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LIGHTCURVES AND ROTATION PERIODS OF ASTEROIDS 1861 KOMENSKY, 2096 VAINO, 3127 BAGRATION, 3289 MITANI, 3582 CYRANO, 3589 LOYOLA, 3811 KARMA, 4226 DAMIAAN, 4458 OIZUMI, 6086 VRCHLICKY, 6875 GOLGI, (18118) 2000 NB24 AND 29185 REICH

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We present lightcurves and synodic rotation periods for 1861 Komensky, 2096 Vaino, 3127 Bagration, 3289 Mitani, 3582 Cyrano, 3589 Loyola, 3811 Karma, 4226 Damiaan, 4458 Oizumi, 6086 Vrchlicky, 6875 Golgi, (18118) 2000 NB24 and 29185 Reich observed from 2023 September through 2024 January.

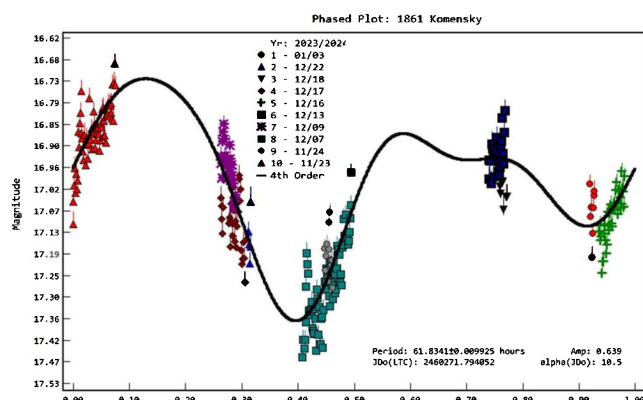
Photometric observation of thirteen asteroids was conducted from 2023 September through 2024 January at Dimension Point Observatory (MPC V42) located near Mayhill, NM.

Images were acquired using a 0.43-m *f*/6.8 Corrected Dall-Kirkham telescope and FLI Kepler KL400 back-illuminated CMOS camera on a PlaneWave Instruments L-500 direct-drive mount. The equipment was operated remotely using *ACP Expert* (Denny, 2023) and *MaximDL* (George et al., 2021). Orbital elements, ephemeris and other information were obtained from the Minor Planet Center (<http://www.minorplanet.net>) the JPL Solar System Dynamics (<http://ssd.jpl.nasa.gov>) and the Lowell Observatory Minor Planet Services (<http://asteroid.lowell.edu>) websites.

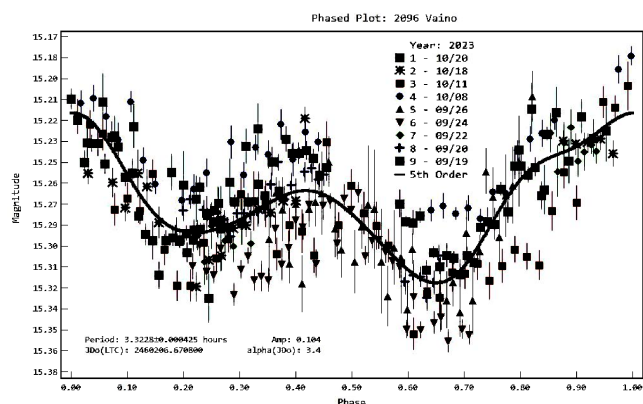
Images were made unfiltered in HDR mode, utilizing camera internal stacking every 30 seconds. Exposure duration varied based on the target brightness and apparent motion but were typically 120 seconds.

Image calibration, plate solving, measurement and period analysis were performed using *Tycho-Tracker* V11.0 (Parrott, 2023). Comparison stars of near solar color were chosen from the ATLAS refcat2 star catalog (Tonry et al., 2018) using the comparison star selection feature of *Tycho-Tracker*.

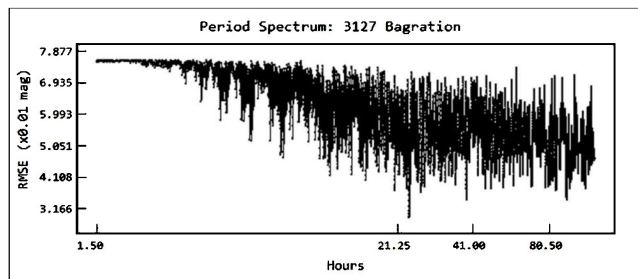
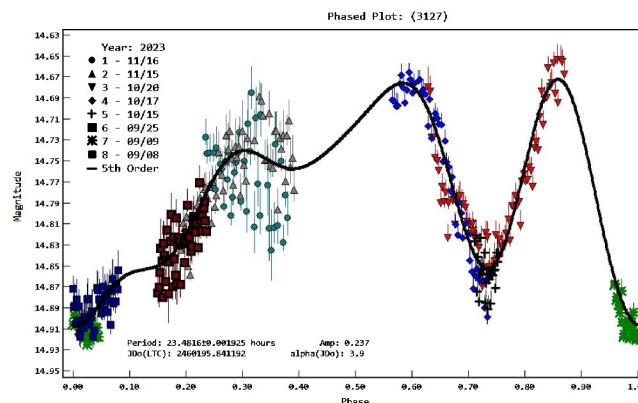
1861 Komensky is an outer main-belt asteroid discovered in 1970 by L. Kohoutek at Bergedorf. We observed in on ten nights in 2023 November through 2024 January resulting in a total of 561 observations. A search of the LCDB found no reported rotation periods. Analysis of the data resulted in a best fit period of 61.8341 ± 0.009925 hours with an amplitude of 0.639 ± 0.06 mag. Coverage is incomplete so this result could be wrong.



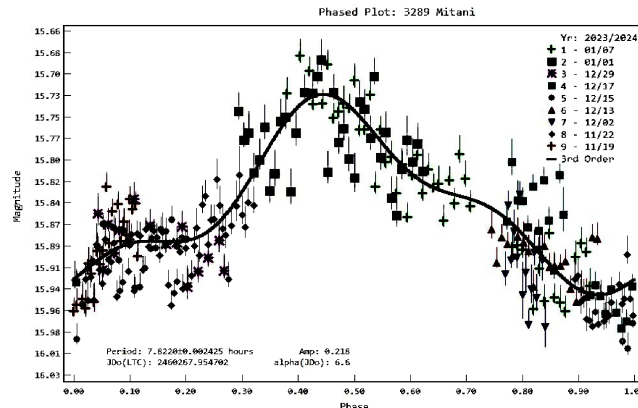
2096 Vaino is an inner main-belt asteroid discovered in 1939 by Y. Vaisala at Turku. It is named for Vainamoinen, an old and wise magician in Finnish folklore. The name also honors Vaino Vaisala, brother of the discoverer. We observed Vaino on nine nights in 2023 September and October resulting in a total of 614 observations. A search of the LCDB resulted in four reports. Mainzer et. al. (2011) and Waszczak et. al. (2015) reported 3.32 hours. Fauerbach and Fauerbach (2019) reported 5.55 and 3.70 hours. Our analysis resulted in a period of 3.3228 ± 0.000425 hours with an amplitude of 0.104 ± 0.02 mag, in close agreement with Mainzer and Waszczak.



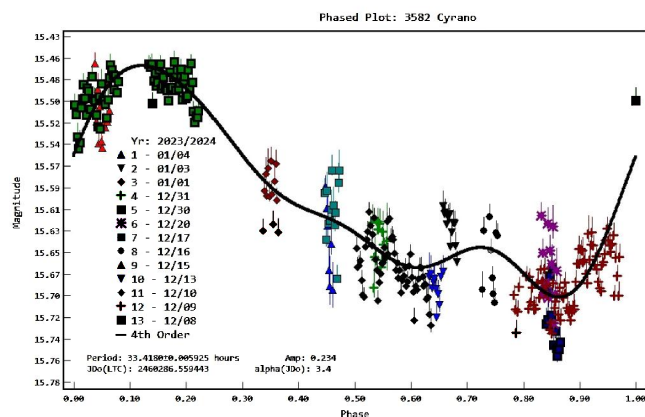
3127 Bagration is a middle main-belt asteroid discovered in 1973 by L. Chernykh at Nauchnyj. We observed it on eight nights resulting in 768 observations. A search of the LCDB resulted in two reports by Behrend in 2015 and 2019 showing >12 hours and >16 hours respectively. There were no references given to the reports themselves. Analysis of the data resulted in a period of 23.4816 ± 0.001925 hours with an amplitude of 0.237 ± 0.02 mag. Coverage of the cycle was incomplete so this result could be wrong. The period spectrum indicates this result is close to the correct value.



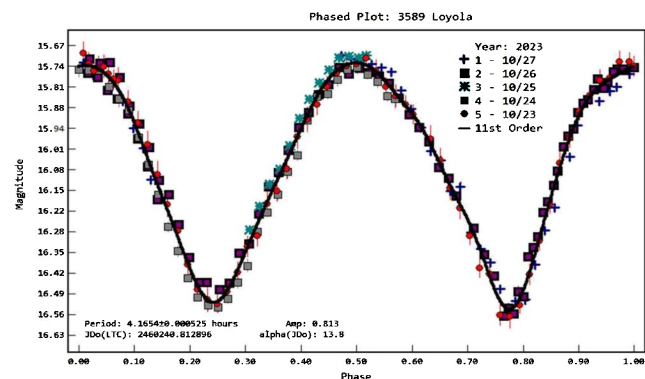
3289 Mitani is an inner main-belt asteroid discovered in 1934 by K. Reinmuth, at Heidelberg. We observed it on nine nights in 2023 November through 2024 January resulting in a total of 577 observations. A search of the LCDB showed no prior rotation period reports. Analysis of the data resulted in a best fit period of 7.822 ± 0.002425 hours with an amplitude of 0.218 ± 0.03 mag.



3582 Cyrano is an outer main-belt asteroid discovered in 1986 by P. Wild at Zimmerwald. We observed it on thirteen nights in 2023 December and 2024 January resulting in a total of 643 observations. No prior rotation periods were found in a search of the LCDB. Analysis of the data resulted in a best fit of 33.4180 ± 0.005925 hours with an amplitude of 0.234 ± 0.03 mag.

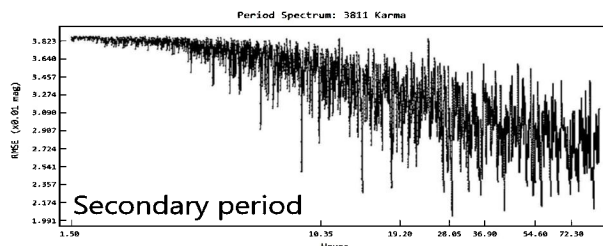
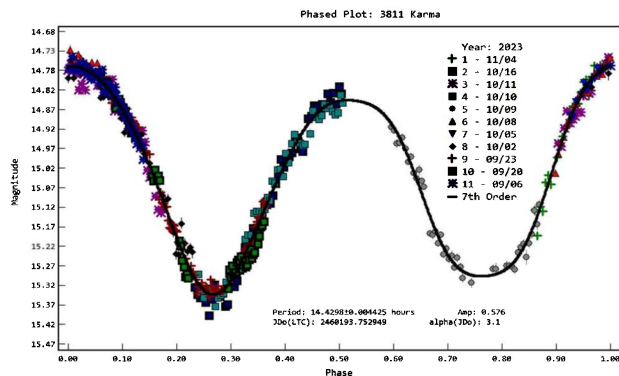
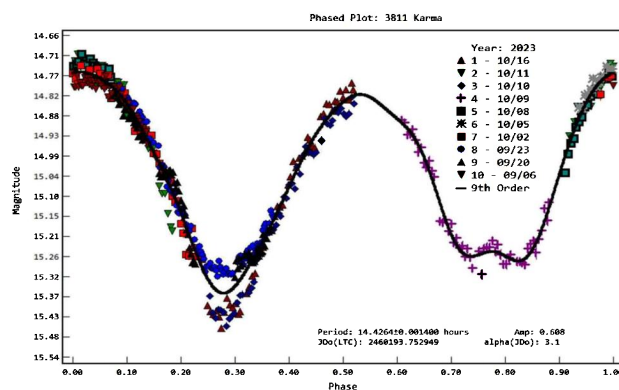


3589 Loyola is an inner main-belt asteroid discovered by J. Wagner at Flagstaff in 1984. We observed it on five nights during 2023 October resulting in 427 total observations. A search of the LCDB resulted in two reports of 4.165750 hours by Āurech et al. (2020) and 4.166 hours by Erasmus et al. (2020). Analysis of our data resulted in a period of 4.1654 ± 0.000525 hours with an amplitude of 0.813 ± 0.03 mag. Coverage was more than two complete cycles so this result can be considered secure.

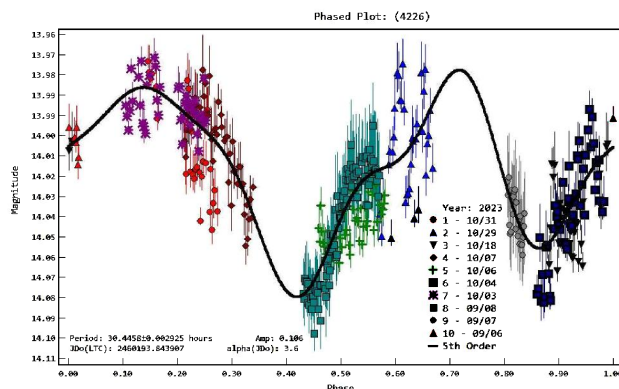


3811 Karma is a main-belt asteroid that is a member of the Karma family (Pavela et al., 2021) situated in the middle part of the main asteroid belt. It was discovered in 1953 by L. Oterma at Turku. We observed it on ten nights in 2023 September and October, resulting in 1032 total observations. A search of the Asteroid Lightcurve Database found four synodic periods reported by Behrend in 2007, Aznar in 2016, Āurech et al. (2020) and Yeh et al. (2020) with periods between 11.23 and 14.4234 hours and a summary period of 13.32 hours. A recent report from Dose (2023) gives a period of 14.421 hours.

Analysis of our data resulted in a period of 14.4262 ± 0.0005 hours and an amplitude of 0.659 ± 0.03 mag, in close agreement with the more recent reports. The resulting lightcurve shape closely matches that shown in Yeh et al. (2020). The initial period analysis revealed a spread at the minima. Dual period analysis found a signal with period of 28.643 ± 0.004 hours with an amplitude of 0.203 ± 0.002 mag. Subtracting this signal resulted in a period of 14.4298 ± 0.004425 hours and amplitude 0.576 ± 0.002 mag. Plots with and without this secondary signal are shown.

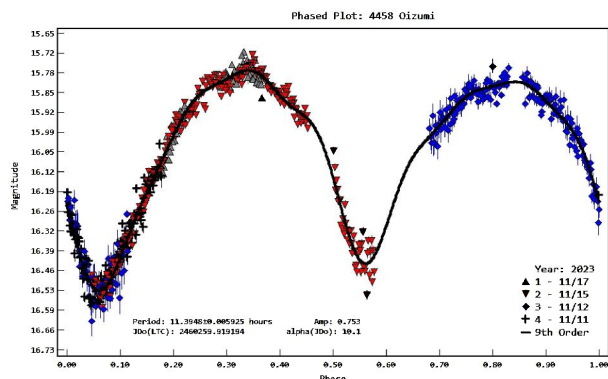


4226 Damiaan is an outer main-belt asteroid discovered in 1989 by E.W. Elst at Haute Provence. We observed it on ten nights resulting in a total of 826 observations. A search of the LCDB resulted in one reported period of 24 hours that is marked “Behrend 2004Web”. We were unable to find a proper reference for this report. Analysis of the data resulted in a best fit period of 30.4458 ± 0.002925 hours with an amplitude of 0.106 ± 0.01 mag. Coverage is incomplete and some of the data is very noisy so this result could be wrong.

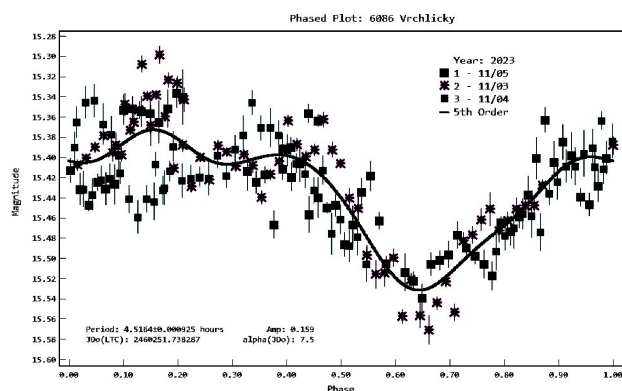


4458 Oizumi is an inner main-belt asteroid discovered in 1990 by Kushida and Muramatsu at Yatsugatake. We observed it on four nights resulting in a total of 682 observations.

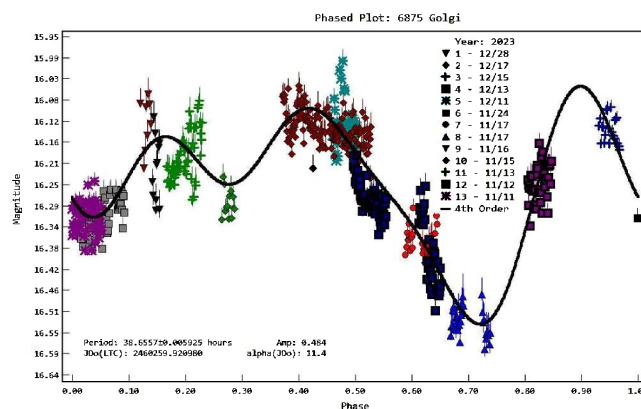
A search of the LCDB resulted in two reported periods. Ďurech, et al. (2018) reported 11.04650 hours and Ďurech, et al. (2019) reported 11.40655 hours. Our analysis resulted in 11.3948 ± 0.005925 hours with an amplitude of 0.753 ± 0.03 mag in close agreement with the prior report.



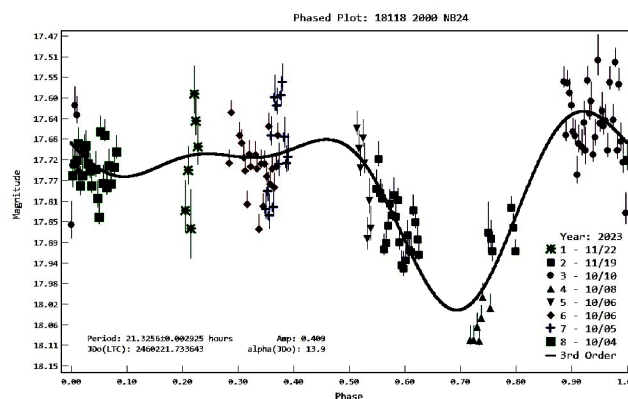
6086 Vrchlicky is a middle main-belt asteroid discovered in 1987 by Z. Vavro at Klet. It is named for Jaroslav Vrchlicky, a Czech poet. We observed it on three nights in 2023 September for a total of 363 observations. A search of the LCDB revealed one report by Pál, et al. (2020) with a period of 2.76772 hours. Their analysis of the TESS data shows two spikes of approximately equal magnitude, one at the reported period and another between 4 and 5 hours. Analysis of our data resulted in a period of 4.5165 ± 0.001 hours with an amplitude of 0.159 ± 0.03 mag.



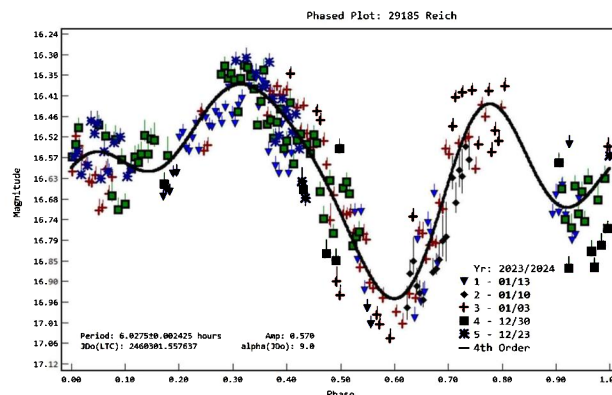
6875 Golgi is an inner main-belt asteroid discovered in 1994 by E.F. Helin at Palomar. It is named for Camillo Golgi, an Italian scientist, physician and biologist. Golgi was awarded the Nobel Prize in Medicine for his studies on the structure of the nervous system. We observed 6875 Golgi on thirteen nights in 2023 November and December resulting in a total of 1260 observations. No prior rotation periods were found in a search of the LCDB. Analysis of the data resulted in a best fit period of 38.6557 ± 0.005925 hours with an amplitude of 0.484 ± 0.05 mag.



18118 2000 NB24 is an inner main-belt asteroid discovered in 2000 by Spacewatch at Kitt Peak. We observed it on eight nights in 2023 October and November resulting in a total of 342 observations. A search of the LCDB found a report by Waszczak et al. (2015) of 2.524 ± 0.0004 hours. Analysis of our data resulted in a best fit period of 21.3256 ± 0.002925 hours with an amplitude of 0.409 ± 0.06 mag, quite different from the prior result. While the period spectrum shows a spike near 3.8 hours, it is not as large as the best fit. Coverage is a sparse so this result could be wrong.



29185 Reich is an outer main-belt asteroid discovered in 1990 by Schmadel and Börngen at Tautenburg. It is named for Ludwig Reich, a professor of Mathematics at the University of Graz. We observed 29185 Reich on five nights in 2023 December and 2024 January resulting in a total of 217 observations. A search of the LCDB revealed no prior rotation period reports. Analysis of the data resulted in a best fit period of 6.0275 ± 0.00245 hours and an amplitude of 0.57 ± 0.09 mag.



Number	Name	yyyy mm/dd	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
1861	Komensky	2023 11/23-01/03	10.4, 6.2	89	11	61.834	0.010	0.64	0.06	MB-O
2096	Vaino	2023 09/19-10/20	*3.3, 15.0	1	1	3.3228	0.001	0.10	0.02	MB-I
3127	Bagration	2023 09/08-11/16	*3.8, 24.7	351	6	23.4816	0.002	0.237	0.02	MB-M
3289	Mitani	2023 11/19-01-07	*6.6, 20.9	68	1	7.822	0.002	0.218	0.03	MB-I
3582	Cyrano	2023 12/08-01/04	3.4, 13.5	68	3	33.418	0.006	0.23	0.03	MB-O
3589	Loyola	2023 10/23-10/27	13.8, 11.6	48	-6	4.1654	0.001	0.81	0.03	MB-I
3811	Karma	2023 09/06-11/04	3.9, 23.4	339	2	14.4262	0.001	0.659	0.03	MB-M
4226	Damiaan	2023 09/06-10/31	*3.6, 22.8	346	5	30.4458	0.003	0.106	0.01	MB-O
4458	Oizumi	2023 11/11-11/17	10.0, 6.9	65	4	11.3948	0.006	0.753	0.03	MB-I
6086	Vrchlicky	2023 11/03-11/05	*7.0, 6.5	53	3	4.5165	0.001	0.159	0.03	MB-M
6875	Golgi	2023 11/11-12/28	*11.4, 17.4	65	3	38.6557	0.006	0.484	0.05	MB-I
18118	2000 NB24	2023 10/04-11/22	*13.8, 15.2	32	0	21.3256	0.003	0.409	0.06	MB-I
29185	Reich	2023 23/23-01/13	9.0, 14.7	85	18	6.0275	0.002	0.570	0.09	MB-O

Table I. Observing circumstances and results. The phase angle is given for the first and last date. If preceded by an asterisk, the phase angle reached an extrema during the period. L_{PAB} and B_{PAB} are the approximate phase angle bisector longitude/latitude at mid-date range (see Harris et al., 1984). Grp is the asteroid family/group (Warner et al., 2009).

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