COLLABORATIVE ASTEROID PHOTOMETRY FROM UAI: 2023 JANUARY-MARCH

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(Received: 2023 April 12)

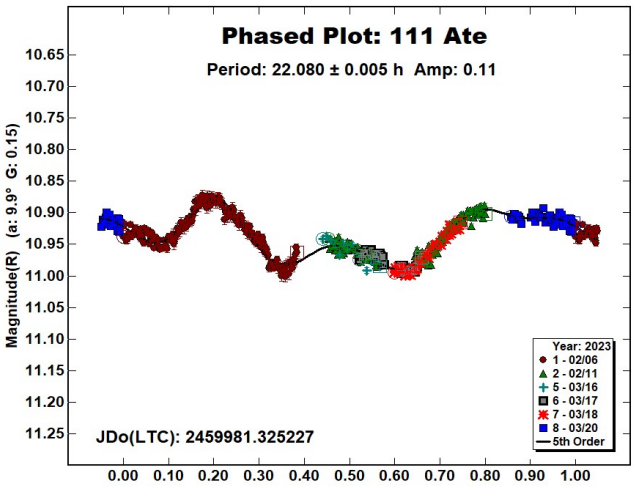
Photometric observations of eight asteroids were made to acquire lightcurves for shape/spin axis modeling. Synodic period and lightcurve amplitude were found for 111 Ate, 197 Arete, 261 Prymno, 325 Heidelberga, 359 Georgia, 737 Arequipa, 1523 Pieksamaki, and 2023 BU. Color indices were measured for 111 Ate, 197 Arete, 261 Prymno, and 737 Arequipa. H-G parameters were found for 197 Arete, 261 Prymno, and 359 Georgia.

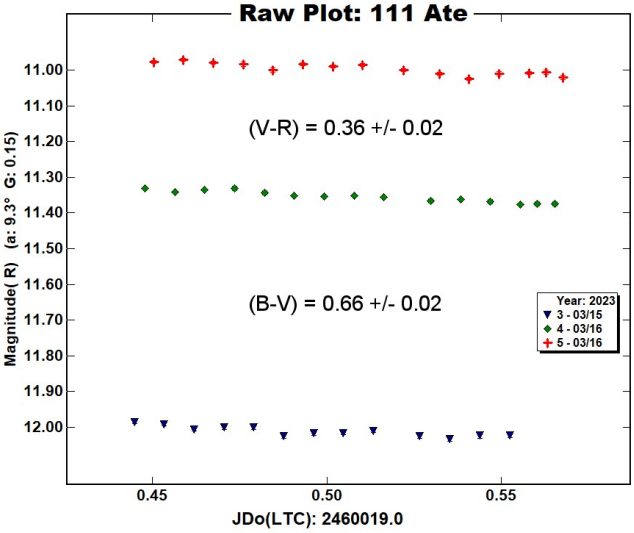
Collaborative asteroid photometry was done inside the Italian Amateur Astronomers Union (UAI; 2023) group. The targets were selected mainly in order to acquire lightcurves for shape/spin axis modeling. Table I shows the observing circumstances and results.

The CCD observations of eight asteroids were made in 2023 January-March using the instrumentation described in the Table II. Lightcurve analysis was performed at the Balzaretto Observatory with *MPO Canopus* (Warner, 2021). All the images were calibrated with dark and flat frames and converted to standard magnitudes using solar colored field stars from custom versions of the CMC15 and ATLAS catalogues distributed with *MPO Canopus*. For brevity, the following citations to the asteroid lightcurve database (LCDB; Warner et al., 2009) will be summarized only as "LCDB".

For H-G plots, the R band magnitudes were converted to V band adding the color index (V-R) and evaluating the half peak-to-peak magnitude using a Fourier model of the same order of the lightcurve plot (Buchheim, 2010).

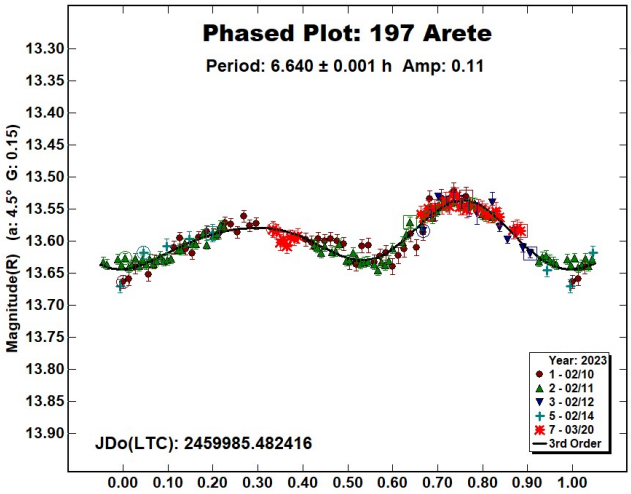
111 Ate is a Ch-type (Bus and Binzel, 2002) middle main-belt asteroid. Collaborative observations were made over six nights. The period analysis shows a synodic period of $P = 22.080 \pm 0.005$ h with an amplitude $A = 0.11 \pm 0.02$ mag. The period is close to the previously published results in the LCDB. Multiband photometry was made by M. Iozzi (L63) on 2023 March 15. We found B-V = 0.66 ± 0.02 and V-R = 0.36 ± 0.02, which are consistent with a C-type asteroid (Shevchenko and Lupishko, 1998).

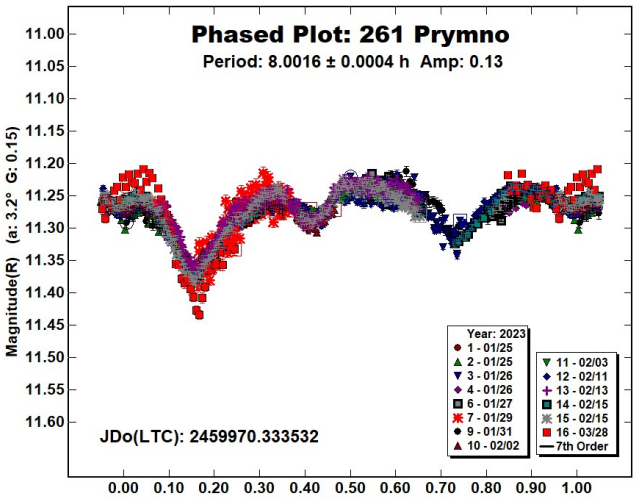


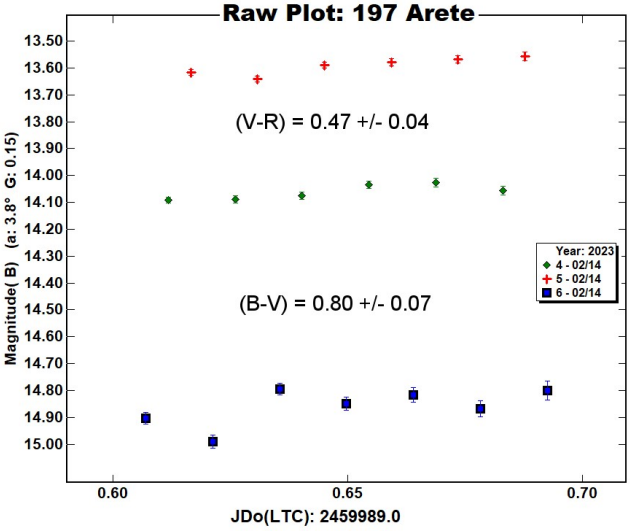


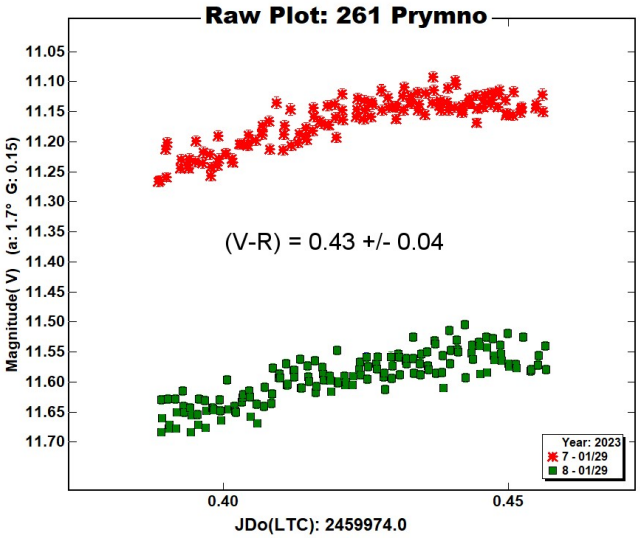
197 Arete is a S-type (Bus and Binzel, 2002) middle main-belt asteroid. Collaborative observations were made over four nights. The period analysis shows a synodic period of $P = 6.640 \pm 0.001$ h with an amplitude $A = 0.11 \pm 0.02$ mag. The period is close to the previously published results in the LCDB. Multiband photometry was done by M. Iozzi (L63) on 2023 February 14. We found the B-V = 0.80 ± 0.07 and V-R = 0.47 ± 0.04. These are close to an S-type asteroid (Shevchenko and Lupishko, 1998). We also found H-G parameters of $H = 9.44 \pm 0.06$ and $G = 0.19 \pm 0.11$.

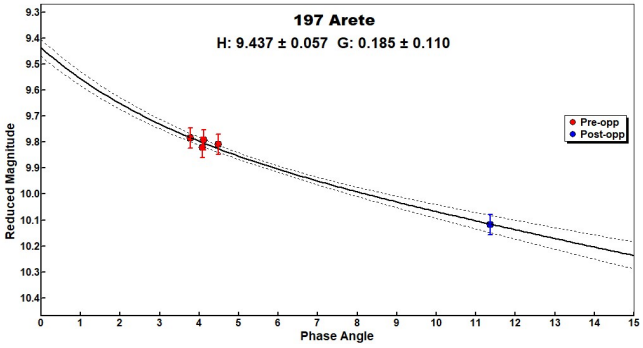
261 Prymno is an X-type (Bus and Binzel, 2002) inner main-belt asteroid. Collaborative observations were made over nine nights. The lightcurve analysis shows a synodic period of $P = 8.0016 \pm 0.0004$ h with an amplitude $A = 0.13 \pm 0.05$ mag. The period is close to the previously published results in the LCDB. Multiband photometry was done by P. Fini and G. Betti (L73) on 2023 January 29. We found V-R = 0.43 ± 0.04, which is close to an M-type asteroid (Shevchenko and Lupishko, 1998). For the H-G parameters we found $H = 9.42 \pm 0.03$ and $G = 0.12 \pm 0.05$.

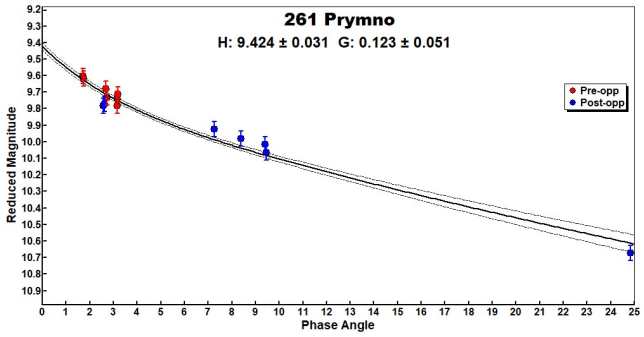




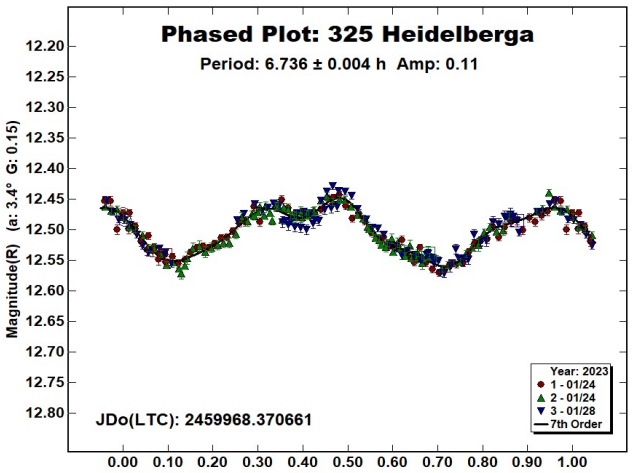




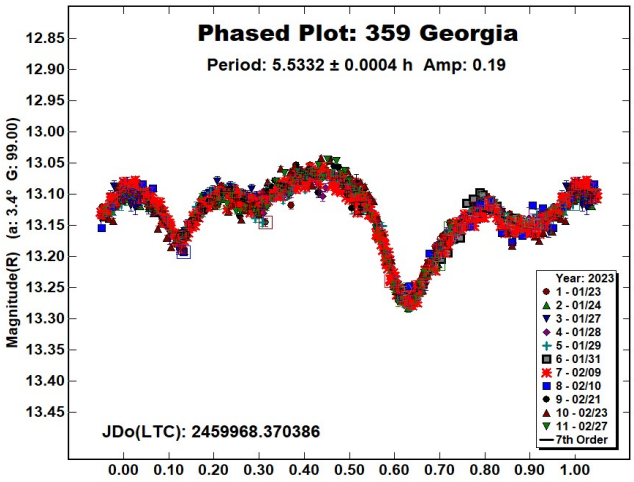


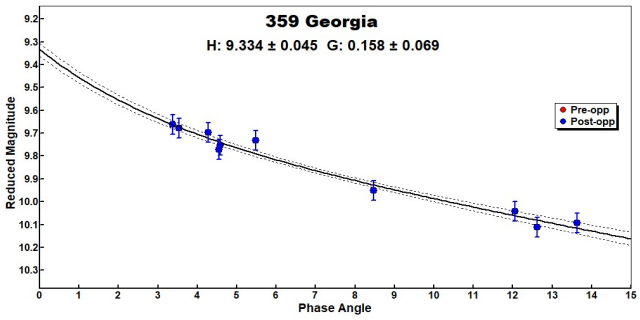


325 Heidelberga is an M-type (Tholen, 1984) outer main-belt asteroid. Observations were made over three nights by A. Marchini (K54). We found a synodic period of P = 6.736 ± 0.004 h with an amplitude A = 0.11 ± 0.02 mag. The period is close to the previously published results in the LCDB.

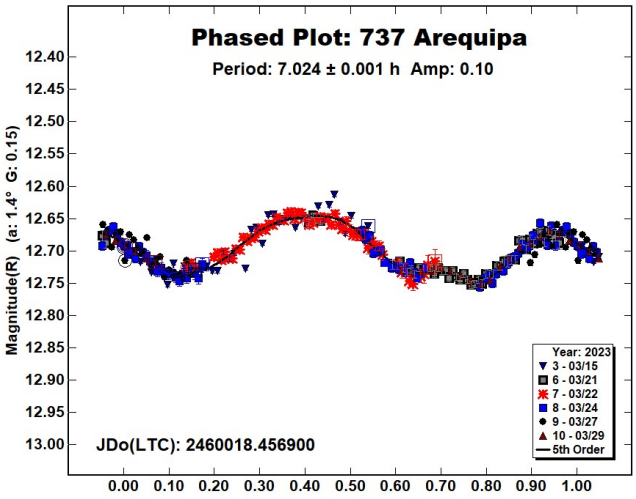


359 Georgia is an X-type (Bus and Binzel, 2002) middle main-belt asteroid. Collaborative observations were made over ten nights. Analysis shows P = 5.5332 ± 0.0004 h and A = 0.19 ± 0.03 mag. The period is close to the previously published results in the LCDB. Not having the color index, we assumed V-R = 0.42, which is typical for M-type asteroids (Shevchenko and Lupishko, 1998). This leads H = 9.33 ± 0.05 and G = 0.16 ± 0.07.





737 Arequipa is an S-type (Bus and Binzel, 2002) middle main-belt asteroid. Collaborative observations were made over six nights. We found a synodic period of P = 7.024 ± 0.001 h and amplitude A = 0.10 ± 0.02 mag. The period is close to the previous results in the LCDB. Multiband photometry was done by P. Bacci and M. Maestripieri (104) on 2023 March 28. We found color indices of B-V = 0.88 ± 0.04 and V-R = 0.51 ± 0.04; these are a good match to an S-type asteroid (Shevchenko and Lupishko, 1998).

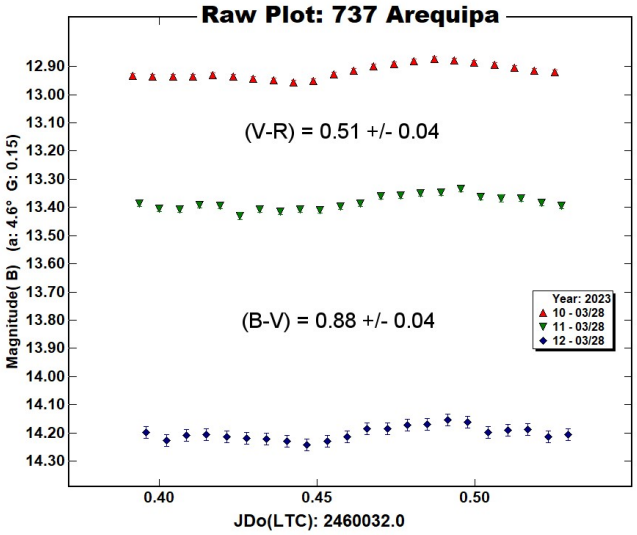


Number	Name	2023 mm/dd	Phase	L_{PAB}	B_{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
111	Ate	02/06-03/20	*9.4, 11.4	156	-3	22.080	0.005	0.11	0.02	MB-M
197	Arete	02/10-03/20	*4.3, 11.3	148	10	6.640	0.001	0.11	0.02	MB-M
261	Prymno	01/25-03/28	*3.2, 24.8	132	3	8.0016	0.0004	0.13	0.05	MB-I
325	Heidelberga	01/23-01/28	3.3, 4.5	120	7	6.736	0.004	0.11	0.02	MB-O
359	Georgia	01/23-02/27	3.3, 13.6	120	7	5.5332	0.0004	0.19	0.03	MB-M
737	Arequipa	03/14-03/28	*1.4, 4.5	176	-2	7.024	0.001	0.10	0.02	MB-M
1523	Pieksamaki	02/17-03/15	*1.6, 13.6	152	-1	5.3210	0.0005	0.45	0.04	MB-I
	2023 BU	01/25-01/26	25.0, 22.7	128	12	0.021605	0.000005	0.81	0.35	NEA

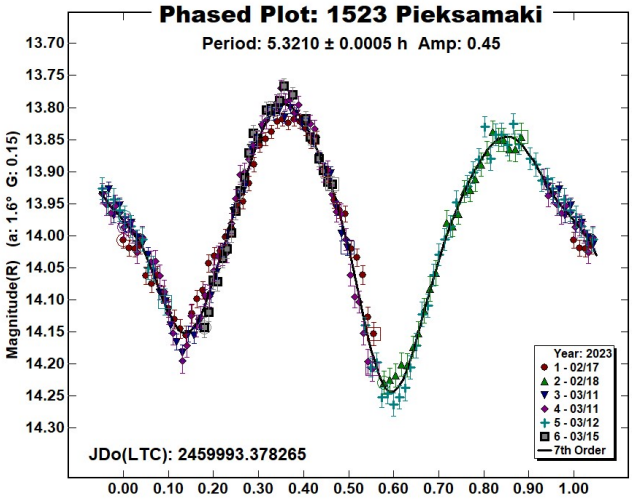
Table I. Observing circumstances and results. The first line gives the results for the primary of a binary system. The second line gives the orbital period of the satellite and the maximum attenuation. The phase angle is given for the first and last date. If preceded by an asterisk, the phase angle reached 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).

Observatory (MPC code)	Telescope	CCD	Filter	Asteroids Sessions
Astronomical Observatory University of Siena (K54)	0.30-m MCT f/5.6	SBIG STL-6303e (2x2)	Rc	111(2) 197(1) 261(2) 325(3) 359(3) 737(3)
HOB Astronomical Observatory (L63)	0.20-m SCT f/6.0	ATIK 383L+	BVRcC	111(4) 197(2)
Iota Scorpii (K78)	0.40-m RCT f/8.0	SBIG STXL-6303e (2x2)	Rc	197(2) 359(1) 1523(2)
GiaGa Observatory (203)	0.36-m SCT f/5.8	MORAVIAN G2-3200	Rc	261(1) 359(1) 1523(2)
Blessed Hermann Obs. (L73)	0.30-m SCT f/6.0	QHY 174MGPS (2x2)	VRc	261(4) 359(1)
Osservatorio Serafino Zani (130)	0.40-m RCT f/5.8	SBIG ST8 XME (2x2)	C	261(2) 359(1)
GAMP (104)	0.60-m NRT f/4.0	Apogee Alta	BVRcC	737(1) 2023 BU(2)
Osservatorio Astronomico Nastro Verde (C82)	0.35-m SCT f/6.3	SBIG ST10XME (2x2)	C	359(3)
Hypatia Observatory (L62)	0.25-m RCT f/5.3	Moravian C2-7000A	Rc	261(3)
M57 (K38)	0.35-m RCT f/5.5	SBIG STT1603ME	Rc	261(1)
Zen Observatory (M26)	0.30-m RCT f/8.0	SXV-H9C (2x2)	Rc	359(1)
Seveso Observatory (C24)	0.30-m SCT f/10.0	Moravian KAF 8300 (3x3)	Rc	737(1)
GAV (Gruppo Astrofili Villasanta)	0.20-m SCT f/7.0	SXV-H9	Rc	737(1)

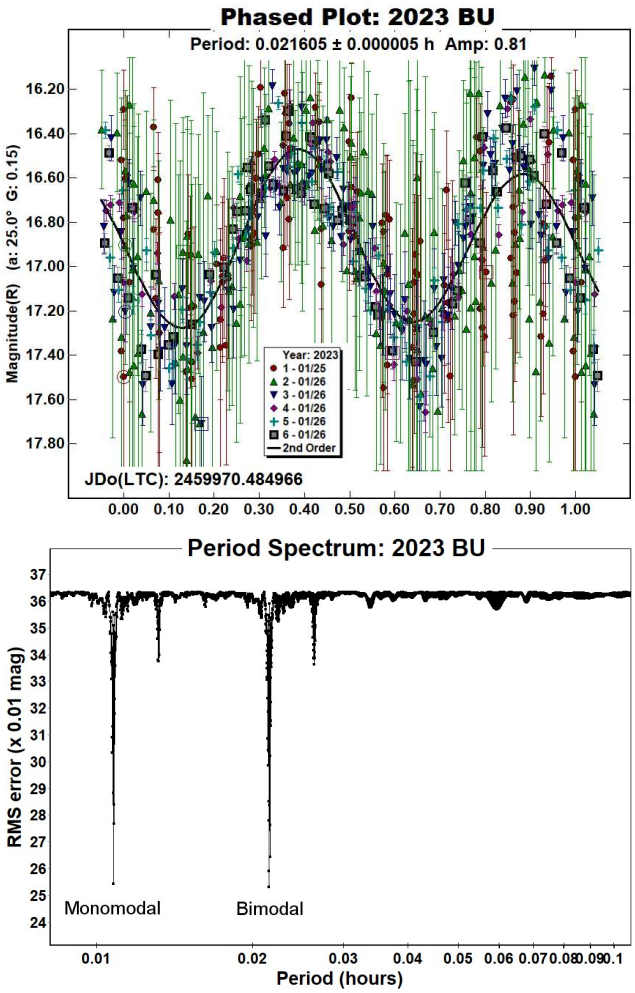
Table II. Observing Instrumentations. MCT: Maksutov-Cassegrain, NRT: Newtonian Reflector, RCT: Ritchey-Chretien, SCT: Schmidt-Cassegrain. The numbers in parentheses in the CCD column are the binning sizes. The Asteroids/Sessions column gives the number or designation of the asteroid(s) observed at the station while the number in parentheses immediately after is the number of observing sessions for that object.



1523 Pieksamaki is a medium-albedo middle main-belt asteroid. Collaborative observations were made over three nights. We found a synodic period of P = 5.3210 ± 0.0005 h and amplitude A = 0.45 ± 0.04 mag. The period is close to the previously published results in the LCDB.



2023 BU is an Apollo Near-Earth asteroid. Observations were made over two nights by P. Bacci and M. Maestripieri (104) near the time of the asteroid's closest approach to the Earth. We found a bimodal solution with a synodic period of P = 0.021605 ± 0.000005 h and an amplitude A = 0.81± 0.35 mag. No previously reported periods were found in the LCDB.



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ROTATIONAL PERIOD AND LIGHTCURVE DETERMINATION FOR FIVE MINOR PLANETS

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(Received: 2023 March 3)

Photometric measurements of CMOS observations for five main-belt asteroids were made from 2022 December through 2023 February. Phased lightcurves were created for each one. Three of the asteroids have no prior published period solutions. All the data have been submitted to the ALCDEF database.

CMOS observations of five main-belt asteroids were performed at NAC Observatory (MPC U98) in Benson, AZ. Images were taken using a 0.35m *f*/7.2 Corrected Dall-Kirkham telescope, Moravian C5A-100M CMOS camera featuring a Sony IMX-461 sensor. Images were captured at a scale of 1.21"/pixel after binning 4×4. Table I shows observing circumstances and results. All images for these observations were obtained between 2022 December and 2023 February.

Data reduction and period analysis were done using *Tycho* (Parrott, 2023). The CMOS sensor provides a 58'×44' field of view, enabling the use of the same field center for three to four consecutive nights. The asteroid and five or more comparison stars were measured. Comparison stars were selected with colors within the range of 0.5 < B-V < 0.95 to correspond with color ranges of asteroids.

Comparison star magnitudes were obtained from the ATLAS catalog (Tonry et al., 2018), which is incorporated directly into *Tycho*. A 10-pixel (12.2 arcsec) diameter measuring aperture was used for asteroids and comp stars. Interference from field stars resulted in the exclusion of affected observations. Period determination was done using *Tycho*.

Asteroids were selected from the CALL website (Warner, 2011), either for having uncertain periods or no reported period at all. In this set of observations, three of the five asteroids had no previous period analysis and two had U = 1 (likely wrong). The Asteroid Lightcurve Database (LCDB; Warner et al., 2009) was consulted to locate previously published results. All new data for these asteroids have been submitted to the ALCDEF database.

1478 Vihuri was discovered in 1938 by Vaisala at Turku. A period solution published by Binzel (1987) of 19.5 hours is the only listed value in the LCDB. A total of 203 observations were made over the course of eight nights in 2023 January. These data were used to calculate a period of 19.742 h ± 0.002 h, longer than Binzel's period solution by 0.242 hours. The amplitude of the lightcurve is 0.13 ± 0.02 mag.