	+11
06/15	19 43.5	+27 09	0.05	1.04	14.6	56.9	121	127	+0.19	+2
06/20	19 12.3	-09 16	0.06	1.07	14.0	22.1	157	85	+0.71	-9
06/25	18 53.0	-29 31	0.09	1.11	14.4	9.7	169	6	-1.00	-13
06/30	18 40.1	-39 23	0.13	1.14	15.4	14.4	164	68	-0.68	-15
07/05	18 31.2	-44 34	0.16	1.17	16.2	19.3	158	127	-0.22	-15
07/10	18 25.4	-47 29	0.20	1.20	16.8	22.8	153	156	+0.00	-16
07/15	18 22.0	-49 08	0.25	1.23	17.4	25.3	149	103	+0.25	-16
07/20	18 20.7	-50 01	0.29	1.27	17.9	27.4	145	41	+0.78	-16

(441987) 2010 NY65 (H = 21.5, PHA)

Finding a definitive period for the 160-m 2010 NY65 has proved to be somewhat difficult. Warner (2016) found a period of 4.979 h based on data from 2016 July. A similar period was found about a year later (Warner, 2017). Behrend (2019web), however, found what appeared to be a more convincing solution of 5.195 h. Warner and Stephens (2020) observed the asteroid again in 2019 and 2020. All their previous data sets along with the new data appeared to fit near the original period of 4.979 h and an entirely new solution of about 5.8 h.

The core of the problem is that the periods are nearly commensurate with an Earth day and so *rotational aliasing* comes into play. This is when the number actual rotations over the range of the data set cannot be uniquely defined. To find an unambiguous will likely require a coordinated campaign involving observers from a wide range of longitudes.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
06/27	12 47.1	+23 40	0.04	1.01	17.8	91.6	86	123	-0.93	+86
06/28	13 26.9	+22 19	0.05	1.02	17.6	83.5	94	126	-0.86	+81
06/29	14 00.1	+20 42	0.05	1.03	17.6	76.6	101	130	-0.78	+73
06/30	14 27.3	+19 02	0.05	1.03	17.6	70.9	106	134	-0.68	+67
07/01	14 49.4	+17 28	0.06	1.04	17.7	66.2	111	138	-0.59	+61
07/02	15 07.4	+16 04	0.07	1.05	17.8	62.5	114	142	-0.49	+57
07/03	15 22.2	+14 48	0.07	1.05	17.9	59.4	117	146	-0.39	+53
07/04	15 34.6	+13 42	0.08	1.06	18.0	56.9	119	149	-0.30	+50

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