



Figure 7: Model fit (black line) versus observed lightcurves (red points) for ($\lambda = 9^\circ$, $\beta = 38^\circ$) solution.

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LIGHTCURVE PHOTOMETRY OPPORTUNITIES: 2021 JULY-SEPTEMBER

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We present lists of asteroid photometry opportunities for objects reaching a favorable apparition and having 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 be (or might be) radar targets. Lightcurves for these objects can help constrain pole solutions and/or remove rotation period ambiguities that might arise from using radar data alone.

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

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 $V \leq 18.0$ 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.

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 more than 3.9 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, *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			LCDB Data		U
		Date	Mag	Dec	Period	Amp	
3109	Machin	07 11.0	14.8	-35	20.3	0.46	2
9601	1991 UE3	07 11.5	14.9	-31	3.733	0.09	2+
3942	Churivannia	07 11.7	14.9	-32			
819	Barnardiana	07 17.5	13.4	-28	66.7	0.82	2+
2229	Mezzarco	07 17.7	15.0	-11			
1034	Mozartia	07 19.1	12.8	-22			
3485	Barucci	07 20.3	14.7	-22	14.65	0.19	1
2844	Hess	07 20.4	14.4	-19			
285571	2000 PQ9	07 20.4	12.7	-22			
1701	Okavango	07 22.5	14.4	-42	13.204	0.32-0.45	2
6975	Hiroaki	07 23.1	14.2	-24			
2898	Neuvo	07 25.8	14.9	-22	17.591	0.06-0.62	2-
1714	Sy	07 26.0	14.2	-19			
4396	Gressmann	07 27.3	14.9	-27			
4319	Jackierobinson	07 28.9	15.1	-26			
7198	Montelupo	07 30.7	14.9	-17			
2232	Altaj	07 31.0	14.8	-12			
6753	Fursenko	08 05.6	15.0	-16	4.99	0.19	1+
3702	Trubetskaya	08 07.0	14.1	-24			
1705	Tapio	08 07.5	14.7	-3	54.8	0.29-0.44	2
2412	Wil	08 07.8	14.4	-14			
2728	Yatskiv	08 11.0	14.7	-11			
2865	Laurel	08 12.3	14.3	-16	21.5	0.15	2
938	Chlosinde	08 12.7	14.5	-16	19.204	0.12-0.16	2
3112	Velimir	08 13.0	14.9	-22	3.653		2-
6916	Lewispearce	08 13.2	14.4	-11	23.497	0.25	2
7724	Moroso	08 13.8	15.0	-23			
3053	Dresden	08 15.0	14.8	-21	4.788	0.34	2
3116	Goodricke	08 18.2	13.9	-24	26.7	0.09-0.3	2
2607	Yakutia	08 19.9	14.8	-15			
2098	Zyskin	08 20.1	14.5	-15	3.92	0.08	2
2431	Skovoroda	08 20.1	14.0	-13	3.13	0.21	2
	2016 AJ193	08 20.3	13.5	-36			
17081	Jaytee	08 20.8	15.2	-11			
4781	Sladkovic	08 23.0	14.9	-11			
5095	Escalante	08 28.7	14.8	-14	8.542	0.10-0.54	2
18863	1999 RC191	08 29.0	15.0	-8			
2824	Franke	08 29.9	14.7	-7	3.38	0.06	2
8416	Okada	09 02.7	14.8	-7			
1144	Oda	09 03.1	14.7	-9	648	0.41-0.55	2+
5786	Talos	09 04.1	14.1	+7	23.6	0.23-0.30	2
1285	Julietta	09 05.3	14.7	-3	20.3	0.07-0.23	1
9143	Burkhead	09 06.1	14.8	-5			
3165	Mikawa	09 06.9	14.3	-14	5.08	0.08-0.27	2
1519	Kajaani	09 13.0	14.5	-13			
10940	1999 CE52	09 13.4	14.9	-18			
3729	Yangzhou	09 19.7	14.2	-5	29.158	0.41	2
2646	Abetti	09 20.1	15.0	+0	38.889	0.25	2
994	Othild	09 23.2	12.5	-1	5.95	0.09-0.15	2+
143649	2003 QQ47	09 23.4	13.5	+20	3.679	0.19	2-
22870	Rosing	09 23.9	15.0	+3			
3408	Shalamov	09 29.3	14.7	-2	10.495	0.28	1+
9200	1993 FK21	09 29.4	15.0	+3			
1357	Khama	09 30.1	14.9	-17	15.692	0.34	2
22449	Ottijeff	09 30.7	14.9	+7			

Low Phase Angle Opportunities

The Low Phase Angle list includes asteroids that reach very low phase angles ($\alpha < 1^\circ$). 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 been 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 $1-2^\circ$ 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 $3-6^\circ$ intervals should be sufficient. Coverage beyond about 50° is not generally helpful since the $H-G$ system is best defined with data from $0-30^\circ$.

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 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 fainter when it reaches phase angles out to $20-30^\circ$.

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
27	Euterpe	07 03.4	0.19	10.4	-23	10.4082	0.13-0.21	3
38	Leda	07 06.8	0.64	12.8	-25	12.838	0.05-0.16	3
24	Themis	07 12.2	0.31	11.9	-23	8.374	0.09-0.14	3
92	Undina	07 14.6	0.97	10.6	-24	15.941	0.16-0.20	3
1026	Ingrid	07 14.6	0.86	13.9	-23	5.	0.5	2
543	Charlotte	07 14.9	0.19	13.7	-22	10.718	0.23-0.28	3
462	Eriphyla	07 19.0	0.36	12.8	-22	8.659	0.11-0.39	3
1034	Mozartia	07 19.0	0.83	12.7	-22		0.10	
850	Altona	07 28.2	0.67	13.2	-21	11.1913	0.09-0.17	3
949	Hel	08 05.5	0.79	13.8	-19	8.215	0.13-0.14	2+
558	Carmen	08 06.2	0.75	13.1	-15	11.387	0.2 -0.31	3
781	Kartvelia	08 06.6	0.80	13.2	-15	19.04	0.16-0.28	3-
954	Li	08 09.1	0.34	13.3	-15	7.207	0.11-0.25	3
108	Hecuba	08 10.4	0.99	12.6	-19	14.256	0.09-0.12	3
2431	Skovoroda	08 20.2	0.16	14.0	-13	3.13	0.21	2
208	Lacrimosa	08 25.8	0.49	13.0	-12	14.085	0.15-0.33	3
1842	Hynek	08 27.3	0.21	14.0	-10	3.9410	0.07-0.17	3
53	Kalypso	09 01.0	0.77	12.5	-10	9.036	0.09-0.14	3
1247	Memoria	09 07.7	0.16	13.9	-06			
64	Angelina	09 14.3	0.47	11.8	-02	8.752	0.04-0.42	3
224	Oceana	09 15.2	0.10	11.8	-03	9.401	0.09-0.14	3
229	Adelinda	09 15.3	0.62	13.1	-05	6.60	0.04-0.30	3
117	Lomia	09 16.0	0.62	11.9	-01	9.127	0.10-0.35	3
214	Aschera	09 18.5	0.50	12.6	-01	6.835	0.20-0.23	3
571	Dulcinea	09 21.1	0.54	12.9	-02	126.3	0.50	3
468	Lina	09 22.0	0.11	12.6	-01	16.33	0.13-0.18	3
994	Otthild	09 23.3	0.50	12.5	-01	5.95	0.09-0.15	2+
615	Roswitha	09 29.7	0.23	13.6	+02	4.422	0.11	3
167	Urda	09 29.8	0.43	12.8	+01	13.07	0.24-0.39	3
359	Georgia	10 01.6	0.26	11.8	+04	5.537	0.16-0.54	3
312	Pierretta	10 04.6	0.46	12.4	+06	10.282	0.32	3
551	Ortrud	10 07.2	0.10	13.2	+06	17.416	0.14-0.19	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 \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	
2083	Smither	07 01.0	15.0	-9	2.672	0.08-0.11	3
696	Leonora	07 02.1	14.4	-30	26.896	0.04-0.31	3
78	Diana	07 03.7	12.8	-33	7.299	0.02-0.30	3
1589	Fanatica	07 08.5	14.8	-25	2.583	0.10-0.22	3
5985	1942 RJ	07 09.0	14.5	-22	9.721	0.11-0.18	3
1497	Tampere	07 09.6	14.9	-23	3.64	0.20-0.42	3-
14196	1998 XH59	07 09.7	14.4	-20	3.244	0.20-0.25	3
491	Carina	07 13.3	14.1	+2	14.836	0.08-0.13	3

Num	Name	Brightest			LCDB Data		U
		Date	Mag	Dec	Period	Amp	
1026	Ingrid	07 14.7	13.9	-23	5.437	0.07-0.5	3-
1100	Arnica	07 15.5	14.4	-22	14.535	0.09-0.28	3
658	Asteria	07 18.4	14.4	-23	21.034	0.22-0.28	3
1625	The NORC	07 21.4	13.9	-30	13.959	0.06-0.16	3-
902	Probitas	07 24.6	14.8	-29	10.168	0.10-0.26	3
6708	Bobbievaile	07 24.8	14.9	-22	12.341	0.26-0.41	3
880	Herba	07 25.2	14.4	-4	12.266	0.11-0.21	3
790	Pretoria	07 27.5	12.5	+6	10.37	0.05-0.18	3
738	Alagasta	07 28.1	14.2	-18	17.89	0.11-0.20	3-
850	Altona	07 28.1	13.2	-21	11.191	0.09-0.17	3
2484	Parenago	07 28.3	14.4	-17	3.433	0.28-0.34	3
469	Argentina	08 02.2	13.5	-24	17.573	0.11-0.15	3
477	Italia	08 02.7	12.2	-27	19.413	0.15-0.32	3
1322	Coppernicus	08 06.5	15.0	+27	4.354	0.04-0.86	3
954	Li	08 09.1	13.3	-15	7.207	0.11-0.25	3
488	Kreusa	08 11.8	13.3	-27	32.645	0.08-0.20	3
466	Tisiphone	08 12.1	13.7	-2	8.834	0.03-0.18	3
58	Concordia	08 13.8	12.6	-12	9.895	0.01-0.15	3
3453	Dostoevsky	08 15.1	14.8	-11	3.163	0.05-0.14	3
1264	Letaba	08 16.4	13.8	+25	32.74	0.13-0.43	3
1274	Delportia	08 17.8	14.3	-14	5.56	0.05-0.29	3
1544	Vinterhansenia	08 18.5	14.7	-19	13.536	0.11-0.18	3-
388	Charybdis	08 21.5	12.4	-16	9.516	0.14-0.25	3
1116	Catriona	08 23.3	14.1	-23	8.832	0.09-0.28	3
57	Mnemosyne	08 26.3	11.5	+5	25.324	0.09-0.24	3-
1078	Mentha	08 26.4	14.9	-20	85	0.31-0.87	3
1842	Hynek	08 27.2	14.0	-10	3.941	0.07-0.17	3
653	Berenike	08 29.4	13.6	-15	12.489	0.03-0.11	3
654	Zelinda	08 29.4	12.7	+13	31.735	0.08-0.3	3
1222	Tina	09 01.2	14.4	+26	13.395	0.17-0.30	3
5133	Phillipadams	09 07.5	14.7	-26	6.665	0.40-0.46	3
1304	Arosa	09 07.8	14.3	-29	7.748	0.13-0.38	3
295	Theresia	09 08.5	13.4	-2	10.702	0.11-0.22	3
464	Megaira	09 10.0	12.5	-20	12.879	0.08-0.12	3
921	Jovita	09 11.2	14.1	+9	15.57	0.05-0.13	3
1046	Edwin	09 11.4	14.7	-9	5.291	0.14-0.27	3
910	Anneliese	09 11.7	14.5	-15	11.286	0.13-0.55	3
777	Gutemberga	09 12.3	15.0	+11	12.838	0.11-0.28	3
224	Oceana	09 15.1	11.8	-3	9.401	0.09-0.14	3
1639	Bower	09 15.9	14.1	+3	22.181	0.15-0.38	3-
261	Prymno	09 17.9	12.7	-7	8.002	0.08-0.37	3
468	Lina	09 22.0	12.7	-1	16.33	0.13-0.18	3
392	Wilhelmina	09 22.8	13.1	+11	13.058	0.06-0.70	3
1031	Arctica	09 23.5	14.3	+15	24.904	0.16-0.22	3
1593	Fagnes	09 23.5	14.7	-15	25.25	0.27-0.47	3-
868	Lova	09 28.4	13.3	-7	41.118	0.28-0.40	3
191	Kolga	09 29.4	12.5	-5	17.604	0.30-0.50	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 and/or be significantly larger 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., objects that would have been considered if Arecibo were in service. Detailed discussions and ephemerides may not always be provided for these objects.

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.

Goldstone targets:

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

This list is 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 radar is 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
(285571) 2000 PQ9	-	-	-	-	A: 225 G: 55
2012 BA35	-	-	-	-	A: 485 G: 140
2008 GO20	-	-	-	-	A: 200 G: 55
2016 AJ193	-	-	-	-	A: 6700 G: 1900
(143649) 2003 QQ47	3.679	0.19	1	2014	A: 79 G: 22

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
3103 Eger	5.7059	0.49 1.18	8	2019	13
(523664) 2012 OD1	12.63	0.63	1	2018	28
(7822) 1991 CS	2.389	0.26 0.39	3	2016	18

Table II. This list includes only those objects that would have been within reach of Arecibo but not Goldstone (assuming $\text{SNR} > 10$ for Arecibo). 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 a 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).

(285571) 2000 PQ9 ($H = 18.1$)

There are no rotation periods recorded in the LCDB. The estimated diameter is 700 m, so it’s unlikely, but not impossible, that the rotation period will be less than 2 h. Note that the asteroid goes through a wide range of phase angles in July. This can present an excellent chance to get an H-G phase curve.

To get the best possible solution for the phase curve, you'll need to get a good idea of the rotation period and amplitude. If keeping strictly in the H-G system, data points should be based on the mean amplitude of the lightcurve at the time of the observations. Try to take into account the fact that the lightcurve amplitude increases with increasing phase angle (Zappala et al., 1990).

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
07/01	17 49.4	-64 59	0.13	1.12	15.5	38.1	137	87	-0.59	-18
07/11	18 52.9	-51 16	0.09	1.09	14.3	27.3	150	149	+0.01	-21
07/21	19 50.1	-17 47	0.07	1.08	12.8	3.6	176	40	+0.87	-21
07/31	20 31.2	+19 00	0.08	1.08	14.3	34.7	143	81	-0.55	-12
08/10	20 58.3	+36 32	0.12	1.09	15.5	47.3	128	124	+0.03	-6
08/20	21 16.9	+43 21	0.17	1.11	16.3	49.4	123	71	+0.92	-4
08/30	21 31.1	+45 35	0.21	1.14	16.8	47.4	124	81	-0.53	-4
09/09	21 43.3	+45 22	0.26	1.18	17.2	43.9	126	120	+0.05	-6
09/19	21 55.6	+43 42	0.31	1.22	17.6	40.0	128	60	+0.96	-9
09/29	22 08.8	+41 09	0.37	1.27	17.9	36.4	131	95	-0.51	-12

3103 Eger ($H = 15.2$)

The rotation period for this 2700 m NEA is close to 5.7 h (e.g., Warner and Stephens, 2019b). It's too distant for Goldstone observations and it's been modeled before (Durech et al. 2012), who reported evidence of YORP acceleration. Additional lightcurves this time around can help confirm and refine the amount of rotational increase (period decrease) that they found.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
07/01	22 48.3	+09 36	0.40	1.22	15.5	51.2	111	24	-0.59	-43
07/11	23 41.5	+07 41	0.32	1.16	15.0	55.5	110	120	+0.01	-51
07/21	00 55.3	+03 08	0.26	1.11	14.7	62.6	104	118	+0.87	-60
07/31	02 29.0	-04 01	0.24	1.06	14.7	73.1	94	15	-0.55	-57
08/10	04 04.0	-10 56	0.25	1.01	15.1	83.3	82	100	+0.03	-42
08/20	05 20.4	-15 04	0.30	0.97	15.7	89.0	74	126	+0.92	-27
08/30	06 16.8	-16 46	0.36	0.94	16.1	90.4	68	49	-0.53	-15
09/09	06 59.9	-17 06	0.43	0.92	16.3	89.1	66	88	+0.05	-6
09/19	07 35.2	-16 43	0.50	0.91	16.5	86.1	64	128	+0.96	+2
09/29	08 06.2	-15 57	0.56	0.91	16.6	82.3	64	49	-0.51	+9

(523664) 2012 OD1 ($H = 18.6$, PHA)

This 570-m PHA isn't on the Goldstone schedule until 2024 July. However, it's still worth observing this time around to confirm, if possible, the period of 12.63 h found by Warner and Stephens (2019a) and to provide updated astrometry. The low solar elongations will make this a challenging target.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
07/20	03 10.6	+20 40	0.13	0.97	18.1	106.7	66	169	+0.78	-32
07/23	02 26.0	+33 43	0.11	0.99	17.3	98.2	76	119	+0.98	-25
07/26	01 08.9	+47 55	0.10	1.02	16.8	87.1	87	76	-0.95	-15
07/29	23 09.1	+56 52	0.11	1.04	16.6	76.3	98	61	-0.74	-3
08/01	21 09.8	+57 05	0.13	1.06	16.7	68.5	105	75	-0.46	+6
08/04	19 53.9	+53 04	0.15	1.07	17.0	63.8	108	95	-0.19	+13
08/07	19 10.9	+48 39	0.18	1.09	17.3	61.0	110	106	-0.03	+17
08/10	18 45.3	+44 52	0.22	1.11	17.6	59.3	110	101	+0.03	+20
08/13	18 29.0	+41 47	0.25	1.12	17.9	58.2	110	85	+0.22	+22
08/16	18 18.2	+39 15	0.28	1.14	18.2	57.4	109	68	+0.55	+23

2012 BA35 ($H = 23.8$, NHATS)

Even though only 50 m in diameter, this object will be a strong radar target. The period is unknown, making observations all the more important. Given the size, it's very possible that the rotation period will be $\ll 2$ h.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
07/24	18 28.1	+43 40	0.05	1.03	19.5	65.5	112	72	+1.00	+22
07/25	18 24.3	+44 42	0.04	1.03	19.5	67.0	111	76	-0.99	+23
07/26	18 20.1	+45 48	0.04	1.03	19.4	68.5	109	81	-0.95	+24
07/27	18 15.3	+47 00	0.04	1.03	19.4	70.2	108	86	-0.90	+25
07/28	18 09.7	+48 18	0.04	1.03	19.3	72.0	106	91	-0.82	+27
07/29	18 03.2	+49 42	0.04	1.02	19.2	74.1	104	96	-0.74	+28
07/30	17 55.4	+51 15	0.03	1.02	19.2	76.3	102	100	-0.65	+29
07/31	17 46.1	+52 56	0.03	1.02	19.1	78.7	99	102	-0.55	+31
08/01	17 34.7	+54 47	0.03	1.02	19.1	81.5	97	103	-0.46	+33
08/02	17 20.5	+56 46	0.03	1.02	19.1	84.6	94	102	-0.36	+35
08/03	17 02.5	+58 54	0.03	1.02	19.1	88.0	90	99	-0.28	+37

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
08/04	16 39.0	+61 06	0.02	1.01	19.1	91.9	87	95	-0.19	+39
08/05	16 08.2	+63 16	0.02	1.01	19.1	96.4	82	88	-0.12	+42
08/06	15 27.5	+65 09	0.02	1.01	19.2	101.4	77	81	-0.07	+45
08/07	14 35.4	+66 20	0.02	1.01	19.4	107.1	72	72	-0.03	+48
08/08	13 33.8	+66 16	0.02	1.01	19.6	113.4	66	62	+0.00	+50

2008 GO20 ($H = 22.3$)

2008 GO20 will also be a solid target for Goldstone (SNR ~ 55). Here again, the period is not known for this 100-m NEA. Its size also makes it possible, maybe even likely, that the period is ≤ 2 h.

Normally, such faint objects are not included in this paper. However, given recent work by Peter Birtwhistle (2021), it may be possible to get useable results, but that will depend in large part on the lightcurve amplitude being significantly larger than the individual errors and overall noise in the data set.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
08/01	03 14.2	+05 58	0.04	1.01	18.7	96.7	81	10	-0.46	-42
08/02	02 56.1	+04 26	0.04	1.01	18.7	90.8	87	17	-0.36	-46
08/03	02 40.8	+03 07	0.05	1.02	18.6	85.6	92	31	-0.28	-50
08/04	02 27.7	+01 58	0.05	1.02	18.6	81.0	96	46	-0.19	-53
08/05	02 16.6	+00 59	0.05	1.03	18.7	77.0	100	60	-0.12	-55
08/06	02 06.9	+00 08	0.06	1.03	18.7	73.3	104	75	-0.07	-57
08/07	01 58.4	-00 37	0.06	1.03	18.8	70.0	107	90	-0.03	-59
08/08	01 50.9	-01 16	0.07	1.04	18.8	66.9	110	104	+0.00	-60
08/09	01 44.3	-01 51	0.07	1.04	18.9	64.1	112	119	+0.00	-62
08/10	01 38.4	-02 22	0.07	1.05	18.9	61.5	115	133	+0.03	-63

2016 AJ193 ($H = 18.5$, PHA)

Barring a new discovery, this is going to be the best radar target this quarter. An extensive campaign is being planned using Goldstone and Canberra (Australia) with hopes for detailed delay-Doppler imaging. Having a rotation period before the planned radar observations would be extremely helpful.

Using the default albedo and MPCORB H , the estimated diameter is 590 m. However, Masiero et al. (2017) found a diameter of 1.37 km using $H = 18.7$; this leads to an unusually low albedo of 0.03. When correcting their values by using $H = 18.5$ (Harris and Harris, 1997), the albedo is closer to 0.04, which is still very dark. The revised values from Harris and Harris give $D = 1.38$ km.

All this is to say that the period is very likely to be > 2 h. Unfortunately, the phase angle range isn't sufficient to get a good H-G phase curve. Also unfortunate is that the sky motion when brightest in mid- to late August will be on the order of 80"/min. Getting good data will be a compromise of minimizing trailing but avoiding excessive scintillation noise when using short exposures.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
08/10	23 36.2	-37 57	0.18	1.16	16.4	32.1	142	153	+0.03	-71
08/11	23 40.0	-38 07	0.16	1.15	16.2	32.8	142	151	+0.07	-71
08/12	23 44.4	-38 17	0.15	1.13	16.0	33.6	142	144	+0.14	-72
08/13	23 49.8	-38 28	0.13	1.12	15.8	34.5	141	135	+0.22	-73
08/14	23 56.5	-38 41	0.12	1.11	15.5	35.7	140	125	+0.32	-74
08/15	00 05.1	-38 54	0.10	1.09	15.3	37.2	139	115	+0.43	-75
08/16	00 16.6	-39 07	0.09	1.08	15.0	39.2	138	104	+0.55	-76
08/17	00 32.5	-39 17	0.07	1.07	14.6	42.0	135	95	+0.66	-77
08/18	00 56.2	-39 17	0.06	1.05	14.2	46.2	131	87	+0.76	-78
08/19	01 33.7	-38 38	0.05	1.04	13.8	52.9	125	82	+0.85	-76
08/20	02 37.4	-35 44	0.03	1.03	13.5	64.9	113	85	+0.92	-66
08/21	04 21.2	-25 24	0.02	1.01	13.6	87.9	91	99	+0.97	-43

(7822) 1991 CS ($H = 17.3$)

The rotation period of 2.389 h has been determined several times (e.g., Pravec et al., 2019web). The reported amplitude has ranged from 0.26 to 1.02 mag. Large phase angles and low solar elongations conspire to make this a difficult target but it's worth a try in order to provide additional data for modeling. Mainzer et al. (2019) found a diameter of 1.21 km ($H = 17.4$) and derived an albedo of 0.133. This similar to what radar observations found (Benner et al., 1999).

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
07/20	23 44.4	+52 30	0.44	1.12	18.1	65.2	92	122	+0.78	-9
07/27	00 14.9	+51 35	0.37	1.10	17.7	67.1	93	66	-0.90	-11
08/03	00 53.5	+49 09	0.30	1.08	17.3	69.3	95	50	-0.28	-14
08/10	01 43.1	+43 39	0.23	1.06	16.8	71.7	96	108	+0.03	-18
08/17	02 45.2	+31 45	0.18	1.04	16.3	74.9	95	152	+0.66	-25
08/24	03 56.3	+09 30	0.15	1.03	16.0	80.0	92	69	-0.97	-32
08/31	05 07.0	-16 53	0.16	1.01	16.3	85.6	85	40	-0.43	-30
09/07	06 08.1	-34 34	0.20	0.99	17.0	88.2	80	84	+0.00	-23
09/14	06 56.8	-43 46	0.26	0.98	17.5	88.2	77	109	+0.52	-17
09/21	07 35.0	-48 31	0.33	0.97	17.9	86.8	74	102	-1.00	-13

(143649) 2003 QQ47 (H = 17.4, PHA)

Carbognani (2014) reported a rotation period of 4.09 h while Warner (2014) found 3.679 h. Neither solution is considered definitive so additional observations this time around may help resolve the ambiguity. The best chance is for southern observations around mid-September but northern observations still have an opportunity from late September to early October.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
08/25	04 14.3	-25 42	0.52	1.18	18.5	58.8	95	61	-0.93	-45
09/04	04 02.6	-22 28	0.36	1.15	17.6	58.2	104	80	-0.10	-47
09/14	03 23.2	-13 44	0.20	1.12	16.0	50.2	121	131	+0.52	-52
09/24	00 17.0	+26 13	0.10	1.09	13.7	23.8	154	32	-0.91	-36
10/04	19 30.3	+41 46	0.20	1.06	16.4	67.0	102	109	-0.08	+11
10/14	18 24.7	+38 13	0.36	1.03	17.8	74.7	85	68	+0.60	+21

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