ASTEROID PHOTOMETRY AND LIGHTCURVES OF TWELVE ASTEROIDS – JANUARY 2023

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Observatorio Astronómico Giordano Bruno (MPC G05) - Piconcillo (Córdoba-ESPAÑA)

Observatorio Astronómico El Gato Gris (MPC I19) - Tanti (Córdoba- ARGENTINA)

Observatorio Cruz del Sur (MPC I39) - San Justo (Buenos Aires- ARGENTINA)

Observatorio de Sencelles (MPC K14) - Sencelles (Mallorca-Islas Baleares- ESPAÑA)

Osservatorio Astronomico "La Macchina del Tempo" (MPC M24) Ardore Marina (Reggio Calabria-ITALY)

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Synodic rotation periods and amplitudes are reported for 622 Esther, 783 Nora, 879 Ricarda, 960 Birgit, 1048 Feodosia, 1543 Bourgeois, 2035 Stearns, 2052 Tamriko, 2243 Lonnrot, 4376 Shigemori, 4429 Chinmoy, and 4538 Vishyanand.

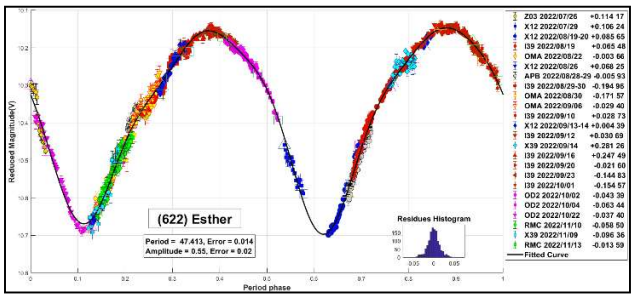
The periods and amplitudes of asteroid lightcurves presented here are the product of collaborative work by GORA (Grupo de Observadores de Rotaciones de Asteroides). In all the studies, we have applied relative photometry assigning V magnitudes to the calibration stars.

Image acquisition was performed without filters and with exposure times of a few minutes. All images used were corrected using dark frames and, in some cases, bias and flat-fields were also used. Photometry measurements were performed using *FotoDif* software and for the analysis, we employed *Periodos* software (Mazzone, 2012).

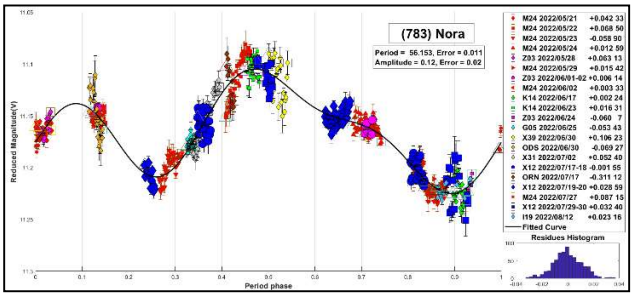
Below, we present the results for each asteroid under study. The lightcurve figures contain the following information: the estimated period and period error and the estimated amplitude and amplitude error. In the reference boxes, the columns represent, respectively, the marker, observatory MPC code, or - failing that - the GORA internal code, session date, session offset, and several data points.

Targets were selected based on the following criteria: 1) those asteroids with magnitudes accessible to the equipment of all participants, 2) those with favorable observation conditions from Argentina, Spain, or Italy, i.e., with negative or positive declinations δ, respectively, and 3) objects with few periods reported in the literature and/or with Asteroid Lightcurve Database (LCDB; Warner et al., 2009) quality codes (U) of less than 3.

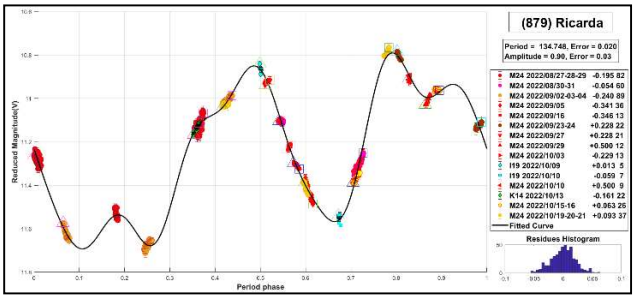
622 Esther is an S-type asteroid discovered in 1906 by J. F. Metcalf. The two more recent periods published in the literature correspond to $P = 47.5042 \pm 0.0005$ h (Hanuš et al., 2011) and $P = 47.5039 \pm 0.0005$ h (Hanuš et al., 2016). We have determined a period of 47.413 ± 0.014 h, which is consistent with those previous results.



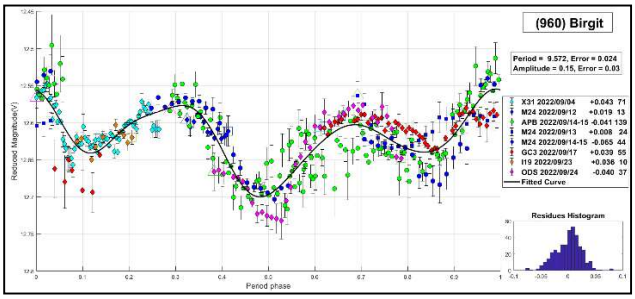
783 Nora was discovered in 1914 by J. Palisa. Several periods were measured for this asteroid with the following results: P = 24 h (Lagerkevist et al., 1992), P = 34.4 ± 0.5 h (Florczak et al., 1997), P = 9.6 h (Behrend, 2007web), and P = 55.53 ± 0.08 h (Polakis, 2018). The results we obtained, P = 56.153 ± 0.011 h with Δm = 0.12 ± 0.02 mag, are consistent with the longer period proposed by Polakis.



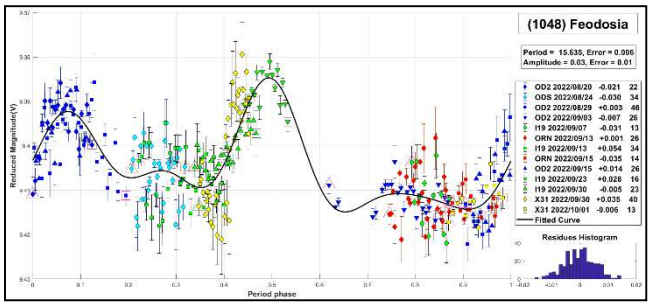
879 Ricarda was discovered in 1917 by M. Wolf. The most recent period published in the literature corresponds to P = 82.9 ± 0.5 h (Kim et al., 2014). In this work, we provide rather different results and propose a longer period of P = 134.748 ± 0.020 h and Δm = 0.9 ± 0.03 mag.



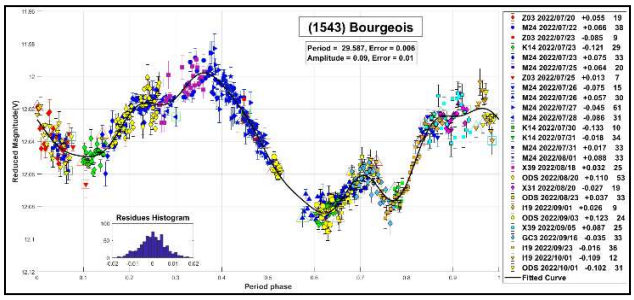
960 Birgit was discovered in 1921 by K. Reinmuth. We found in the literature two rather different periods calculated for this object: P = 17.3558 ± 0.0005 h with Δm = 0.25 ± 0.01 mag (Behrend, 2005web) and P = 8.85 ± 0.05 h with Δm = 0.28 ± 0.02 mag (Kryszczyńska et al., 2012). The results we obtained are P = 9.572 ± 0.024 h and Δm = 0.15 ± 0.03 mag. Our period agrees well with the one measured by Kryszczyńska.



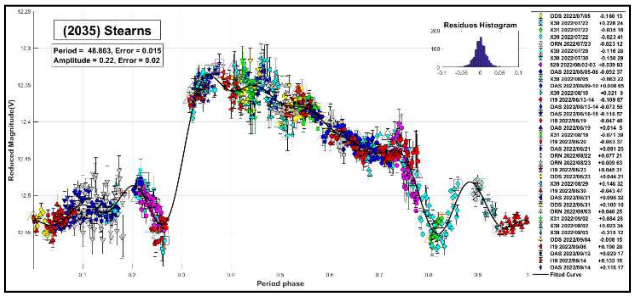
1048 Feodosia is an XC-type asteroid discovered in 1924 by K. Reinmuth. We found two different periods reported in the literature: P = 23 ± 1 h with Δm = 0.04 ± 0.01 mag (Behrend, 2007web) and P = 10.417 ± 0.001 h with Δm = 0.09 ± 0.05 mag (Franco, 2021). In contrast to these reports, our analysis yields a period of P = 15.635 ± 0.006 h with Δm = 0.03 ± 0.01 mag.



1543 Bourgeois was discovered in 1941 by E. Delporte. In the literature, we found only one reported period for this asteroid: P = 2.48 ± 0.01 h with Δm = 0.03 ± 0.01 mag (Behrend, 2005web). In this work, we propose a much longer period of P = 29.587 ± 0.006 h with Δm = 0.09 ± 0.01 mag.



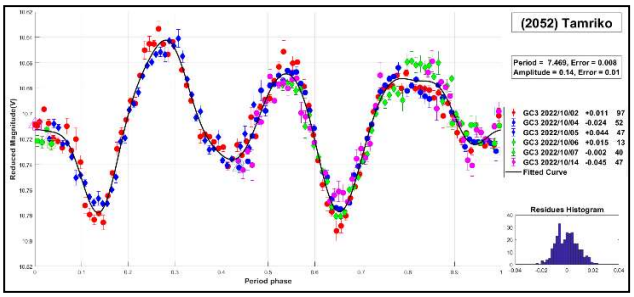
2035 Stearns is an E-type asteroid discovered in 1973 by J. Gibson. Several periods were measured for this asteroid with the following results: P = 85.0 ± 0.1 h (Schevchenko et al., 2003), P = 51.89 ± 0.20 h (Warner, 2011), and P = 93 ± 1 h (Stephens, 2014). We have determined a period of 48.863 ± 0.015 h, which is consistent with the one proposed by Warner.



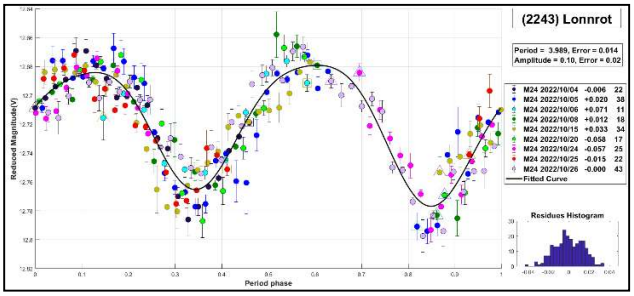
2052 Tamriko is an S-type asteroid, discovered in 1976 by R.M. West. Recent periods found in the literature coincide with the period formerly measured by Foylan (2018): P = 7.470 ± 0.002 h with Δm = 0.15 ± 0.05 mag. In this work, we present a lightcurve with full coverage that also agrees with previous assessments, P = 7.469 ± 0.008 h with Δm = 0.14 ± 0.01 mag. The shape of our lightcurve shows three maxima and three minima, in full agreement with the results obtained by other authors.

Number	Name	2022/ mm/dd	Phase	L_{PAB}	B_{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
622	Esther	07/26-11/14	*14.5,30.9	331	-4	47.413	0.014	0.55	0.02	MB-I
783	Nora	05/21-08/13	*19.7,26.8	272	11	56.153	0.011	0.12	0.02	MB-I
879	Ricarda	08/27-10/21	*18.2,16.1	3	19	134.748	0.020	0.90	0.03	Maria
960	Birgit	09/04-09/24	*5.1,09.4	347	5	9.572	0.024	0.15	0.03	MB-I
1048	Feodosia	08/20-10/02	*9.3,16.3	329	-20	15.635	0.006	0.03	0.01	MB-O
1543	Bourgeois	07/20-10/02	*15.2,25.6	322	11	29.587	0.006	0.09	0.01	MB-M
2035	Stearns	07/05-09/15	23.2,34.0	297	-34	48.863	0.015	0.22	0.02	HUN
2052	Tamriko	10/02-10/14	8.5,3.7	28	2	7.469	0.008	0.14	0.01	
2243	Lonnrot	10/04-10/29	*12.4,3.3	30	1	3.989	0.014	0.10	0.02	Flora
4376	Shigemori	09/19-11/01	*19.8,4.8	30	1	35.992	0.020	0.21	0.03	MB-I
4429	Chinmoy	08/24-09/23	*9.0,8.9	345	1	4.940	0.035	0.07	0.05	HER
4538	Vishyanand	09/29-11/16	*17.2,9.4	36	1	115.748	0.017	0.57	0.02	MB-I

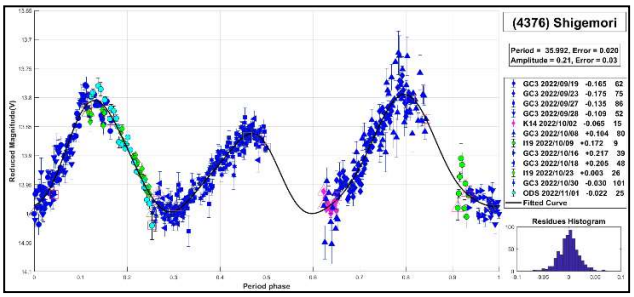
Table I. Observing circumstances and results. The phase angle is given for the first and last date. If preceded by an asterisk, the phase angle reached an extremum during the period. L_{PAB} and B_{PAB} are the approximate phase angle bisector longitude/latitude at mid-date range (see Harris et al., 1984). Grp is the asteroid family/group (Warner et al., 2009). MB-I: main-belt inner; Maria: 170 Maria; MB-O: main-belt outer; MB-M: main-belt middle; HUN: Hungaria; HER: Hertha.



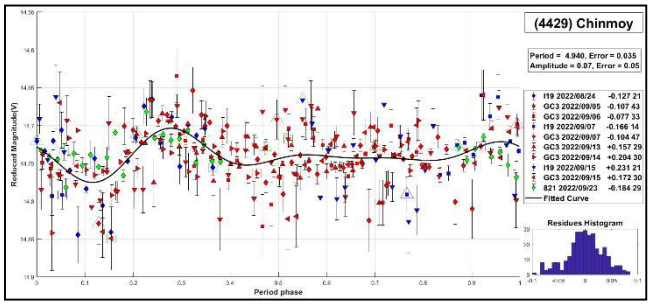
2243 Lonnrot was discovered in 1941 by Y. Vaisala. In the literature, we found only one reported period for this asteroid: P = 3.813 ± 0.004 h with Δm = 0.14 ± 0.05 mag (Marchini et al., 2021). Our study supports the aforementioned period and yielded the following results: P = 3.989 ± 0.014 h with Δm = 0.10 ± 0.02 mag.



4376 Shigemori was discovered in 1987 by Nijima and Urata. Interestingly, we couldn't find a reported period for this object in the literature. According to our observations and after a thorough analysis, we propose a period of P = 35.992 ± 0.020 h and Δm = 0.21 ± 0.03 mag. We performed several observations on this object leading to a very good coverage of the lightcurve.

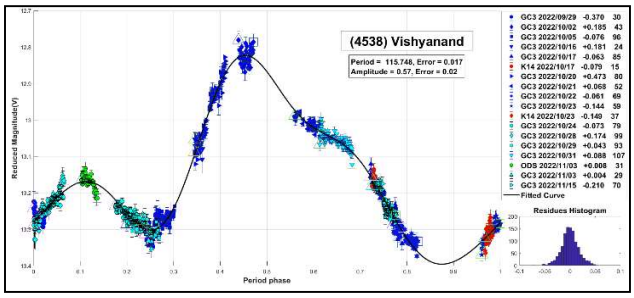


4429 Chinmoy was named in honor of Sri Chinmoy, a Bengali poet, artist and philosopher, preacher of peace, who travels the world, inspiring peace-loving peoples with his music, poetry and works of art. It was discovered in 1978 by N.S. Chernyj.



We couldn't find previously published periods in the literature. We propose a candidate period of P = 4.940 ± 0.035 h with Δm = 0.07 ± 0.05 mag. Given its estimated diameter of 3.5 kilometers and our proposed period, this object likely corresponds to a rubble-pile type asteroid.

4538 Vishyanand was discovered in 1988 byK. Suzuki. For this asteroid, we couldn't find published periods in the literature. In this work, we propose a long-term period of P = 115.748 ± 0.017 h with Δm = 0.57 ± 0.02 mag.



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Observatory	Telescope	Camera
821 Est.Astrof.Bosque Alegre	Newtonian (D=1540mm; f=4.9)	CCD APOGEE Alta U9
829 Complejo Astronómico El Leoncito	RCT (D=2150mm; f=8.48)	CCD Roper 2048
G05 Obs.Astr.Giordano Bruno	SCT (D=203mm; f=6.3)	CCD Atik 420 m
I19 Obs.Astr.El Gato Gris	SCT (D=355mm; f=10.6)	CCD SBIG STF-8300M
I39 Obs.Astr.Cruz del Sur	Newtonian (D=254mm; f=4.7)	CMOS QHY 174M
K14 Obs.Astr.de Sencelles	Newtonian (D=250mm; f=4.0)	CCD SBIG ST-7XME
M24 Oss.Astr.La Macchina del Tempo	RCT (D250mm; f=8.0)	CMOS ZWO ASI 1600MM
X12 Obs.Astr.Los Cabezones	Newtonian (D=200mm; f=5.0)	CMOS QHY 174M
X31 Obs.Astr.Galileo Galilei	RCT ap (D=405mm; f=8.0)	CCD SBIG STF-8300M
X39 Obs.Astr.Antares	Newtonian (D=250mm; f=4.72)	CCD QHY9 Mono
Z03 Obs.Astr.Río Cofio	SCT (D=254mm; f=6.3)	CCD SBIG ST-8XME
APB Obs.Astr.AstroPilar	Refractor (D=150mm; f=7.0)	CCD ZWO ASI 183
GC3 Specola Giuseppe Pustorino 3	RCT (D=400mm; f=5.7)	CCD Atik 383L+Mono
OAS Obs.Astr.de Ariel Stechina 1	Newtonian (D=254mm; f=4.7)	CCD SBIG STF-402
ODS Obs.Astr.de Damián Scotta 1	Newtonian (D=300mm; f=4.0)	CMOS QHY 174M
OD2 Obs.Astr.de Damián Scotta 2	Newtonian (D=250mm; f=4.0)	CCD SBIG STF-8300M
OMA Obs.Astr.Vuelta por el Universo	Newtonian (D=150mm; f=5.0)	CMOS POA Neptune-M
ORN Obs.Astr.de Ricardo Nolte	Newtonian (D=200mm; f=5.0)	CMOS POA Neptune-M
RMC Obs.Astr.de Raúl Melia Carlos Paz	Newtonian (D=254mm; f=4.7)	CMOS QHY 174M

Table II. List of observatories and equipment.

and/or services provided by the International Astronomical Union's Minor Planet Center.

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