SYNODIC ROTATION PERIODS AND LIGHTCURVE AMPLITUDES FOR 12 MINOR PLANETS FROM GORA COLLABORATION

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Synodic rotation periods and amplitudes are reported for: 637 Chrysothemis, 1079 Mimosa, 1155 Aenna, 1287 Lorcia, 1409 Isko, 1841 Masaryk, 3731 Hancock, 3857 Cellino, 4350 Shibecha, 5438 Lorre, 5802 Casteldelpiano, 19793 2000 RX42.

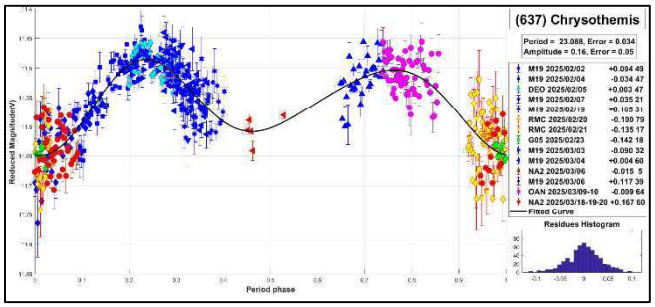
The periods and amplitudes of asteroid lightcurves presented in this paper are the product of collaborative work by the GORA (Grupo de Observadores de Rotaciones de Asteroides) group. In all the studies, we have applied relative photometry assigning V magnitudes to the calibration stars.

The 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-field corrections were also used. Photometry measurements were performed using *FotoDif* software and for the analysis, we employed *Períodos* software (Mazzone, 2012).

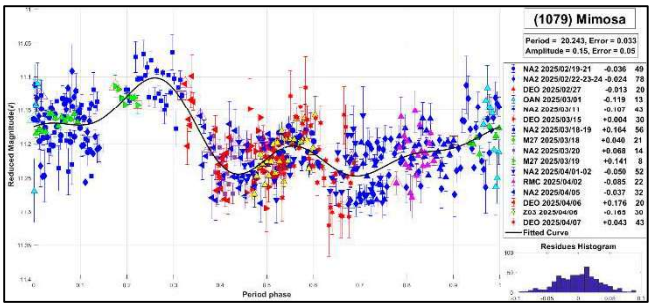
Below, we present the results for each asteroid studied. The lightcurve figures contain the following information: the estimated period and period error and the estimated amplitude and amplitude error. In the reference boxes, the columns represent, respectively, the marker, observatory MPC code, or - 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, Venezuela, Spain, Italy, or Croatia, i.e. with negative or positive declinations δ, and 3) objects with few periods reported in the literature and/or with Lightcurve Database (LCDB) (Warner et al., 2009) quality codes (U) of less than 3.

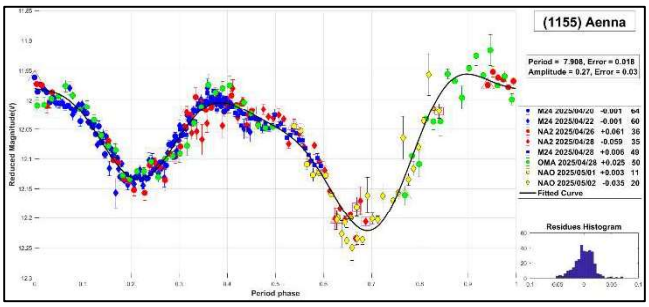
637 Chrysothemis. This outer main-belt asteroid was discovered in 1971 by L. Kohoutek. It is classified as a CX-type asteroid according to the SDSS-based Asteroid Taxonomy (Carvano et al., 2010), with an estimated diameter of 40.24 km. The reported rotational period for this asteroid is P = 3.7 h (based on fragmentary lightcurve; Warner, 2017). In this work, we propose a considerably longer period of P = 23.088 ± 0.034 h with Δm = 0.16 ± 0.05.



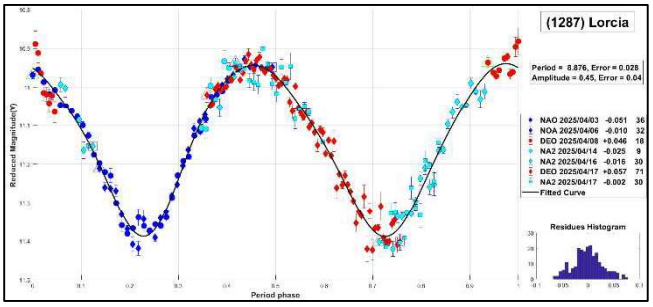
1079 Mimosa. Mimosa is a main-belt Asteroid discovered in 1927 by G. Van Biesbroeck. Classified as an S-type asteroid according to the Tholen taxonomy, it is a member of the Koronis family (Nesvorny et al., 2015). The reported rotational period for this asteroid is P = 64.6 h (Ďurech et al., 2020). In this work, we propose a shorter period of P = 20.243 ± 0.033 h with Δm = 0.15 ± 0.05.



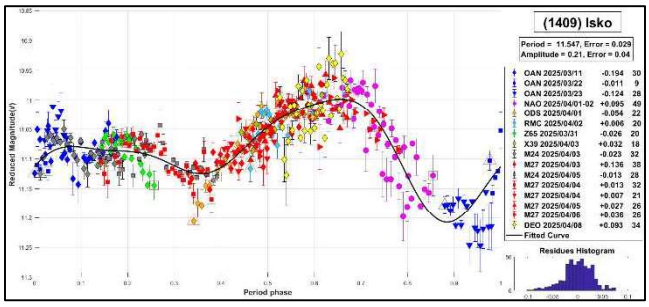
1155 Aenna. Aenna is a main-belt asteroid discovered in 1928 by K. Reinmuth. The estimated diameter is 9.284 km. The reported rotational period for this asteroid is 8.07 h (McNeill et al., 2019). Our measurement of the period, P = 7.908 ± 0.018 h, with Δm = 0.27 ± 0.03, agrees well with the value reported by the authors.



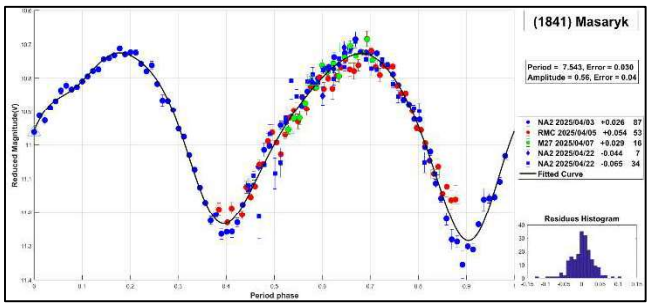
1287 Lorcia. Lorcia is main-belt asteroid with an estimated diameter of 35.54 km, discovered in 1933 by S. Arend. It is classified as an LS-type asteroid according to the SDSS-based Asteroid Taxonomy (Carvano et al., 2010). It is a member of the Eos family (Nesvorny et al., 2015). The reported rotational period for this asteroid is 8.8776 h (based on less than full coverage; Pál et al., 2020). Our measurement of the period, P = 8.876 ± 0.028 h, with Δm = 0.45 ± 0.04, agrees well with the value reported by the authors.



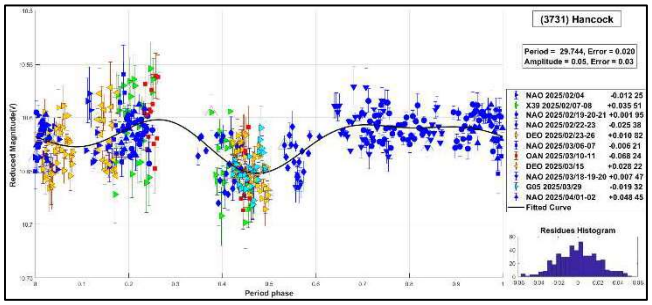
1409 Isko. Isko is a main-belt asteroid with an estimated diameter of 35.54 km, discovered in 1937 by K. Reinmuth. It is classified as a C-type asteroid according to the SDSS-based Asteroid Taxonomy (Carvano et al., 2010). The reported rotational period for this asteroid is 11.639 h (Ďurech et al., 2020). Our measurement of the period, P = 11.639 ± 0.029 h, with Δm = 0.21 ± 0.04, agrees well with the value reported by the authors.



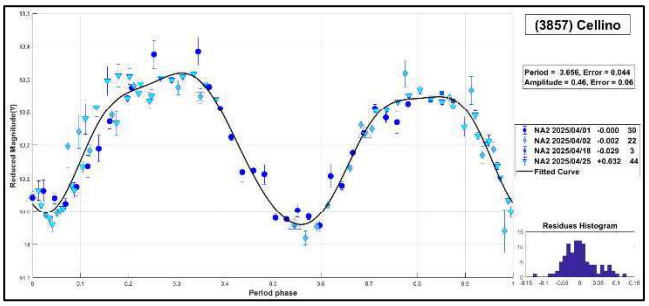
1841 Masaryk. This outer main-belt asteroid has an estimated diameter of 40.24 km, discovered in 1971 by L. Kohoutek. It is classified as a CX-type asteroid according to the SDSS-based Asteroid Taxonomy (Carvano et al., 2010). The reported rotational period for this asteroid is 7.53 h (based on less than full coverage; Ďurech et al., 2016). Our measurement of the period, P = 7.543 ± 0.030 h, with Δm = 0.56 ± 0.04, agrees well with the value reported by the author.



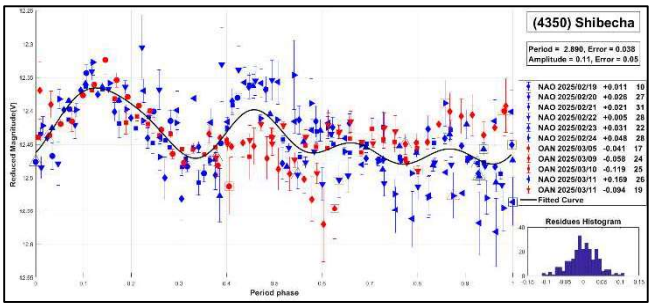
3731 Hancock. This outer main-belt asteroid has an estimated diameter of 53.112 km, discovered in 1984 at Perth. The reported rotational period for this asteroid is P = 6.712 h (based on fragmentary lightcurve; Clark, 2011). Our observations suggest a longer period, yielding a value of P = 29.744 ± 0.020 h with Δm = 0.05 ± 0.03.



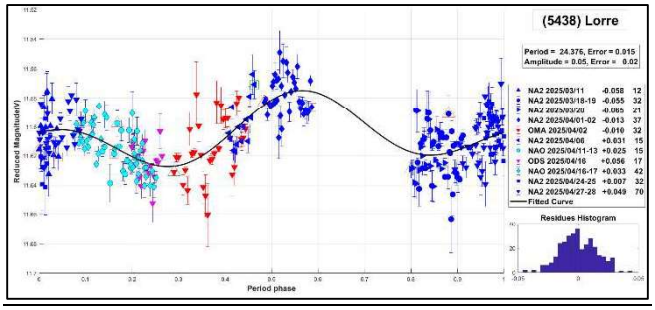
3857 Cellino. Cellino is a main-belt asteroid discovered in 1984 by E. Bowell. It is a member of the Nysa family (Nesvorny et al., 2015), with an estimated diameter of 5.839 km. The reported rotational period for this asteroid is 3.656529 h (Erasmus et al., 2020). We measured a period of P = 3.656 ± 0.044 h, with Δm = 0.46 ± 0.06.



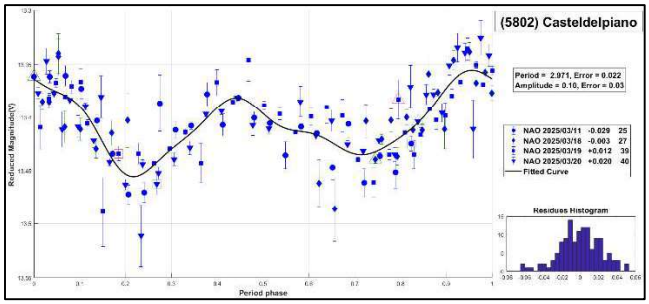
4350 Shibecha. This main-belt asteroid was discovered in 1989 by Ueda y Kaneda, with an estimated diameter of 11.489 km The reported rotational period for this asteroid is P = 2.89 h (Pál et al., 2020). Our observations also support the short-period hypothesis, yielding a value of P = 2.890 ± 0.038 h with Δm = 0.11 ± 0.05.



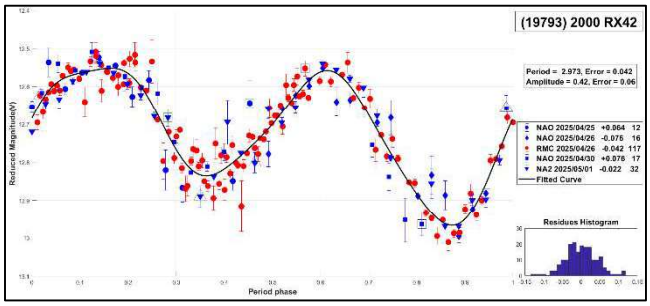
5438 Lorre. Lorre is a main-belt asteroid with an estimated diameter of 28.072 km, discovered in 1990 by E. Helin. The reported rotational period for this asteroid is P = 25.3 h (Polakis, 2020). In this work, we propose a period of P = 24.376 ± 0.015 h with Δm = 0.05 ± 0.02 mag.



5802 Casteldelpiano. This main-belt asteroid was discovered in 1984 by V. Zappala, with an estimated diameter of 4.894 km The reported rotational period for this asteroid is P = 2.9705 h (Dose, 2021). Our observations also support the short-period hypothesis, yielding a value of P = 2.971 ± 0.022 h with Δm = 0.10 ± 0.03.



(19793) 2000 RX42. This main-belt asteroid was discovered in 2000 by LINEAR. It is a member of the Eunomia family (Nesvorny et al., 2015), with an estimated diameter of 8.534 km. The reported rotational period for this asteroid is 3.102 h (Waszczak et al., 2015). We measured a period of P = 2.973 ± 0.042 h, with Δm = 0.42 ± 0.06.



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Number	Name	yy/ mm/dd- yy/ mm/dd	Phase	L_{PAB}	B_{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
637	Chrysothemis	25/02/02-25/03/20	*5.3,12.8	146	0	23.088	0.034	0.16	0.05	Them
1079	Mimosa	25/02/19-25/04/07	*7.7,10.9	169	-1	20.243	0.033	0.15	0.05	Kor
1155	Aenna	25/04/20-25/05/02	2.7,09.3	206	2	7.908	0.018	0.27	0.03	MB-I
1287	Lorcia	25/04/03-25/04/18	0.9,06.1	193	-2	8.876	0.028	0.45	0.04	Eos
1409	Isko	25/03/11-25/04/08	*3.6,08.2	179	0	11.547	0.029	0.21	0.04	MB-M
1841	Masaryk	25/04/03-25/04/23	*1.2,06.5	196	1	7.543	0.030	0.56	0.04	MB-O
3731	Hancock	25/02/04-25/04/02	*9.8,17.4	145	-24	29.744	0.020	0.05	0.03	MB-O
3857	Cellino	25/04/01-25/04/25	15.7,02.9	218	1	3.656	0.044	0.46	0.06	Her
4350	Shibecha	25/02/19-25/03/11	19.5,11.6	188	10	2.890	0.038	0.11	0.05	MB-M
5438	Lorre	25/03/11-25/04/29	*20.2,25.1	182	-35	24.376	0.015	0.05	0.02	Lorr
5802	Casteldelpiano	25/03/11-25/03/20	6.8,01.4	181	1	2.971	0.022	0.10	0.03	MB-I
19793	2000 RX42	25/04/25-25/05/01	6.3,03.5	226	-4	2.973	0.042	0.42	0.06	Euno

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). Them: 24 Themis; Kor: 158 Koronis; MB-I: main-belt inner; Eos: 221 Eos; MB-M: main-belt middle; MB-O: main-belt outer; Her: 135 Hertha; Lorr: 5438 Lorre; Euno: 15 Eunomia.

Observatory	Telescope	Camera
G05 Obs.Astr.Giordano Bruno	SCT (D=203mm; f=6.3)	CCD Atik 420 m
M19 Osservatorio Explorer	Newtonian (D=254mm; f=3.8)	CCD Moravian G2 4000
M24 Oss.Astr.LaMacchina del Tempo	RCT (D250mm; f=8.0)	CMOS ZWO ASI 1600MM
M27 Elijah Observatory	RCT (D250mm; f=8.0)	CCD QSI 683
X39 Obs.Astr.Antares	Newtonian (D=250mm; f=4.72)	CCD QHY9 Mono
Z03 Obs.Astr.RíoCofio	SCT (D=254mm; f=6.3)	CCD SBIG ST-8XME
Z65 Obs.Astr.Corgas	Newtonian (D=310mm; f=4.8)	CMOS ZWO ASI 294 MM
DEO Dark Energy Observatory	Refractor (D=115mm; f=7.0)	CMOS QHY 294M pro
NAO Obs.Astr.Naos	Newtonian (D=250mm; f=4.0)	CMOS QHY 163M
NA2 Obs.Astr.Naos 2	Newtonian (D=200mm; f=5.0)	CMOS ZWO ASI 174
OAN Obs.Astr.Nacional Llano del Hato	Cámara Schmidt (D=1000mm; f=3.0)	CMOS Fujifilm GFX 50R
ODS Obs.Astr.de Damián Scotta 1	Newtonian (D=300mm; f=4.0)	CMOS QHY 174M
OMA Obs.Astr.Vueltaporel Universo	Newtonian (D=150mm; 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.

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