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LIGHTCURVES FOR THREE KORONIS FAMILY ASTEROIDS FROM THE UNION COLLEGE OBSERVATORY

F.P. Wilkin, Z. AlMassri, P. Bowles, M. Pargiello, J. Sindoni
Department of Physics and Astronomy, Union College
807 Union St., Schenectady, NY 12308
wilkinf@union.edu

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We present lightcurves for Koronis family asteroids (243) Ida, (321) Florentina, and (2713) Luxembourg. All had periods consistent with previously reported values and showed classic doubly-periodic lightcurves.

At the Union College Observatory we have undertaken a program to observe rotation lightcurves of Koronis family asteroids in support of determining spin vectors and shape models (Kaasalainen et al., 2001; Slivan et al., 2003). Members of this family (named for its lowest numbered member (158) Koronis) are believed to share a common progenitor which was broken up in a collision long ago; thus, they share similar orbits in the outer asteroid belt and similar S-type spectral characteristics. Long-term interaction with solar radiation via the YORP effect has modified members' spin properties (Slivan, 2002; Vokrouhlicky et al., 2003), and determination of spin vectors for a sufficiently large sample of Koronis members may shed light on YORP-driven evolution in the solar system.

We have obtained lightcurves for three Koronis Family asteroids using observations at the Union College Observatory during 2018-2019. This represents the first published asteroid data from the Union College Observatory. Target selection and ephemerides were based upon the Koronis family asteroids web tool (Slivan, 2003). The three selected objects for our first study were chosen because they have well-established short periods and large enough amplitudes. All observations were conducted at the 0.51-m Optical Guidance Systems f/8.1 Ritchey-Chrétien telescope using an SBIG STXL 11002 CCD camera, cooled to -30°C, with an Astrodon Bessel R filter. The detector has 4008×2672 μm square pixels. With 2×2 binning, the pixel scale is 0.93 "/pix and the field of view is $30' \times 20'$.

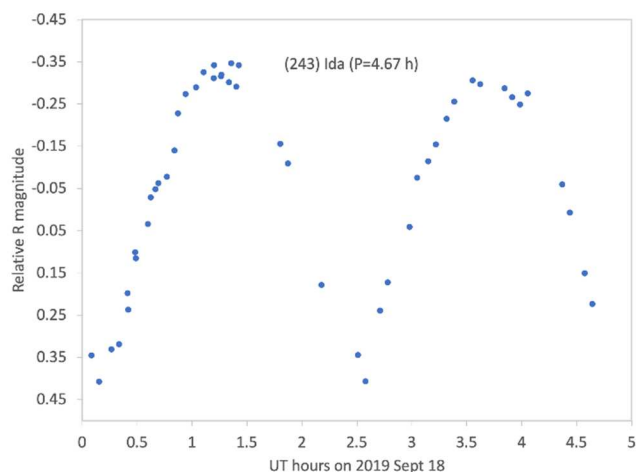
Bias, dark, flat field corrections and subsequent photometry were performed in *AstrolImageJ* software (Collins et al., 2017). We corrected for light travel time for all three targets using ephemerides from the NASA Horizons website.

(243) *Ida* has the distinction in that it is only the second asteroid to have been photographed at close range by a spacecraft. On 1993 Aug 28 NASA's Galileo flew by *Ida* at a distance of roughly 1,500 miles on its way to Jupiter. Its sidereal period was determined to be 4.633632 ± 0.000007 h (Binzel et al., 1993) using pre-Galileo observations. Because the pre-encounter analysis was based upon 9 years of observations and the flyby extended this by only three months, the Galileo spacecraft trajectory was not well-suited to

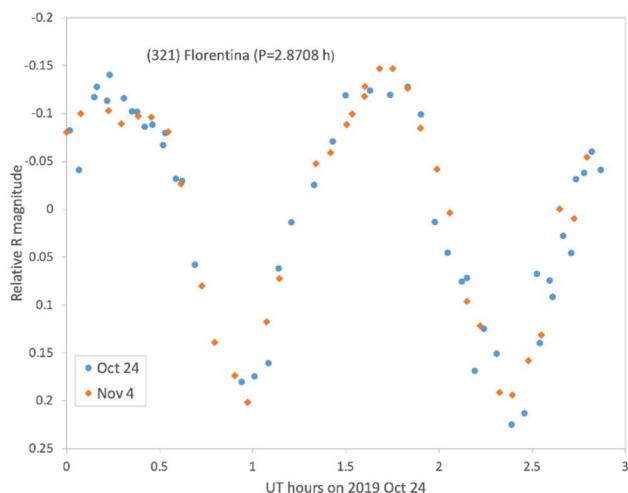
Number	Name	yyyy mm/dd	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
243	Ida	2019 9/18	6.9	338	0	4.67	0.04	0.76	0.04	KOR
321	Florentina	2019 10/24-11/4	19.1, 17.0	86	2	2.8708	0.0003	0.35	0.03	KOR
2713	Luxembourg	2018 12/05-12/11	5.6, 7.9	59	2	3.581	0.002	0.53	0.05	KOR

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. Grp is the asteroid family/group.

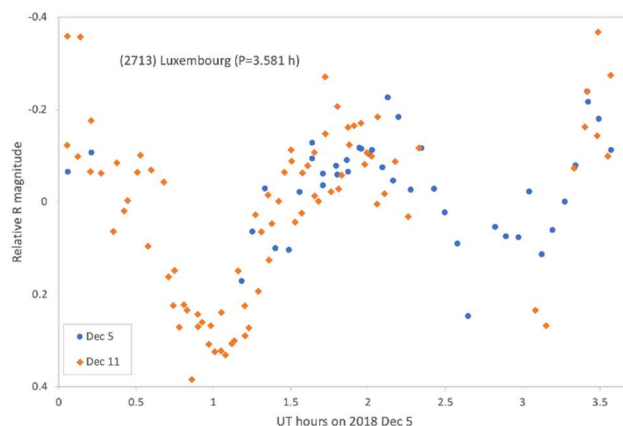
refinement of that period (Davies et al., 1996). Given the years since the intense study of the 1990s, new observations of the object may prove useful for this purpose. The single-night lightcurve from Union College Observatory yields a rotation period of 4.67 ± 0.04 h, which is consistent with published periods. We obtain an amplitude of 0.76 ± 0.04 mag.



(321) *Florentina* has a sidereal rotation period of $2.87086579 \pm 0.00000019$ h determined by Slivan et al. (2003), who also reported a spin pole and shape model. We observed this object on 2019 Oct 23 and 2019 Nov 3. We determined a period of 2.8708 ± 0.0003 h, consistent with previously-reported values, and amplitude 0.35 ± 0.03 mag.



(2713) *Luxembourg*. A complete lightcurve and unambiguous period of $P=3.579 \pm 0.002$ h were presented by Mailhot and Midkiff (2014). They remarked that the relative brightness of the minima changed noticeably over the range of solar phase angle observed. We observed Luxembourg two nights in 2018 Dec. The magnitude values of Dec 11 were shifted visually for a self-consistent composite by a constant offset relative to those of Dec 5. Our best-fit period of 3.581 ± 0.002 h is in agreement with that of Mailhot and Midkiff. Amplitude was 0.53 ± 0.05 mag for Luxembourg in Dec 2018.



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