TRAPPIST LIGHTCURVES OF MAIN-BELT ASTEROIDS 31 EUPHROSYNE, 41 DAPHNE AND 89 JULIA

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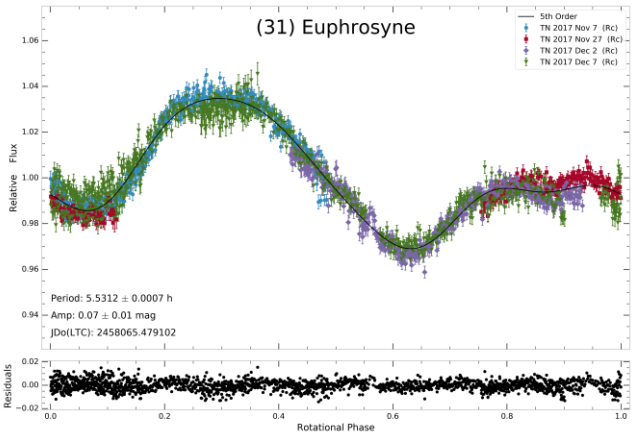
Densely sampled lightcurves of three large main-belt asteroids were obtained with the TRAPPIST-South (TS) and TRAPPIST-North (TN) telescopes from September 2017 to July 2018 and their Synodic rotation periods and amplitudes are found to be respectively: 5.5312 ± 0.0007 h and 0.07 mag for 31 Euphrosyne; 5.9912 ± 0.0028 h and 0.18 mag for 41 Daphne and 11.3844 ± 0.0002 h and 0.19 mag for 89 Julia.

Observations of the three large and bright main-belt asteroids 31 Euphrosyne, 41 Daphne and 89 Julia were obtained with the robotic telescopes TRAPPIST-North (TN, Z53) and TRAPPIST-South (TS, I40) of the Liège University (Jehin et al., 2011). They are located, respectively, at the Oukaimeden Observatory in Morocco and the ESO La Silla Observatory in Chile. Both telescopes are 0.6-m Ritchey-Chrétien telescopes operating at F/8 on German Equatorial mounts. The camera models are the Andor IKONL BEX2 DD for TN and the FLI ProLine 3041-BB for TS with pixel sizes of 0.60 arcsec/pixel and 0.64 arcsec/pixel, respectively.

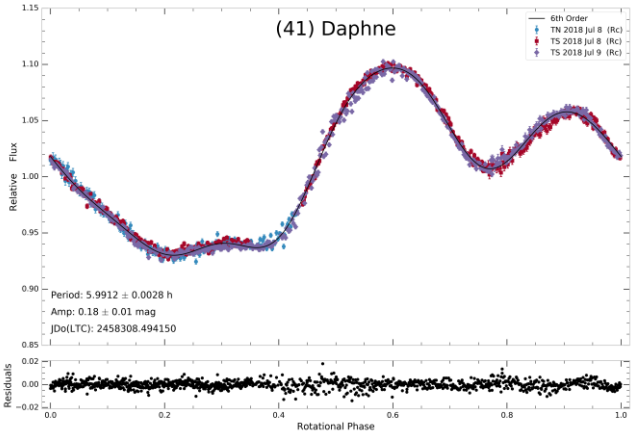
The photometric measurements were made with IRAF scripts after proper calibration with corresponding flat fields, bias and dark frames. The differential photometry and lightcurve construction was made with Python scripts. For the differential photometry, all the stars with a high enough SNR are used and were checked to discard the variable stars. Various apertures were tested to maximize the SNR. In the lightcurves below, the normalized relative flux is plotted against the rotational phase. The rotation periods were determined with the software Peranso, which implements the FALC algorithm (Harris et al., 1989). The reported amplitudes are from the Fourier model curves.

These three asteroids were observed in the framework of the ESO Large Programme ID 199.C-0074 (Vernazza et al., 2016) using the new SPHERE AO facility of the ESO VLT to model the precise volume of a substantial fraction of the largest MBAs.

31 Euphrosyne was observed with TN between November 7 and December 7, 2017, during 4 different nights. We used the Rc filter, no binning, and an exposure time of 10 s. Rotation periods for the three targets have already been reported multiple times. A compilation of these results can be found in the asteroid lightcurve database (LCDB; Warner et al., 2009). The period best fitting our data of 31 Euphrosyne is 5.5312 h, in agreement with values in the LCDB.



41 Daphne was observed the same night of 8 July 2018 with both TN and TS and the next night with TS. It had a V mag of 12 and we used an exposure time of 30 s with the Rc filter. About 100 comparison stars were used. We derived a period of 5.9912 h, in agreement with values in the LCDB. Those measurements were used in the multi data sources modelling aiming at the characterization of 41 Daphne and its satellite by Carry et al. (2019).

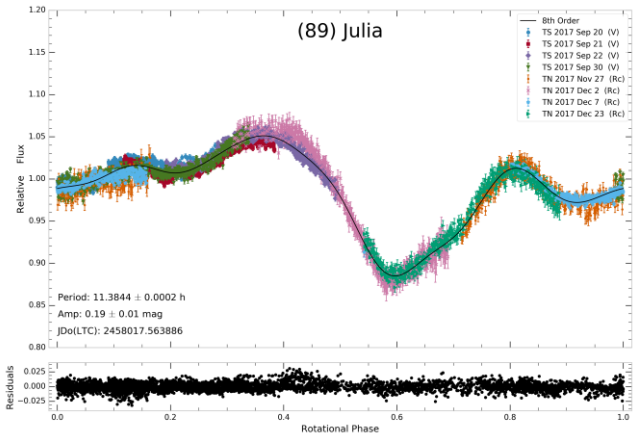


89 Julia. This inner large main-belt asteroid was observed with TS between September 20 and 30, 2017 and then with TN between November 27 and December 23, for a total of 8 nights. The TS observations were made with the V filter while the Rc filter was used with TN. We used exposure times of 10 s and about 50 comparison stars. A very dense phased lightcurve was constructed using 4411 individual measurements and a rotation period of

Number	Name	yyyy	mm/dd	Pts	Phase	L_{PAB}	B_{PAB}	Period (h)	P.E.	Amp	A.E.	Grp
31	Euphrosyne	2017	11/07-12/07	1836	19.8,14.8	90	27	5.5312	0.0007	0.07	0.01	MB-O
41	Daphne	2018	07/08-07/09	1158	19.3,19.1	338	9	5.9912	0.0028	0.18	0.01	MB-O
89	Julia	2017	09/20-12/23	4411	11.4,27.5	88	24	11.3844	0.0002	0.19	0.01	MB-I

Table I. Observing circumstances and results. Pts is the number of data points. The phase angle is given for the first and last date. L_{PAB} and B_{PAB} are the approximate phase angle bisector longitude and latitude at mid-date range (see Harris et al., 1984). Grp is the asteroid orbital group (see Warner et al., 2009). MB-I/O = main-belt inner/outer.

11.3844 h is in agreement with values in the LCDB. This lightcurve has been used in the shape modelling of 89 Julia in Vernazza et al. (2018).



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