

PHOTOMETRIC OBSERVATIONS AND ANALYSIS OF SIX MAIN-BELT ASTEROIDS

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We report the results of our photometric observations and lightcurve analysis of six main-belt asteroids: 3423 Slouka, 4367 Meech, (7878) 1992 DZ, 9628 Sendaiotsuna, (14127) 1998 QA91, and 17851 Kaler. The asteroids were observed by a network of four observatories located in Malta and Slovakia.

We conducted photometric observations of six main-belt asteroids from observatories located in Malta (3) and Slovakia (1). Through these observatories listed in Table I, we have observed 3423 Slouka, 4367 Meech, (7878) 1992 DZ, 9628 Sendaiotsuna, (14127) 1998 QA91, and 17851 Kaler. We employed a clear filter (unfiltered observations) with SR (Sloan r) zero point for all other images and calibrated all of our images using dark and flat-field subtraction frames.

Observatory/ Country	Scope	Camera	Observed
Flarestar Obs. (MPC: 171) MALTA	0.25-m SCT	Moravian G2-1600	14127 (5) 7878 (3)
Luckystar Obs. (MPC: M55) SLOVAKIA	0.25-m SCT	Atik 460EX	4367 (6) 9628 (6)
Manikata Obs. MALTA	0.20-m SCT	SBIG ST-10	17851 (4)
Znith Astronomy Obs. MALTA	0.20-m SCT	Moravian G2-1600	3423 (4)

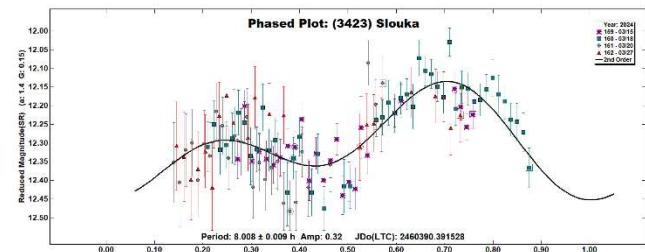
Table I. Instrumentation and observation runs. SCT: Schmidt-Cassegrain Telescope. The number in parentheses is the number of nights observed.

We remotely-controlled all of our equipment over the Internet or from a nearby location for each telescope. We used *Sequence Generator Pro* software (Binary Star Software) for image acquisition at the Maltese observatories. Luckystar Observatory, situated in Slovakia, used the *NINA* image acquisition software (Berg, 2023). We used *MPO Canopus* software version 10 (Warner, 2017) for our image analysis, to obtain differential aperture photometry, and to construct lightcurves. Table I gives the details of the instrumentation and number of observation nights for each

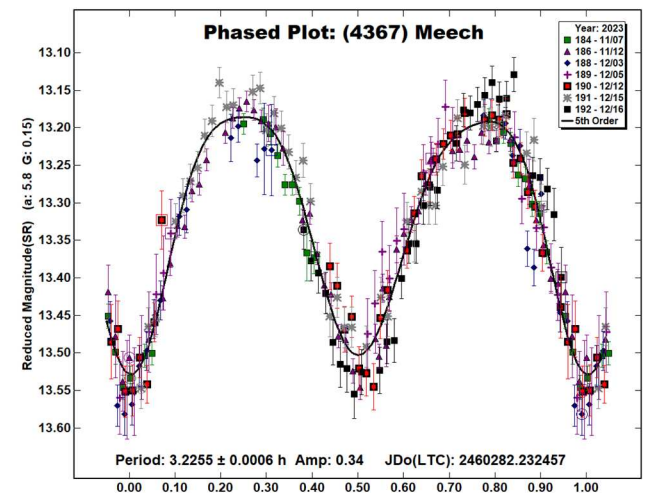
target. We selected near-solar color comparison stars using the Comparison Star Selector (CSS) feature of *MPO Canopus*. We based all brightness measurements on the Asteroid Terrestrial-impact Last Alert System (ATLAS) catalogue (Tonry et al., 2018).

3423 Slouka is a main-belt asteroid that was discovered on 1981 February 9 by Czech astronomer L. Brožek at Klet observatory. This body has estimated diameter of 16.58 km based on an absolute magnitude of $H = 12.63$. The orbital semi-major axis is 3.051 au, the eccentricity is 0.11, and period is 5.33 yr (JPL, 2024).

The asteroid was observed from Znith observatory on four nights between 2024 March 16-27. Based on these observations, the synodic period was determined to be 8.008 ± 0.009 h, with an amplitude of 0.32 ± 0.09 mag. It is worth noting that the LCDB database (Warner et al., 2009) does not currently show any published period for this target.

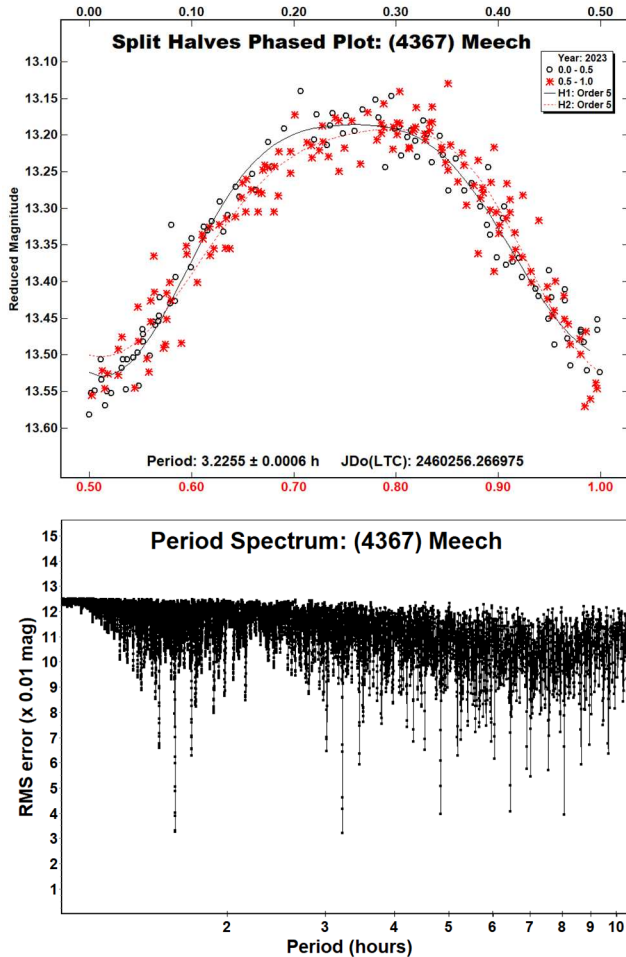


4367 Meech is a main-belt asteroid discovered at Siding Spring observatory by J.S. Bus on 1981 March 2; it is named in honor of Dr. Karen J. Meech, astrobiologist and astronomer, who is a specialist in planetary astronomy. The absolute magnitude is $H = 12.85$ mag, which gives $D \sim 14.98$ km. It orbits the sun with a semi-major axis of 2.879 au and an eccentricity is 0.23 (JPL, 2024).

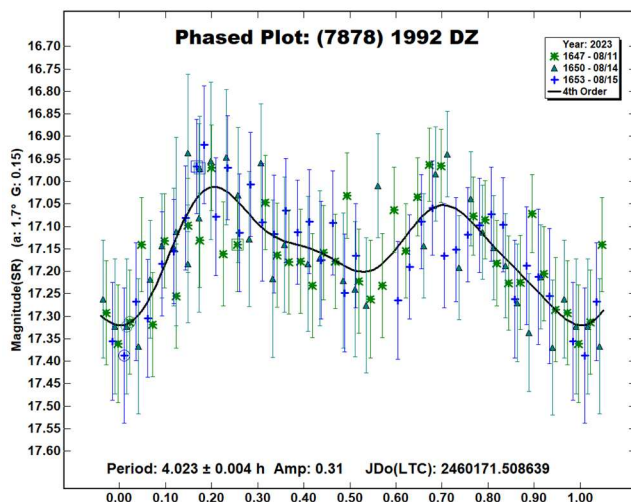


The asteroid was observed on six nights by Luckystar Observatory from 2023 November 7 to December 16. Analysis of the data shows $P = 3.2255 \pm 0.0006$ h, with an amplitude of 0.34 ± 0.04 mag. The LCDB database does not currently show any published period for Meech. Our analysis of the lightcurve shows standard bimodal solution as the most probable (based on the lowest RMS value), but this solution shows very similar shape of both halves. The half-period of 1.613 h was considered, based on the split-halves diagram and very similar RMS values (RMS = 3.2061 for bimodal and RMS = 3.2740 for monomodal solution). Considering minor differences in the shape of both halves and the fact that the

monomodal solution led to result of C-type asteroid of 15 km diameter rotating beyond the spin barrier, the bimodal solution appears more plausible.



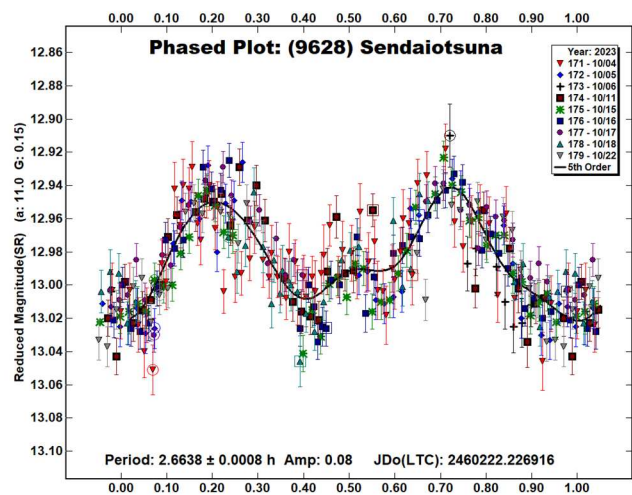
(7878) 1992 DZ is a main-belt asteroid discovered by N. Kawasato at Uenohara on 1992 February 27. The estimated diameter is 5.853 ± 0.230 km ($H = 13.42$ mag). The orbit has semi-major axis of 2.621 au, eccentricity of 0.098, and period of 4.24 yr.



Flarestar Observatory observed this target on three nights from 2023 August 11-15. Our results show a synodic period of 4.023 ± 0.004 h with an amplitude of 0.31 ± 0.2 mag. It's worth noting that the significantly higher RMS of observations were caused by the low brightness of the target ($V \sim 17.1$ -17.3), which was at the limit of the equipment capabilities. Due to the fact that the LCDB database does not show any published period, we consider our results as a good starting point for further analysis of this target.

9628 Sendaiotsuna is a main-belt asteroid discovered by E.F. Helin at Palomar on 1993 July 16. It has an estimated diameter of 8.884 ± 0.152 km based on an absolute magnitude of $H = 12.40$ mag. It orbits the sun with a semi-major axis of 2.609 au, eccentricity of 0.203, and period of 4.21 yr. The asteroid is named after the Sendai Otsunahiki, which is a 400-year-old tug-of-war festival held in Satsumasendai City in the evening of the day before the autumnal equinox.

Luckystar Observatory observed the asteroid on six nights from 2023 October 4-22. Our results show a synodic period of 2.6638 ± 0.0008 h with an amplitude of 0.08 ± 0.01 mag. These are consistent with the previously published period by Dose (2024; 2.664 ± 0.001 h), Marcini and Papini (2024; 2.664 ± 0.001 h), and (Farfan et al., 2024; 2.674 ± 0.009 h).

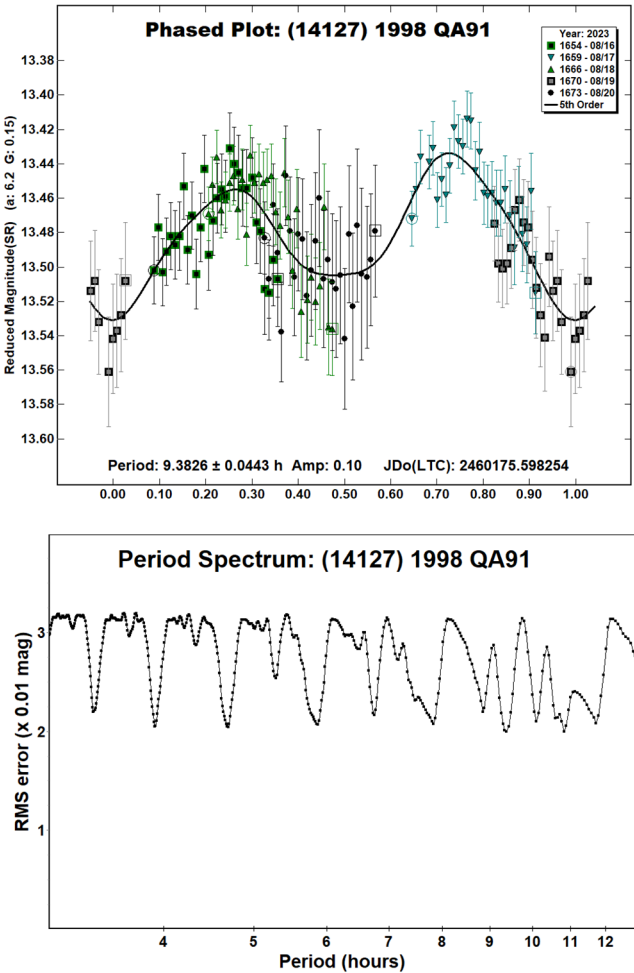


(14127) 1998 QA91 is a main-belt asteroid discovered by LINEAR at Socorro on 1998 August 28. It has estimated diameter of 6.076 ± 0.127 km based on $H = 13.09$ mag and orbits the sun with a semi-major axis of 2.604 au, eccentricity of 0.200, and period of 4.20 yr (JPL, 2024).

1998 QA91 was observed on five nights from Flarestar Observatory from 2023 August 16-20. Our data produced a rotation period of 9.3826 ± 0.0443 h with an amplitude of 0.08 ± 0.02 mag. The limited amount of data for this target resulted into several potential solutions with nearly the same RMS value. The adopted binodal solution is likely correct, but further observations will be needed to confirm this result since the LCDB database does not show any previously published period.

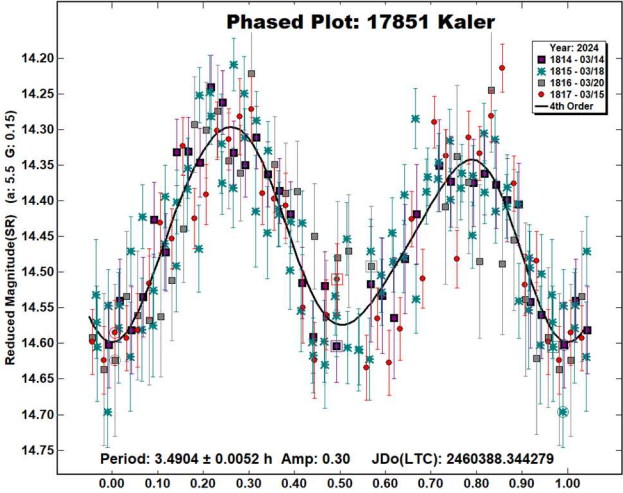
Number	Name	yyyy mm/dd	Phase	LPAB	BPAB	Period(h)	P.E.	Amp	A.E.
Grp									
3423	Slouka	2024 03/15-03/27	0.9, 6.1	172	0	8.008	0.009	0.32	0.09
4367	Meech	2023 11/07-12/16	5.5, 20.2	41	10	3.2255	0.0006	0.34	0.04
7878	1992 DZ	2023 08/11-08/15	1.4, 2.9	315	2	4.023	0.004	0.31	0.20
9628	Sendaiotsuna	2023 10/04-10/22	11.1, 12.1	161	7	2.6638	0.0008	0.08	0.01
14127	1998 QA91	2023 08/16-08/20	6.6, 4.8	331	6	9.3826	0.0443	0.08	0.02
17851	Kaler	2024 03/14-03/20	6.0, 3.3	182	4	3.4904	0.0009	0.30	0.06

Table II. Observing circumstances and results. The phase angle is given for the first and last date. LPAB and BPAB are the approximate phase angle bisector longitude and latitude at mid-date range (see Harris et al., 1984). Grp is the asteroid family/group (Warner et al., 2009).



(17851) Kaler is a main-belt asteroid discovered by the Near-Earth Asteroid Tracking program (NEAT) at Haleakala on 1998 May 1. It has an estimated diameter of 4.911 ± 0.198 km ($H = 13.88$). It orbits the sun with semi-major axis of 2.398 au, an eccentricity of 0.146, and period of 3.71 yr (JPL, 2024). This asteroid is named after James B. Kaler, a professor at the University of Illinois from 1976 to 2003, who is known for his spectroscopic research on planetary nebulae.

Manikata Observatory observed the asteroid on four nights from 2024 March 14-20. Our analysis yielded a synodic period of 3.4904 ± 0.0009 h with an amplitude of 0.30 ± 0.06 mag. These results are consistent with previously published period of $P = 3.492 \pm 0.002$ h by Benishek (2024).



Acknowledgements

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References

Benishek, V. (2024). “Photometry of 18 asteroids from Sopot astronomical observatory: 2023 December - 2024 April.” *Minor Planet Bull.* **51**, 239-243.

Berg, S. (2023). “Nighttime Imaging ‘N’ Astronomy (NINA) website.” <https://nighttime-imaging.eu/>. Last accessed 2024 January 6.

Dose, E.V. (2024). “Lightcurves of eighteen asteroids.” *Minor Planet Bull.* **51**, 42-49.

Farfán, R.G.; de la Cuesta, F.G.; Lorenz, E.R.; Mañanes, E.F.; Andújar, J.M.F.; Fernández, J.R.; Casal, J.D.; de Elías Cantalapiedra, J.; de la Fuente, P.; Collada, J. (2024). “Photometry and lightcurve analysis of 26 asteroids.” *Minor Planet Bull.* **51**, 133-138.

Harris, A.W.; Young, J.W.; Scaltriti, F.; Zappala, V. (1984). “Lightcurves and phase relations of the asteroids 82 Alkmene and 444 Gyptis.” *Icarus* **57**, 251-258.

JPL (2024). Small-Body Database Browser - JPL Solar System Dynamics web site. <http://ssd.jpl.nasa.gov/sbdb.cgi>. Last accessed: 2024 October 22.

Marchini, A.; Papini R. (2024). “Photometric observations of asteroids 1631 Kopff, 2967 Vladisvyat and 9628 Sendaiotsuna.” *Minor Planet Bull.* **51**, 158-160.

Tonry, J.L.; Denneau, L.; Flewelling, H.; Heinze, A.N.; Onken, C.A.; Smartt, S.J.; Stalder, B.; Weiland, H.J.; Wolf, C. (2018). “The ATLAS All-Sky Stellar Reference Catalog.” *Astrophys. J.* **867**, A105.

Warner, B.D.; Harris, A.W.; Pravec, P. (2009). “The asteroid lightcurve database.” *Icarus* **202**, 134-146. Updated 2024 Oct. <https://minplanobs.org/MPInfo/php/lcdbsummaryquery.php>

Warner, B.D. (2016). Collaborative Asteroid Lightcurve Link website. <http://www.minorplanet.info/call.html>. Last accessed: 2024 January.

Warner, B.D. (2017). MPO Software, *MPO Canopus* version 10.7.10.0. Bdw Publishing. <http://www.bdwpublishing.com/>

Warner, B.D. (2021). Asteroid Lightcurve Photometry Database (ALCDEF) at <https://minplanobs.org/alcdef/index.php>

PHOTOMETRIC OBSERVATIONS AND LIGHTCURVE ANALYSIS OF (25450) 1999 XQ7

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In this paper we report the results of our photometric observation campaign and lightcurve analysis of an asteroid (25450) 1999 XQ7 during its favorable opposition in 2024.

(25450) 1999 XQ7 is an inner main-belt asteroid with no record of a synodic period in LCDB database (Warner et al., 2009). The CALL webpage (Warner, 2016) listed this asteroid as a potential target for photometric observation due to the favorable opposition on 2024 November 7 and relatively high brightness of $V \sim 15.6$.

Photometric observations were carried out from three observatories located in Slovakia, Malta and Canada. A total of 23 sessions were obtained from 2024 November 1 to December 14, totaling 688 individual observations. Table I provides the complete equipment list and the observer's total runs. Initial sessions were all-night observations (approximately 9 hours) and then they were adapted to batch observations plan of approximately one hour duration. Exposure times varied from 180 s (Luckystar Observatory) to 240/300 s (Flarestar and A la belle étoile Observatory).

All images were taken through a clear filter (unfiltered) with an SR (SLOAN r') bandpass zero point and were calibrated using dark and flat-field master frames subtraction. All brightness measurements were based on the Asteroid Terrestrial-impact Last Alert System (ATLAS) catalogue (Tonry et al., 2018).

We remotely-controlled all our equipment over the Internet or from a nearby location for each telescope. *NINA* software (Berg, 2023) was used for image acquisition by A la belle étoile and Luckystar Observatories. Flarestar Observatory used *Sequence Generator Pro* software (Binary Star Software). We used *MPO Canopus* software versions 10 and 12 (Warner, 2017) for our image analysis, to obtain differential aperture photometry, and to create the final lightcurve. We selected near-solar color comparison stars ($0.5 \leq B-V \leq 0.9$) using the Comparison Star Selector (CSS) feature of *MPO Canopus*.

We estimate the synodic rotation period of (25450) 1999 XQ7 to be 299.68 ± 0.37 h, with an amplitude of 0.92 ± 0.05 mag. The suggested, and most probable solution, has the lowest RMS value. Another solution, proposed by Fourier algorithm, has a very similar RMS value close to a double-period length (719 h). Based on the fact that asteroids with amplitudes greater than 0.2 magnitudes typically exhibit a bimodal solution, we preferred the solution with nearly 300-hour period.

Number	Name	Family	H	Dkm	a (au)	e	i (deg)	P(ys)	Discovered by	yyyy/mm
25450	1999 XQ7	9104	14.39	3.94	2.35	0.228	5.87	3.61	C.W. Jue1s	1999/12

Table II. Orbital and discovery information. Fam is the group or family using the LCDB values. An asterisk indicates a generic group, otherwise, the numbers are from Nesvorný et al. (2015). Web Sources: JPL: https://ssd.jpl.nasa.gov/tools/sbdb_lookup.html# MPInfo: <https://minorplanet.info/php/oneasteroidinfo.php>

Number	Name	yyyy mm/dd	Phase	LPAB	BPAB	Period(h)	P.E.	Amp	A.E.	Grp
25450	1999 XQ7	2024 11/01-12/14	5.3, 21.2	47	6	299.68	0.37	0.92	0.05	MBI

Table III. Observing circumstances and results. The phase angle is given for the first and last date. LPAB and BPAB are the approximate phase angle bisector longitude and latitude at mid-date range (see Harris et al., 1984). Grp is the asteroid family/group (Warner et al., 2009).