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SERENDIPITOUS ASTEROIDS

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We present here a byproduct of a large photometric survey of slow rotators led since the year 2013. The observations within the campaign sometimes serendipitously registered additional asteroids moving in the same field with the main target. Here we gather all 24 such asteroids, which had strong enough S/N, and also presented any traceable brightness variations, and we estimate their rotation periods and amplitudes. For best covered lightcurves we also present their plots. For ten asteroids there were apparently no previous period determinations. All the lightcurve data for these serendipitous asteroids are now uploaded to ALCDEF for the use in future spin/shape studies.

Since the year 2013 a worldwide photometric campaign of slowly rotating asteroids has been conducted at AOI AMU, led by coauthor A. Marciniak. The campaign is aimed at reducing the selection effects against slow rotators and low amplitude targets, to complement the set of asteroid spin and shape models for more realistic picture of the main-belt asteroids, and also for determinations of their sizes and thermal properties (see Marciniak et al. 2015 for the campaign description, and, e.g., Marciniak et al. 2019 for the results).

As a byproduct, sometimes additional asteroids are unexpectedly captured in the same field of view with the main target. When their signal-to-noise ratio is high enough for photometry of acceptable quality we measure them as well in an additional circular aperture. Moreover, there are cases when the on-sky movement of the main target is similar to that of the additional asteroid. Then the other can also be captured in more than one night, enabling to complement its lightcurve and to determine rotation period with greater precision.

Such serendipitous asteroids with strong enough signal were not found often in our programme, due to small fields of view and small sizes of most of the telescopes used. Still, over the years we gathered a substantial collection containing 24 targets, that is summarised in Table 1.

The main instrument used in our campaign is a 40-cm Newtonian with SBIG ST7 CCD camera located in the Borowiec station near Poznań, Poland. For most of the observations a clear (C) filter was used.

Another instrument is a 70-cm Dall-Kirkham telescope located in Winer Observatory near Sonoita, Arizona, and remotely operated from AOI UAM institute in Poland. It is equipped with Andor iXon CCD with a broad “Luminance” (L) filter, and a set of Johnson's filters, from which R filter was used for brighter targets, otherwise we observed in aforementioned L filter.

An additional telescope that was extensively used in the campaign is a robotic 80-cm TJO telescope at Montsec Observatory (OAdM), Catalonia. Specific, semi-sparse observing cadence was used there, registering one frame per 0.5 hour. MEIA and MEIA-2 CCD cameras were used there for observations in R filter.

Thanks to collaboration with Pedagogical University in Cracow, Poland, we also obtained data from 60-cm Cassegrain telescope at Suhora Observatory. The camera used there is Apogee Aspen-47m, and observations were done in R filter.

We also used the IAC80 telescope located in Observatorio del Teide on Tenerife. This is an 80-cm instrument with CAMELOT CCD camera. Our observations there were done with Johnson's R filter.

Within our campaign we were also granted a 5-nights run at 120-cm Mercator telescope based on Observatorio Roque de los Muchachos, on La Palma. The MAIA camera (Raskin et al., 2013) splits the light into three passbands: R, G, and B, where R band gave the best S/N, thus it was used here.

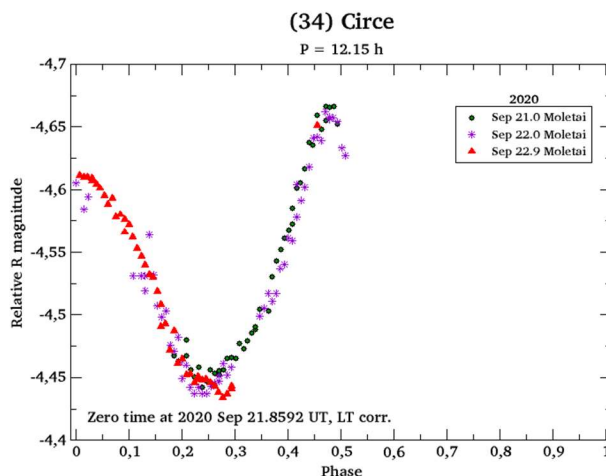
Data came also from 76 cm telescope at South African Astronomical Observatory equipped with 0.76M WRT1 CCD and R filter.

Lastly, thanks to a new collaboration with Vilnius University our targets have also been observed at Moletai Observatory, Lithuania, at 35/51-cm Maksutov telescope with Apogee Alta U47-BB camera. Unfiltered or R filter exposures were acquired there.

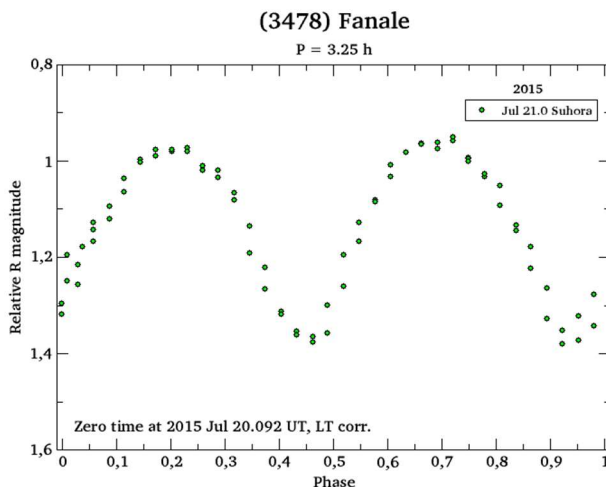
All the raw data, after standard bias, dark and flatfield corrections were applied, were semi-automatically processed using aperture photometry procedures of the *CLR Starlink* package. Three comparison stars were used, where the relative magnitudes were usually obtained by comparison with the brightest from the comparison stars, provided its brightness was stable. Before that step, additional asteroids were searched for via blink-comparison procedure, and identified using *XEphem* software (<https://github.com/XEphem/XEphem>) with an up-to-date asteroid orbit database from Minor Planet Center (<https://www.minorplanetcenter.net/iau/mpc.html>). All the frames were checked for star passages and removed in such an instance.

Below we describe targets with best covered lightcurves in more detail. For other targets, where only a fragment of a lightcurve was captured, we could only estimate a lower limit for its period and the amplitude (see Table 1).

34 Circe. This large, middle main-belt asteroid, was previously observed for lightcurve by Magnusson and Lagerkvist (1991), and Pilcher (2008). It displayed a 12.15 - 12.17-hour period and 0.17 - 0.25 mag amplitudes. We serendipitously captured it on three nights in 2020 September during an observing run at 35-cm telescope at Moletai Observatory, Lithuania. In spite of its long period, which is commensurate with an Earth day, we managed to capture both peaks of its lightcurve. Our result ($P = 12.15$ h and $A = 0.22$ mag) is in line with previous determinations.



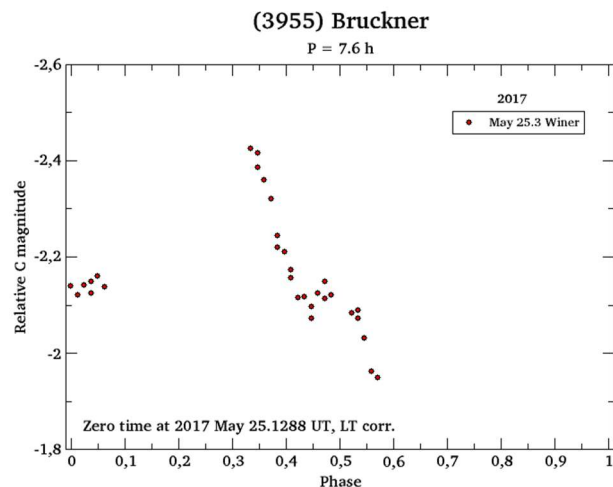
3478 Fanale. This asteroid belonging to Flora family was captured one time in 2015 July at 60-cm telescope at Mt. Suhora, Poland. We obtained a double-peaked lightcurve that clearly covered full rotation. Fanale was previously observed by Stephens (2013) and Owings (2013). It then displayed a 3.245-hour period and 0.47-0.60 mag amplitude. Our result for the period ($P = 3.25$ h) is consistent with those determinations, and various amplitudes registered (here $A = 0.38$ mag) are indicative of variable viewing aspects of the spin axis.



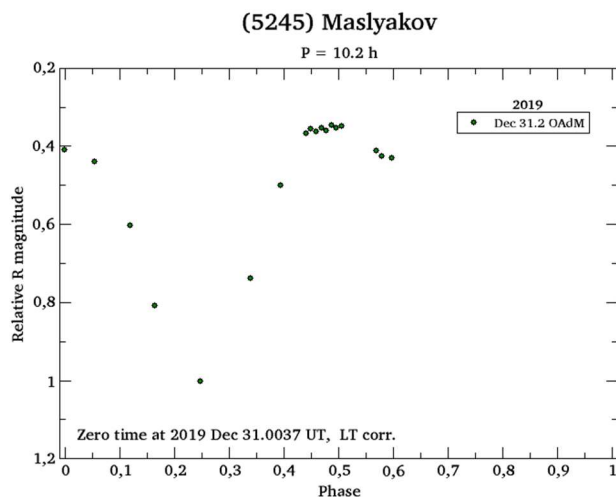
Number	Name	yyyy mm/dd	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
34	Circe	2020 09/20-09/22	13.3-13.9	33	-3	12.15	0.02	0.22	0.02	MB-M
535	Montague	2015 05/15	13.8	204	7	>10.2		>0.12		MB-I
2549	Baker	2015 07/20	5.2	310	0	>5.3		>0.36		THM
2875	Lagerkvist	2008 06/12	15.7	307	-7	>5.		>0.6		MB-O
3478	Fanale	2015 07/20	7.4	309	0	3.25	0.02	0.38	0.01	FLOR
3955	Bruckner	2016 06/01	19.4	150	7	>7.6		>0.4		EOS
4004	List'ev	2018 03/27-03/28	3.9-4.0	199	1	>8.6		>0.25		MB-O
5245	Maslyakov	2019 12/31	7.8	113	-3	10.2	0.1	0.62	0.03	FLOR
6353	Semper	2020 08/22	3.1	337	-3	>6.		>0.3		THM
6520	Sugawa	2013 08/07	6.7	320	7	>5.		>0.18		FLOR
6600	Qwerty	2015 07/20	7.6	309	0	>11.		>0.6		MB-I
7052	Octaviabutler	2020 01/07	27.4	21	-7	6.1	0.2	0.68	0.02	MB-O
7327	Crawford	2016 10/04	23.0	56	2	2.7	0.2	0.26	0.03	MB-I
8361	1990 JN1	2020 09/27	16.4	49	0	>3.		>0.8		EUN
13374	1998 VT10	2017 08/27-08/31	12.4-14.2	316	-6	3.235	0.002	0.43	0.04	FLOR
14381	1990 CE	2021 03/04	12.3	143	-1	5.7	0.2	0.8	0.2	BAP
14411	Clerambault	2019 12/31	8.7	112	-3	3.07	0.05	0.4	0.1	BAP
15375	Laetitiafoggia	2021 03/03	6.7	151	1	3.9	0.2	0.7	0.2	FLOR
17431	Sainte-Colombe	2018 09/20	17.6	30	8	>5.		>1.1		MB-I
31146	1997 UV3	2020 09/27	24.0	46	0	>9.		>0.4		NYS
33785	1999 RD192	2015 05/06	13.6	198	6	7.13	0.08	0.33	0.02	MB-M
37870	1998 FJ23	2020 02/17	16.4	32	3	4.23	0.08	0.9	0.2	MB-I
69695	1998 HL36	2019 02/11-02/15	10.1-11.7	153	13	4.78	0.07	0.13	0.02	MB-I
163799	2003 QR69	2019 07/26	17.4	301	-6	>2.5		>0.6		MC

Table I. Observing circumstances and results. The phase angle is given for the first and last date. 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).

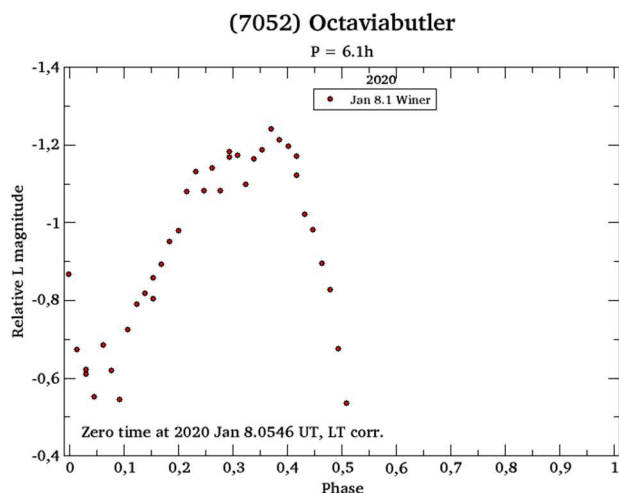
3955 Bruckner. This minor body belonging to the Eos family was previously observed by Behrend et al. (2021web) and displayed a 7.5513-hour period with 0.36 mag amplitude. Also observed by Polakis (2021), it displayed a 7.566-hour period and 0.25 mag amplitude. We captured it once in 2017 May using the 70-cm telescope at Winer Observatory. Due to covering only a short segment of the complete lightcurve, we can only estimate the period as being around 7.6 hours and amplitude of at least 0.4 magnitudes.



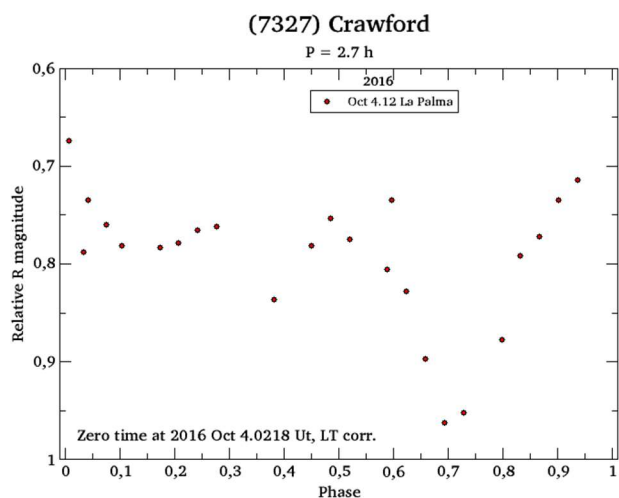
5245 Maslyakov. This Flora family asteroid was serendipitously captured on one night in 2019 December during an observing run at the robotic 80-cm telescope in Montec Observatory. Previously observed by Behrend et al. (2021web), Maslyakov displayed a 10.2-hour period and 0.63-mag amplitude. Our result ($P = 10.2$ h and $A = 0.62$ mag) is very close to earlier work.



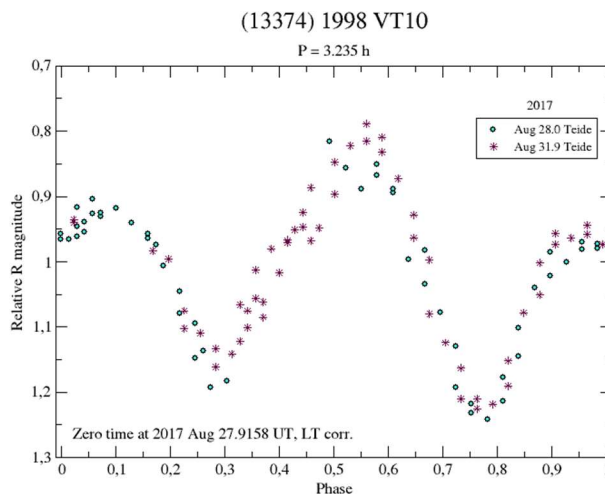
7052 Octaviabutler. This outer main-belt asteroid has no previous period determination that could be found in literature. It was captured once during 3-hours observations with the 70-cm telescope in Winer Observatory. The resulting one-peaked lightcurve of 0.68 mag amplitude seems to cover half of full rotation. From this, we determined a 6.1-hour period.



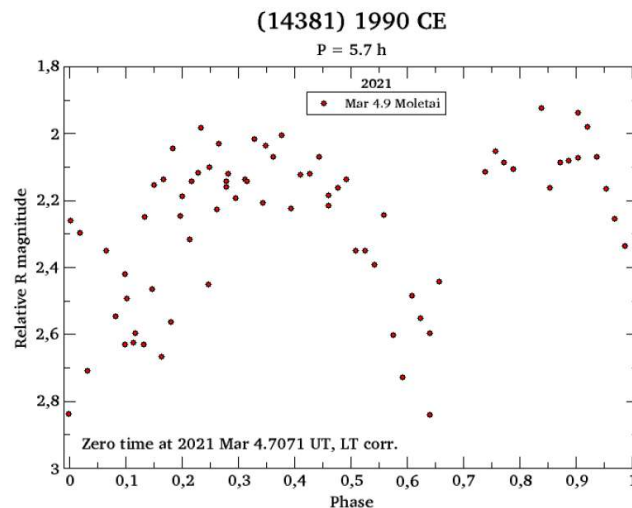
7327 Crawford. This is an inner main-belt asteroid with apparently no previous rotation period determination. On one night, during the observing run at 120-cm Mercator telescope at La Palma in 2016 October, we registered it displaying a double-peaked, asymmetric lightcurve that seems to cover full rotation. We estimate the period at 2.7 hours and the amplitude at 0.26 magnitudes.



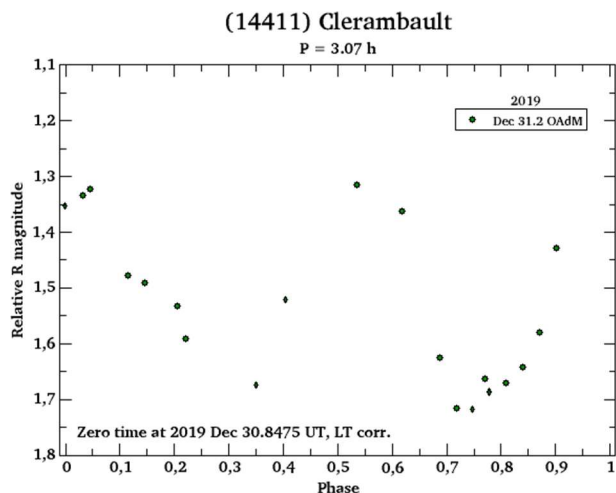
(13374) 1998 VT10. This asteroid belonging to Flora family was serendipitously captured during two nights in 2017 August during our observing run at 80-cm IAC telescope at Teide Observatory. Previously observed by Behrend et al. (2021web), it displayed a 3.23-hour period and 0.41 mag amplitude. We managed to obtain a lightcurve clearly covering full rotation with many overlapping segments from two nights. Our result for the period ($P = 3.236$ h) is consistent with previously published results.



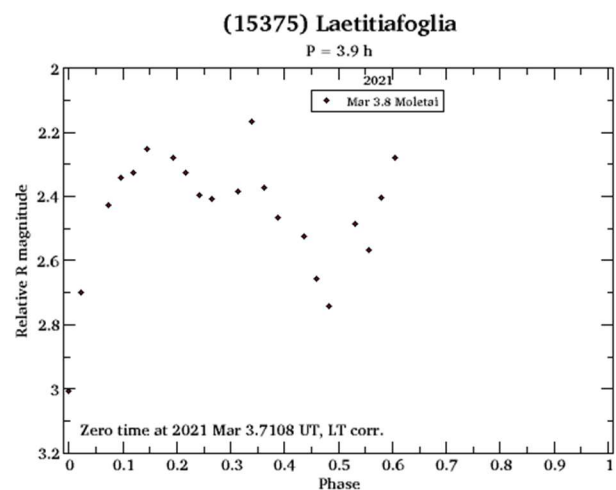
(14381) 1990 CE. This Baptistina family asteroid has no previous rotation period determination that could be found in literature. It was captured during one night in 2021 March during our observing run at 35-cm telescope at Moletai Observatory. The rather noisy lightcurve points to a 5.7-hour rotation period and a large, 0.8 mag amplitude.



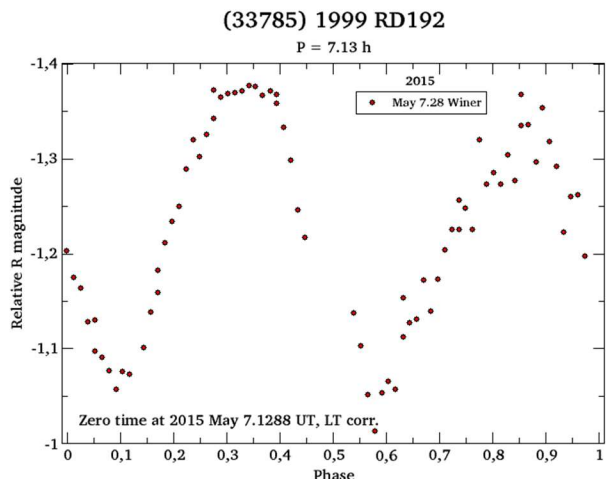
14411 Clerambault. This Baptistina asteroid was serendipitous captured once, together with 5245 Maslyakov, in 2019 December 2019 during an observing run with the 80-cm telescope at Montec Observatory. Previously it displayed 3.053 to 3.07-hour period and a 0.41 to 0.44-mag amplitude (Behrend et al., 2021web; Waszczak et al., 2015). Our result ($P=3.07$ h, $A=0.4$ mag) is consistent with earlier works.



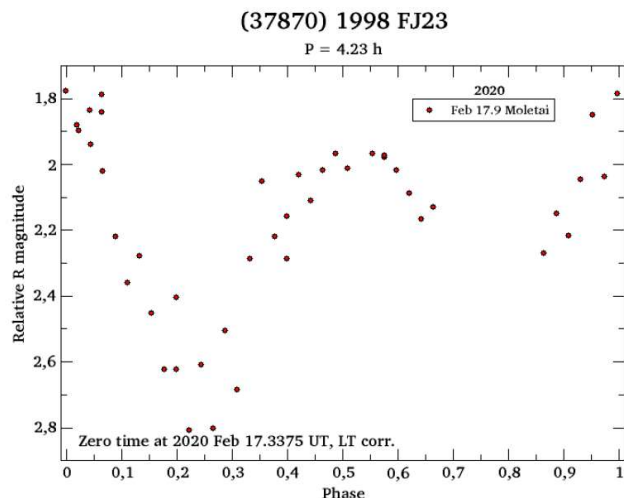
15375 Laetitiafoglia. This target is a Flora family asteroid with apparently no previous rotation period determination. It was captured once in March 2021 at 35-cm telescope at Moletai observatory. We estimate its period at 3.9 hours, and amplitude at 0.7 mag.



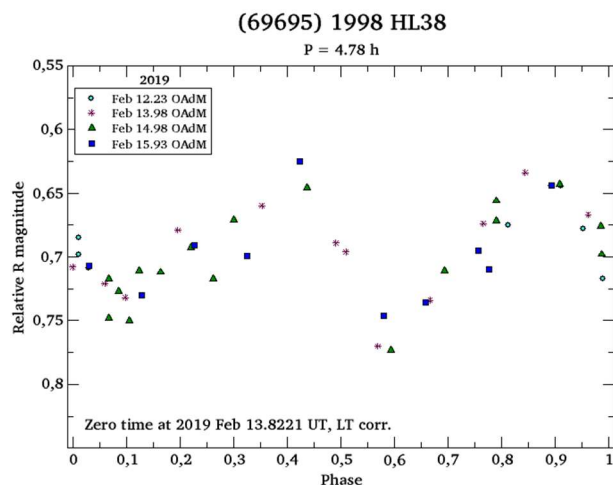
(33785) 1999 RD192. The lightcurve of this middle-main belt asteroid was previously published by Waszczak et al. (2015). It then displayed a 7.126-hour period and a 0.29-mag amplitude. We captured it with a single night of observations in 2015 May using the 70-cm telescope in Winer Observatory. The double-peaked lightcurve covers exactly one full rotation. Our result ($P=7.13$ h; $A=0.33$ mag) is in line with previously published values.



(37870) 1998 FJ23. This is an inner main-belt asteroid with apparently no previous rotation period determination. It was captured during one night of observations in 2020 February 2020 with the 35-cm telescope at Moletai Observatory. We obtained a double-peaked lightcurve that seems to cover full rotation, and determined a 4.23-hour period with a large 0.90-mag amplitude.



(69695) 1998 HL36. This target is an inner main-belt asteroid with no previous rotation period determination that could be found in literature. It was captured during as many as four nights in 2019 February in the data from the 80-cm telescope in Montsec Observatory. We determined a 4.78-h period and a 0.13- mag amplitude.



The Joan Oró Telescope (TJO) of the Montsec Astronomical Observatory (OAdM) is owned by the Catalan Government and operated by the Institute for Space Studies of Catalonia (IEEC).

This article is based on observations made in the Observatorios de Canarias del IAC with the 0.82-m IAC80 telescope operated on the island of Tenerife by the Instituto de Astrofísica de Canarias (IAC) in the Observatorio del Teide.

Based on observations made with the Mercator Telescope, operated on the island of La Palma by the Flemish Community, at the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias. Based on observations obtained with the MAIA camera, which was built by the Institute of Astronomy of KU Leuven, Belgium, thanks to funding from the European Research Council under the European Community's Seventh Framework Programme (FP7/2007-2013)/ERC grant agreement no 227224 (PROSPERITY, PI: Conny Aerts) and from the Research Foundation - Flanders (FWO) grant agreement G.0410.09. The CCDs of MAIA were developed by e2v in the framework of the ESA Eddington space mission project; they were offered by ESA on permanent loan to KU Leuven.

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