ASTEROID PHOTOMETRY AND LIGHTCURVE ANALYSIS AT GORA'S OBSERVATORIES, PART V.

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Observatorio Los Cabezones (MPC X12) -
Santa Rosa (La Pampa-Argentina)

Observatorio Galileo Galilei (MPC X31) -
Oro Verde (Entre Ríos-Argentina)

Observatorio Antares (MPC X39) -
Pilar (Buenos Aires-Argentina)

Observatorio AstroPilar (GORA APB) -
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Observatorio de Aldo Mottino (GORA OAM) -
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Observatorio Río Cofio (GORA ORC) -
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Observatorio de Raúl Melia (GORA RMG) -
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Synodic rotation periods and amplitudes are reported for 153 Hilda, 357 Ninina, 366 Vincentina, 709 Fringilla, and 739 Mandeville.

Observatory	Telescope	Camera
I39 Obs.Astr.Cruz del Sur	Telesc. Newtoniano (D=200mm; f=4.0)	CMOS QHY174
K14 Obs.Astr.de Sencelles	Telesc. Newtoniano (D=250mm; f=4.0)	CCD SBIG ST-7XME
X12 Obs.Astr.Los Cabezones	Telesc. Newtoniano (D=200mm; f=5.0)	CMOS QHY174MGPS
X31 Obs.Astr.Galileo Galilei	Telesc. RCT ap (D=405mm; f=8.0)	CCD SBIG STF8300M
X39 Obs.Astr.Antares	Telesc. Newtoniano (D=250mm; f=4.7)	CCD QHY9 Mono
APB Obs.Astr.AstroPilar	Telesc. Refractor (D=150mm; F=7.0)	CCD ZWO-ASI183OAM
Obs.Astr.de Aldo Mottino	Telesc. Newtoniano (D=250mm; f=4.7)	CCD SBIG STF8300M
OAP Obs.Astr.Astro Pulver	Telesc. SCT (D=203mm; f=7.0)	CMOS QHY5 LII M
OAS Obs.Astr.de Ariel Stechina 1	Telesc. Newtoniano (D=254mm; f=4.7)	CCD SBIG STF402
ODS Obs.Astr.de Damián Scotta 1	Telesc. Newtoniano (D=300mm; f=4.0)	CCD SBIG St-402 XME
OD2 Obs.Astr.de Damián Scotta 2	Telesc. Newtoniano (D=250mm; f=4.0)	CCD Atik 314L+
OGB Obs.Astr.Giordano Bruno	Telesc. SCT (D=203mm; f=6.0)	CCD Atik 420 m
ORC Obs.Astr.Río Cofio	Telesc. SCT (D=254mm; f=6.3)	CCD SBIG ST8-XME
RMG Obs.Astr.de Raúl Melia	Telesc. SCT (D=200mm; f=10.0)	CCD Meade DSI Pro II

Table I. List of observatories and equipment.

Number	Name	20yy/ mm/dd- 20yy/ mm/dd	Phase	L_{PAB}	B_{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
153	Hilda	21/02/19-21/04/02	2.4,10.4	150	-8	5.962	0.005	0.040	0.007	HIL
357	Ninina	21/01/10-21/03/03	3.3,15.5	112	-7	35.982	0.010	0.17	0.01	MB-O
366	Vincentina	21/03/21-21/04/17	1.5,10.2	177	-3	17.338	0.010	0.09	0.01	MB-O
709	Fringilla	21/03/06-21/04/06	*3.3,10.0	169	-9	52.172	0.011	0.23	0.02	MB-O
739	Mandeville	20/11/07-21/01/25	*12.9,18.9	69	-23	35.842	0.008	0.09	0.01	MB-O

Table II. 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-O: main-belt outer.

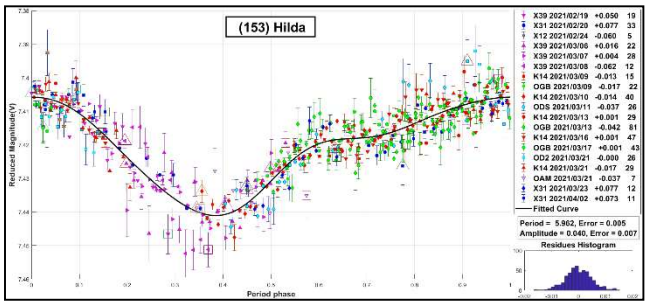
The periods and amplitudes of asteroid lightcurves presented here are the product of a collaborative work by GORA (Grupo de Observadores de Rotaciones de Asteroides). In all the studies we have applied relative photometry assigning V magnitudes to the calibration stars.

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 were also used. Photometry measurements were performed using *FotoDif* software and for the analysis we employed *Periodos* software (Mazzone, 2012).

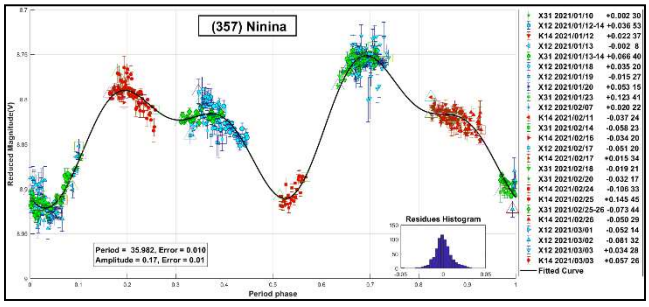
Below, we present the results for each asteroid under study. The lightcurve figures contain the following information: the estimated period and period error and the estimated amplitude and amplitude error. In the reference boxes the columns represent, respectively, the marker, observatory MPC code or, failing that, the GORA internal code, session date, session off-set, and number of 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, i.e., with negative declinations, 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.

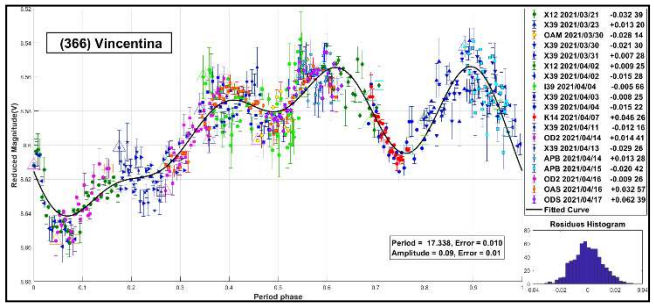
153 Hilda is a dark P-type asteroid. It was discovered in 1875 by Johann Palisa. Our analysis yields a period of $P = 5.962 \pm 0.005$ h with $\Delta m = 0.040 \pm 0.007$ mag. This period is in agreement with the one measured by Shevchenko et al. (2009), who obtained $P = 5.9587 \pm 0.0005$ h with $\Delta m = 0.20 \pm 0.02$ mag. The difference in Δm is likely due to a change in the aspect angle.



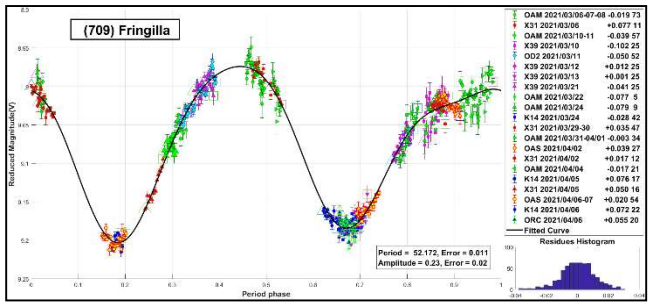
357 Ninina is a main-belt asteroid. It was discovered in 1893 by Auguste Charlois. The latest periods reported in the literature are $P = 35.98 \pm 0.07$ h with $\Delta m = 0.12 \pm 0.01$ mag (Behrend, 2005web) and $P = 35.9 \pm 0.1$ h with $\Delta m = 0.12 \pm 0.01$ mag (Oey, 2014). The results we obtained, $P = 35.982 \pm 0.010$ h with $\Delta m = 0.17 \pm 0.01$ mag, are consistent with those presented by the authors mentioned above.



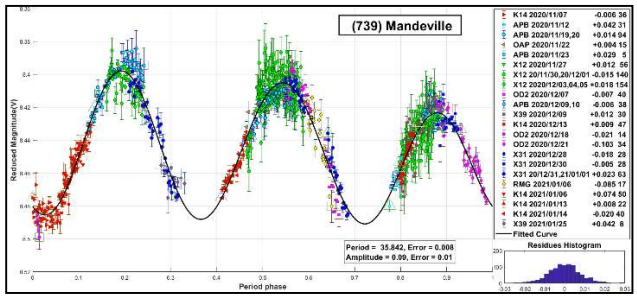
366 Vincentina was discovered in 1893 by Auguste Charlois. The periods published for this asteroid are P = 15.5 ± 0.1 h with Δm = 0.08 ± 0.03 mag (Robinson, 2002) and P = 12.7365 ± 0.0005 h with Δm = 0.05 ± 0.01 mag (Benishek, 2013). Our results show a period longer than those previously reported. Our data give P = 17.338 ± 0.010 h and Δm = 0.09 ± 0.01 mag.



709 Fringilla is a X-type asteroid. It was discovered in 1911 by Joseph Helffrich. We found in the literature two different periods calculated for this object: P = 52.4 ± 0.2 h with Δm = 0.18 ± 0.02 mag (Harris & Young, 1980) and P = 20 h with Δm = 0.05 mag (Behrend, 2008web). The results we obtained are P = 52.172 ± 0.011 h and Δm = 0.23 ± 0.02. Our period well agrees with the one measured by Harris & Young (1980), which is also the one exhibiting the highest U quality code.



739 Mandeville is classified as type X in the Tholen taxonomy. It was discovered by Joel Hastings Metcalf. This was a very difficult case to solve since we had to deal with candidate periods that were integer multiple or divisors of 12 h. Harris & Young (1989) reported a period of 11.931 ± 0.010 h. Our own previous estimation (Colazo et al., 2020) was 23.92 ± 0.02 h, twice the period proposed by Harris & Young. We are currently proposing a new period, different from all those reported previously. We have determined a period of 35.842 ± 0.008 h (~1.5 times our last published period). Our new contribution is based on several observations including five performed linking two or three consecutive nights. The same equipment, identical configurations and calibration stars were used in these particular observations. Further coordinated observations from different longitudes would help confirm our latest result.



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