

**PHOTOMETRIC OBSERVATIONS OF MAIN-BELT
ASTEROIDS 784 PICKERINGIA, 1465 AUTONOMA,
1477 BONSDORFFIA, 3057 MALAREN,
5708 MELANCHOLIA, AND 8548 SUMIZIHARA**

Charles Galdies, PhD
Znith Observatory
Armonie, E. Bradford Street,
Naxxar NXR 2217, MALTA
charles.galdies@um.edu.mt

Stephen M. Brincat
Flarestar Observatory (MPC code: 171)
Fl.5 George Tayar Street,
San Gwann SGN 3160, MALTA
stephenbrincat@gmail.com

Marek Buček, PhD
Luckystar Observatory (MPC code: M55)
Dr. Lučanského 547, Važec, 032 61, SLOVAKIA
marbucek@hotmail.com

Martin Mifsud
Manikata Observatory
Manikata, MLH 5013, MALTA
mifsudm0@gmail.com

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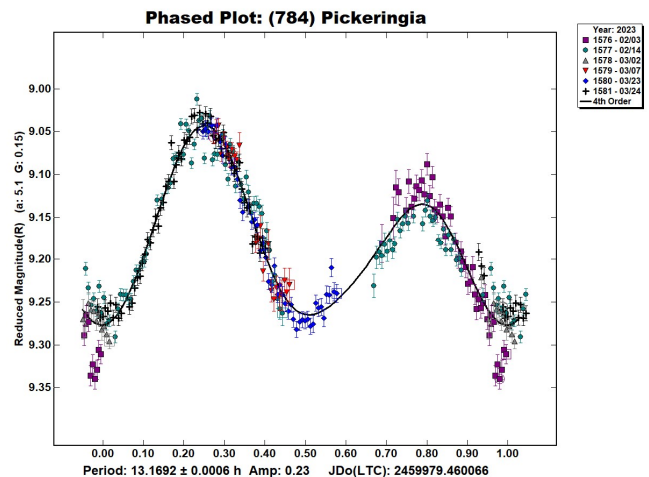
Photometric observations of selected asteroids were done from Znith Observatory, Flarestar Observatory (MPC-171), Luckystar Observatory (MPC-M55), and Manikata Observatory in 2023. The observations were made during a favorable apparition for each asteroid. Some of these targets were never studied in the past and thus their rotation periods were unknown.

In between the months of April 2022 and June 2023, photometric observations of 6 main-belt asteroids were carried out from five observatories located in Malta (Europe) and Slovakia. Observations of 784 Pickeringia and 8548 Sumizihara were obtained from Znith Observatory through a 0.20-m $f/6.3$ Schmidt-Cassegrain telescope (SCT) equipped with a Moravian G2-1600 CCD camera. Observations of 5708 Melancholia and 3057 Malaren were obtained from Luckystar Observatory through a 0.25-m $f/8$ Schmidt-Cassegrain telescope (SCT) equipped with an Atik460Exm CCD camera at 1×1 binning mode with a resultant pixel scale of $0.66''$ per pixel. 1477 Bonsdorffia was observed by Flarestar Observatory through a 0.25-m $f/6.3$ Schmidt-Cassegrain telescope (SCT) using a Moravian G2-1600 camera at 1×1 binning mode with a resultant pixel scale of $0.99''$ per pixel. 1465 Autonoma was jointly observed by Manikata Observatory, through a 0.20-m $f/10$ Schmidt-Cassegrain telescope (SCT) equipped with an SBIG ST-9 CCD camera and by Znith Observatory. All cameras were operated at sensor temperature of -15°C and images were dark subtracted and flat-fielded.

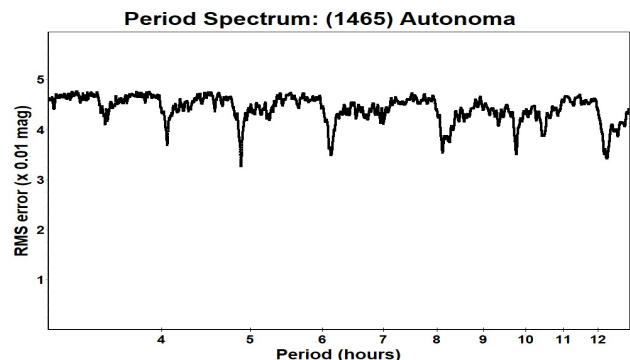
Telescopes and cameras were controlled remotely from a nearby location via *Sequence Generator Pro* (Binary Star Software) and *Nighttime Imaging 'N' Astronomy* (Berg, 2023). Photometric reduction, lightcurve construction and analyses were derived through *MPO Canopus* software (Warner, 2017). Differential aperture photometry was utilized and photometric measurements were derived through the use of *MPO Canopus*, Comparison Star Selector (CSS) that utilized comparison stars of near-solar color.

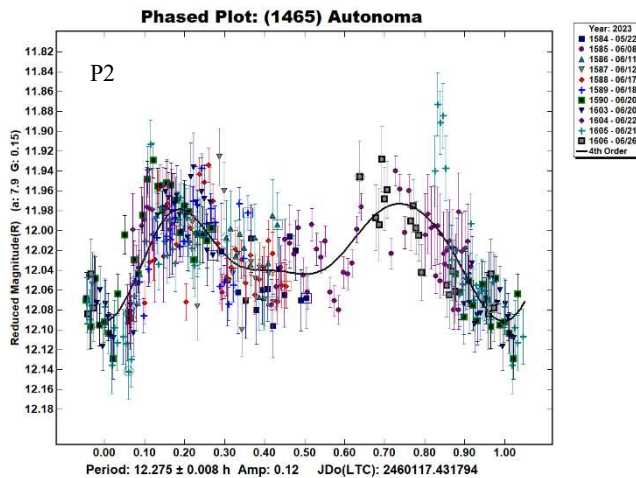
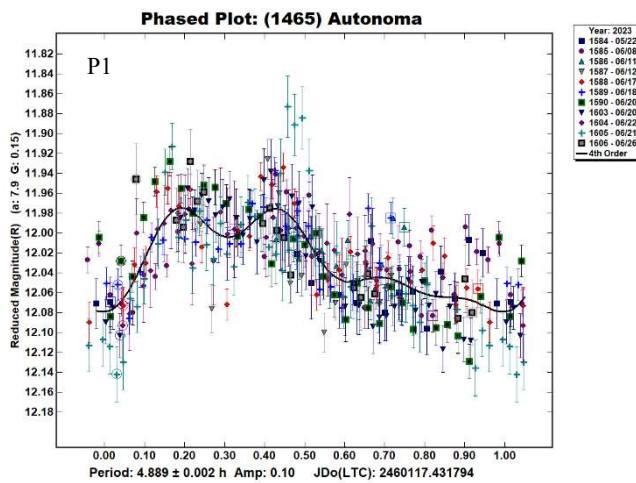
All measurements were taken from the MPOSC3 Catalog that is based on the 2MASS catalog (<http://www.ipac.caltech.edu/2mass>) with magnitudes converted from J-K to BVRI (Warner, 2007). The 6 asteroids for this research have been selected through the CALL website as maintained by Warner (2016).

784 Pickeringia is a main-belt asteroid that was discovered in 1914 March 20 by J.H. Metcalf at Winchester, UK. The asteroid orbits the sun with a semi-major axis of 3.099 AU, eccentricity 0.2411, and a period of 5.46 years (JPL, 2023). The JPL Small-Bodies Database Browser (JPL, 2023) lists the diameter of this asteroid as $75.596 \text{ km} \pm 0.311 \text{ km}$ based on an absolute magnitude $H = 13.2$. 784 Pickeringia was observed from Znith Observatory on 6 nights starting on the night of 2023 February 14/15 and ending on the night of 2023 March 24. Our results yielded a synodic period of $13.1692 \pm 0.0006 \text{ h}$ and amplitude of $0.23 \pm 0.03 \text{ mag}$. This is in line with the results published in the LCDB by Pilcher (2022) and Dose (2023).

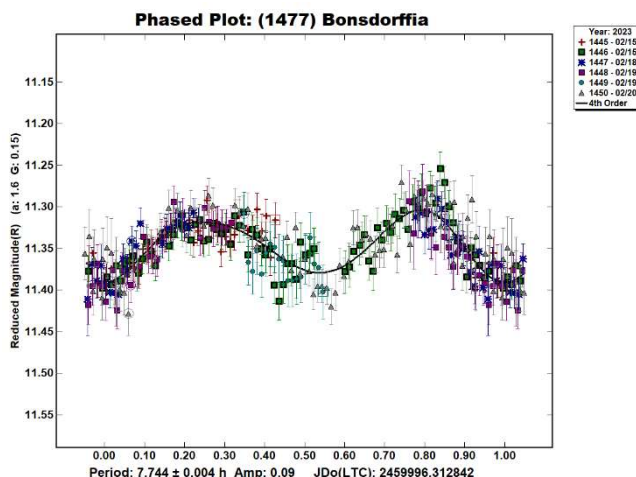


(1465) Autonoma is a main-belt asteroid that was discovered in 1938 March 20 by A. Wachmann at Bergerdorf. The asteroid orbits the sun with a semi-major axis of 3.027 AU, eccentricity 0.178, and a period of 5.27 years (JPL, 2023). The JPL Small-Bodies Database Browser (JPL, 2023) lists the diameter of 1465 Autonoma as $18.111 \text{ km} \pm 0.276 \text{ km}$ based on an absolute magnitude $H = 11.8$. Asteroid (1465) was observed from Znith Observatory on three nights from 2023 June 20 to June 22, and by Manikata Observatory on seven nights from 2023 May 22 to June 20. The derived lightcurves indicate a possible synodic period of $4.889 \pm 0.002 \text{ h}$ and amplitude of $0.10 \pm 0.005 \text{ mag}$ ("P1 figure") with an RMS of 3.2672. Another period spectrum ("P2 figure"), shows a higher period than that of the other derived period of $12.275 \pm 0.008 \text{ h}$ and amplitude of $0.12 \pm 0.005 \text{ mag}$ but with a slightly higher RMS of 3.4158.

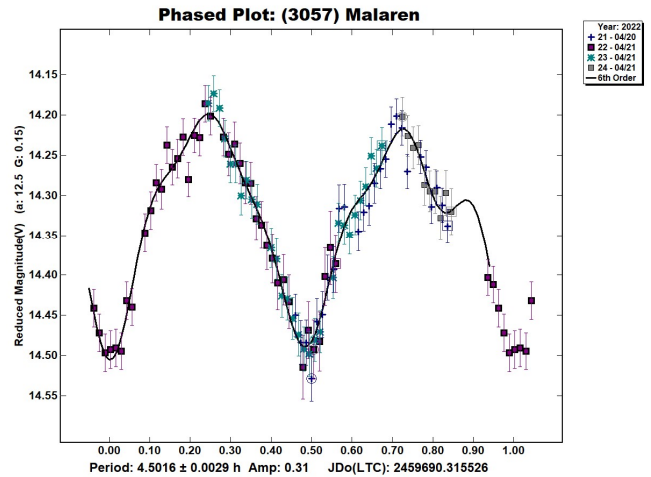




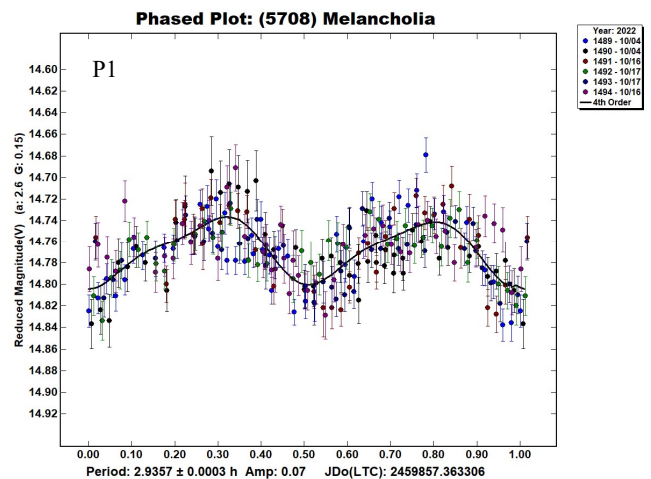
(1477) *Bonsdorffia* is a main-belt asteroid that was discovered in 1938 February 06 by Y. Vaisala at Turku. The asteroid orbits the sun with a semi-major axis of 3.208 AU, eccentricity 0.266, and a period of 5.74 years (JPL, 2023). The JPL Small-Bodies Database Browser (JPL, 2023) lists the diameter of 1477 *Bonsdorffia* as 25.851 ± 0.390 km based on an absolute magnitude $H = 11.5$. *Bonsdorffia* was observed from Flarestar Observatory on 2023 February 15 to February 20. The derived lightcurve indicates a synodic period of 7.744 ± 0.004 h and amplitude of 0.09 ± 0.04 mag. This is close to the U2 LCDB published value of 7.8 ± 0.1 h by Aznar (2011web; LCDB, 2023).



(3057) *Malaren* is a main-belt asteroid that was discovered on 1981 March 9 by E. Bowell at Flagstaff. This asteroid has an absolute magnitude (H) of 13.7 and orbits the sun with a semi-major axis of 2.260 AU, eccentricity 0.075, and a period of 3.397 years (JPL, 2023). Observations were conducted from Luckystar Observatory on 2 nights from 2022 April 20 until April 21. The derived lightcurve, which is based on an almost coverage, indicates a synodic period of 4.5016 ± 0.00029 h and amplitude of 0.31 ± 0.02 mag.

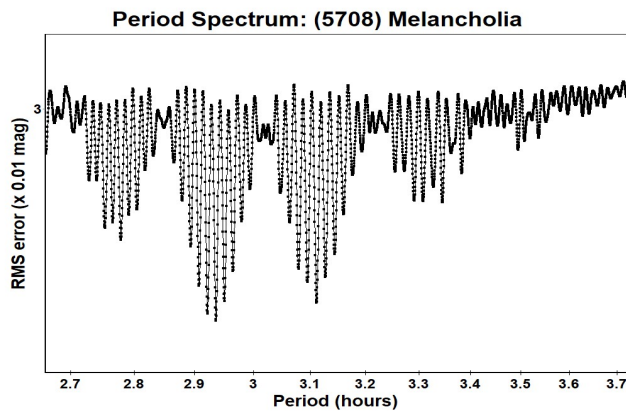
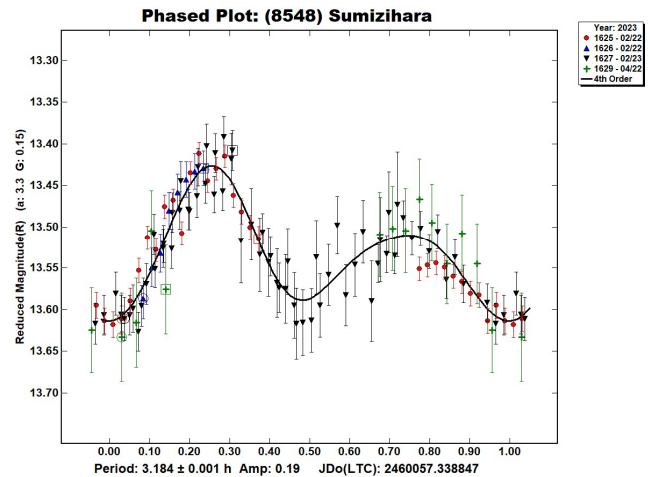
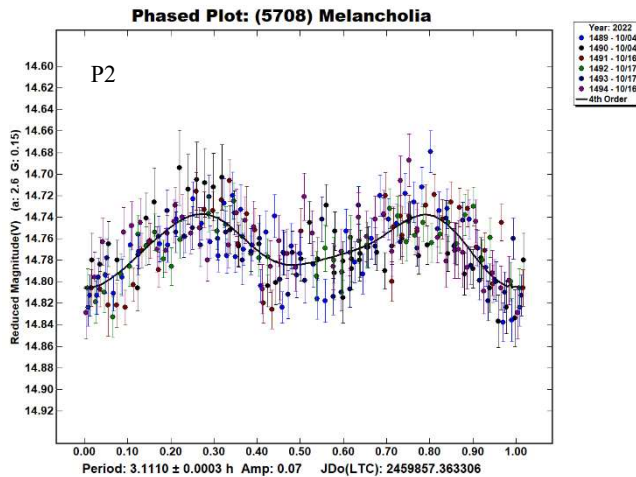


(5708) *Melancholia* is a main-belt asteroid that was discovered on 1977 October 12 by P. Wild at Zimmerwald. The asteroid orbits the sun with a semi-major axis of 2.179 AU, eccentricity 0.212, and a period of 3.216 years (JPL, 2023). The JPL Small-Bodies Database Browser does not list the diameter of this asteroid. Its absolute magnitude $H = 14.6$. Observations were conducted from Luckystar Observatory on 3 nights from the night of 2022 October 4 and ending on the night of October 16. Results following period spectrum analysis show two possible periods for this target, one with a synodic period of 2.9357 ± 0.0003 h and amplitude of 0.07 ± 0.04 mag ("P1 figure"; RMS 2.2135) and 3.1110 ± 0.0003 h and amplitude of 0.07 ± 0.04 mag ("P2 figure"; RMS 2.2801). The LCDB did not display any published periods of this asteroid.



Number	Name	yyyy mm/dd	Pts	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
784	Pickeringia	2023 02/14-03/24	299	4.5, 6.4	142	12	13.1692	0.0006	0.23	0.03	MB
1465	Autonoma	2023 05/22-06/22	312	7.9, 10.6	252	13	4.889	0.002	0.10	0.005	MB
							12.275	0.008	0.12	0.005	
1477	Bonsdorffia	2023 02/15-02/20	323	1.9, 4.0	142	-1	7.744	0.004	0.09	0.04	MB
3057	Malaren	2022 04/20-04/21	109	12.4, 12.9	192	9	4.5016	0.00029	0.31	0.02	MB
5708	Melancholia	2022 10/04-10/16	272	2.6, 7.0	14	3	2.9357	0.0003	0.07	0.04	MB
							3.1110	0.0003	0.07	0.04	
8548	Sumizihara	2023 02/22-02/23	117	3.8, 4.4	148	2	3.184	0.001	0.19	0.05	MB

Table I. Observing circumstances and results. Pts is the number of data points. 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).



(8548) Sumizihara is a main-belt asteroid that was discovered in 1994 March 14 by K. Endate and K. Watanabe at Kitami. The asteroid orbits the sun with a semi-major axis of 2.587 AU, eccentricity 0.260, and a period of 4.16 years (JPL, 2023). The JPL Small-Bodies Database Browser (JPL, 2023) lists the diameter of 8548 Sumizihara as 5.286 km ± 0.090 km based on an absolute magnitude H = 13.5. Sumizihara was observed from Zñith Observatory on 2 nights from the night of 2023 February 22 until February 23. The derived lightcurve indicates a synodic period of 3.184 ± 0.001 h and amplitude of 0.19 ± 0.05 mag.

Acknowledgements

We would like to thank Brian Warner for his work in the development of *MPO Canopus* and for his efforts in maintaining the CALL website. This research has made use of the JPL's Small-Body Database.

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LIGHTCURVES AND ROTATION PERIODS OF 903 NEALLEY, 1051 MEROPE, AND 1187 AFRA

Frederick Pilcher
Organ Mesa Observatory (G50)
4438 Organ Mesa Loop
Las Cruces, NM 88011 USA
fpilcher35@gmail.com

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Synodic rotation periods and amplitudes at their year 2023 oppositions are found for 903 Nealley 29.063 ± 0.006 hours, 0.06 ± 0.01 magnitudes with one maximum and minimum per rotational cycle; 1051 Merope 13.712 ± 0.001 hours, 0.17 ± 0.01 magnitudes with one maximum and minimum per rotational cycle; 1187 Afra 14.071 ± 0.001 hours, 0.68 ± 0.05 magnitudes.

The new observations to produce the results reported in this paper were made at the Organ Mesa Observatory with a Meade 35-cm LX200 GPS Schmidt-Cassegrain, SBIG STL-1001E CCD, 60 to 120 second exposures, unguided, clear filter. Image measurement and lightcurve construction were with *MPO Canopus* software with calibration star magnitudes for solar colored stars from the CMC15 catalog reduced to the Cousins R band. Zero-point adjustments of a few $\times 0.01$ magnitude were made for best fit. To reduce the number of data points on the lightcurves and make them easier to read, data points have been binned in sets of 3 with maximum time difference 5 minutes.

903 Nealley. Several different rotation periods of have been published previously. Warner (2004), near celestial longitude 150° , found 21.60 h, revised in Warner (2012) to 19.58 h. Also, in Warner (2012), additional data near celestial longitude 312° showed 19.72 h. Behrend (2020web) obtained 16.2 h near celestial longitude 140° . Pál et al (2020) found a longer period of 28.9882 h near celestial longitude 60° and based on a lightcurve with three unequal maxima and minima. Dose (2022) published a bimodal lightcurve with several gaps phased to a period 58.032 h near celestial longitude 195° .

New observations on 13 nights 2023 July 17 - Aug. 27, near celestial longitude 338° , provide a fit to a lightcurve with period 29.063 ± 0.006 hours, amplitude 0.06 ± 0.01 magnitudes with one maximum and minimum per rotational cycle (Fig. 1). This period is consistent with Pál et al. (2020), and also with Dose (2022) if his data were replotted to 29.016 h with a monomodal lightcurve analogous to the one found from this study and with half of his published period.

A period spectrum of the year 2023 data (Fig. 2) shows minima near 29 hours and the double period 58 hours to be much deeper than any minimum near 20 hours. The three maxima and minima per 28.9882-hour cycle in the study by Pál et al. (2020) make the double period with six maxima and minima per cycle highly unlikely. An attempt to draw a lightcurve phased to near 20 hours from the data of the current study shows a complete misfit, with segments from separate sessions overlapping in the form of an X. This failed lightcurve is not published here but is available from the author upon request. The periods by Warner (2004), Warner (2012), and Behrend (2020web) may be safely rejected.

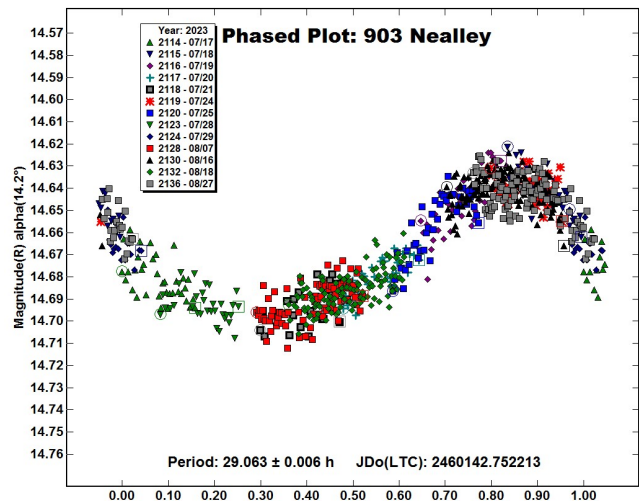


Figure 1. The lightcurve of 903 Nealley from year 2023 data (this study) phased to 29.063 hours.

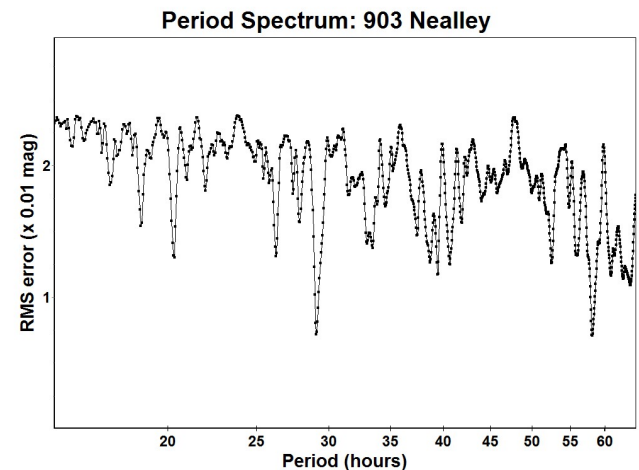


Figure 2. Period spectrum of 903 Nealley from year 2023 data (this study).