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ROTATION PERIOD ANALYSIS FOR FIVE ASTEROIDS

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Synodic rotation periods and amplitudes are reported for 318 Magdalena, 455 Bruchsalia, 486 Cremona, 503 Evelyn, and 664 Judith.

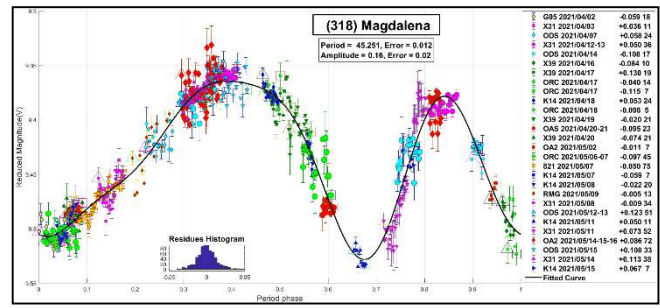
The periods and amplitudes of asteroid lightcurves presented here are the product of collaborative work by GORA (Grupo de Observadores de Rotaciones de Asteroides) group. In all the studies we have applied relative photometry assigning V magnitudes to the calibration stars.

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

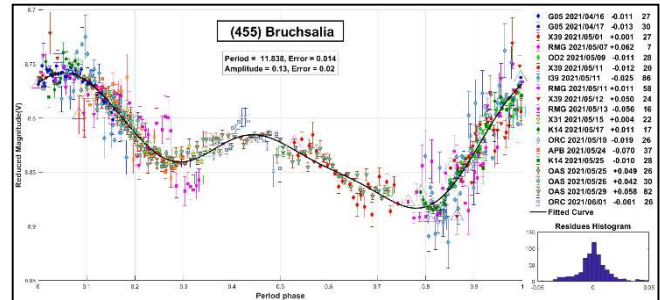
Below, we present the results for each asteroid under study. The lightcurve figures contain the following information: the estimated period and period error and the estimated amplitude and amplitude error. In the reference boxes, the columns represent, respectively, the marker, observatory MPC code,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

318 Magdalena was discovered in 1891 by Charlois, A. The two more recent periods published in the literature correspond to $P = 42.49 \pm 0.01$ h with $\Delta m = 0.06 \pm 0.01$ mag (Pilcher & Martinez, 2015) and $P = 42.65 \pm 0.01$ h with $\Delta m = 0.08 \pm 0.01$ mag (Pilcher, 2019). The results we obtained, $P = 45.251 \pm 0.012$ h with $\Delta m = 0.16 \pm 0.02$ mag, are consistent with those presented by Pilcher. Moreover, our analysis shows an asymmetric bimodal light curve, quite similar to the one presented by this same author.



455 Bruchsalia was discovered in 1900 by M. Wolf and A. Schwassmann. Ferrero (2020) and Pilcher (2020) reported a period of 11.839 ± 0.001 h. Although they measured the same period, they reported different amplitudes, which were 0.42 mag (Ferrero, 2020) and 0.50 ± 0.03 mag (Pilcher, 2020). Our analysis yields a period of $P = 11.838 \pm 0.014$ h with $\Delta m = 0.13 \pm 0.02$ mag. The difference in amplitude with respect to previous observations likely reflects a significant change in the viewing aspect angle of the asteroid.



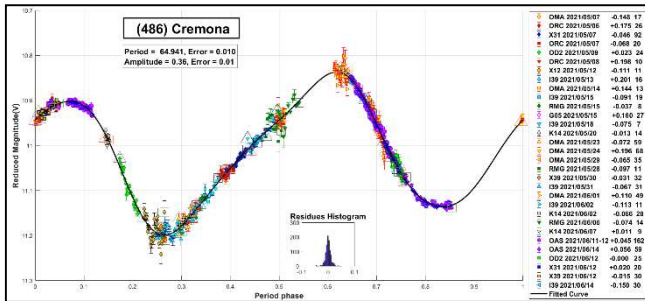
486 Cremona was discovered in 1902 by Carnera, L. The two more recent periods reported in literature are $P = 65.151 \pm 0.005$ h (Hanus et al., 2011) and $P = 65.15 \pm 0.10$ h with $\Delta m = 0.80 \pm 0.05$ mag (Cooney et al., 2007). Our observations determined a period of $P = 64.941 \pm 0.010$ h with an amplitude of $\Delta m = 0.36 \pm 0.01$ mag. This result is in good agreement with those mentioned above. Also, we noted that our light curve is bimodal with little asymmetric peaks as also shown by Hanuš and Cooney.

Observatory	Telescope	Camera
821 Est.Astrof.Bosque Alegre	Telesc. Newtoniano (D=1540mm; f=4.9)	CCD APOGEE Alta U9
G05 Obs.Astr.Giordano Bruno	Telesc. SCT (D=203mm; f=6.0)	CCD Atik 420 m
I39 Obs.Astr.Cruz del Sur	Telesc. Newtoniano (D=254mm; f=4.7)	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-ASI183
OAO Obs.Astr.Aficionado Omega	Telesc. Newtoniano (D=150mm; f=5.0)	CMOS ZWO ASI178mm
OAS Obs.Astr.de Ariel Stechina 1	Telesc. Newtoniano (D=254mm; f=4.7)	CCD SBIG STF402
OA2 Obs.Astr.de Ariel Stechina 2	Telesc. Newtoniano (D=305mm; f=5.0)	CMOS QHY 174M
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+
OMA Obs.Astr.Vuelta por el Universo	Telesc. Newtoniano (D=150mm; f=5.0)	CMOS Qhy5III 290
ORC Obs.Astr.RioCofio	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

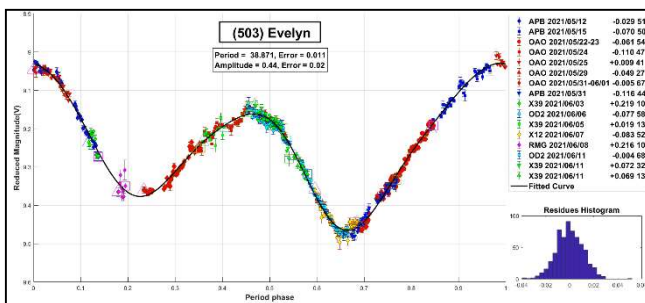
Table II. List of observatories and equipment.

Number	Name	yy/ mm/dd- yy/ mm/dd	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
318	Magdalena	21/04/02-21/05/16	*4.6, 11.4	202	9	45.251	0.012	0.16	0.02	MB-O
455	Bruchsalia	21/04/16-21/06/01	*5.4, 13.4	215	9	11.838	0.014	0.13	0.02	MB-M
486	Cremona	21/05/06-21/06/14	8.6, 18.4	233	10	64.941	0.010	0.36	0.01	MB-I
503	Evelyn	21/05/12-21/06/11	*7.8, 03.6	251	0	38.871	0.011	0.44	0.02	MB-O
664	Judith	21/04/03-21/06/05	*12.2, 14.4	222	9	19.303	0.012	0.30	0.02	MB-O

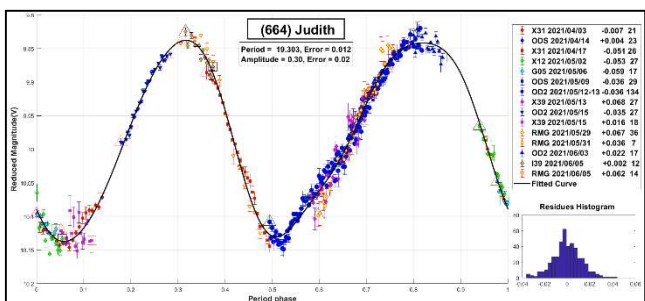
Table I. Observing circumstances and results. The phase angle is given for the first and last date. If preceded by an asterisk, the phase angle reached an extremum during the period. L_{PAB} and B_{PAB} are the approximate phase angle bisector longitude/latitude at mid-date range (see Harris et al.,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



503 Evelyn was discovered in 1903 by R.S. Dugan. We measured a period of 38.871 ± 0.011 with $\Delta m = 0.44 \pm 0.02$ mag. These results agree well with those reported by Fauerbach (2007): $P = 38.70 \pm 0.01$ with $\Delta m = 0.30 \pm 0.03$ mag. As a further contribution, our lightcurve provides more coverage on the rotational phase space.



664 Judith was discovered in 1908 by A. Kopff. We found two different periods reported in the literature: $P = 19.35 \pm 0.06$ h with $\Delta m = 0.35 \pm 0.02$ mag (Melton et al., 2012) and $P = 18.51 \pm 0.01$ h with $\Delta m = 0.37 \pm 0.03$ mag (Garcerán, 2015). Our period agrees well with the one measured by Melton et al. (2012). The bimodal shape of the lightcurve is also in good agreement with that from Melton et al. (2012). As a further contribution, we provide almost full coverage of this lightcurve.



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