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CCD PHOTOMETRY OF SIX RAPIDLY ROTATING ASTEROIDS

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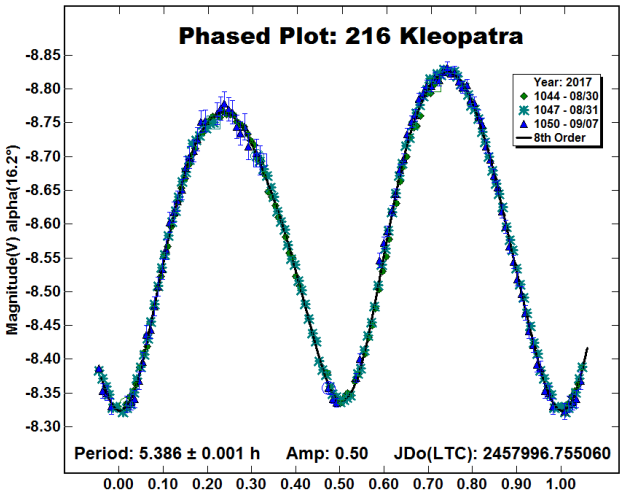
Fourier analysis of ccd-based photometric data has led to the determination of synodic periods for the asteroids 216 Kleopatra (5.386 h), 218 Bianca (6.339 h), 276 Adelheid (6.320 h), 694 Ekard (5.922 h), 1224 Fantasia (4.995 h), and 1627 Ivar (4.796 h)

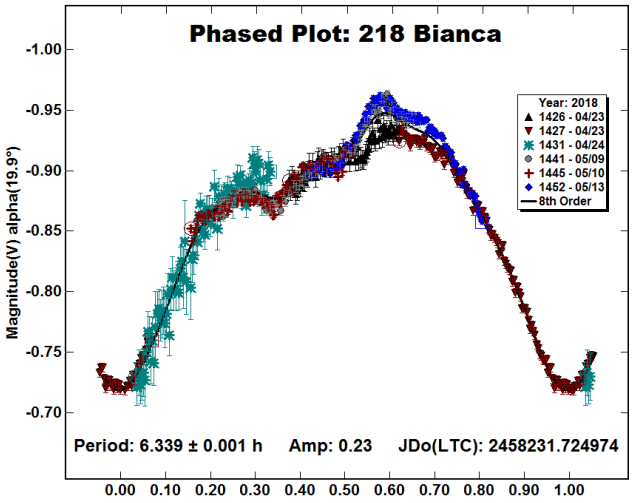
Photometric data from six rapidly rotating minor planets collected at UnderOak Observatory (UO: Cedar Knolls, NJ) and Desert Bloom Observatory (DBO: Benson, AZ) in 2017 and 2018 are reported herein. CCD image acquisition, calibration, registration and data reduction at both sites has been described elsewhere (Novak and Alton 2018; Alton 2018). In all cases, photometric data were subjected to Fourier period analysis (FALC; Harris *et al.* 1989) in order to produce a best fit folded lightcurve.

216 Kleopatra, a main belt M-type asteroid was first discovered in 1880 by J. Palisa. Due to its "dogbone" shape (217 km x 94 km x 71 km) (Ostro *et al*., 2000) it can produce large lightcurve (LC) amplitudes. A total of 275 values (V-passband; 75 s) were acquired between Aug 30 2017 and Sep 7 2017 at DBO; the best fit lightcurve corresponded to a synodic period of 5.386 ± 0.001 h. This rotational period is consistent with literature values most recently reported by Alton, 2009; Kaasalainen and Viikinkoski, 2012, and Shevchenko *et al*., 2014, Novak and Alton, 2018 along with other unpublished lightcurve data referenced at the JPL Solar System Dynamics website (http://ssd.jpl.nasa.gov/sbdb.cgi). During this apparition the minimum to maximum peak amplitude was mid-range (A=0.50) compared to those previously observed (0.12 – 1.22) for this system.

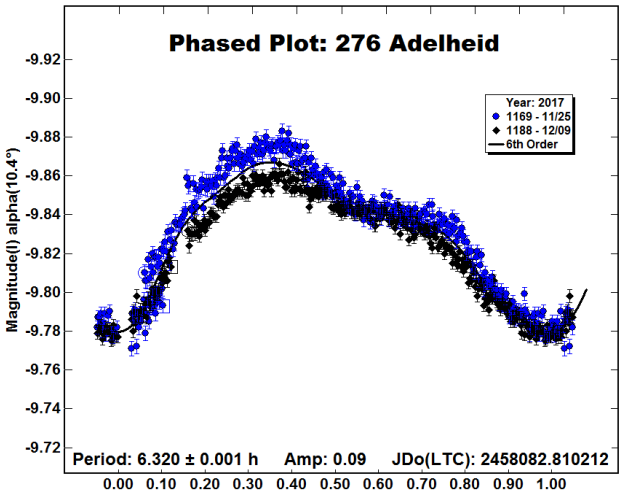


218 Bianca is a moderately sized (~60 km) main belt S-type asteroid discovered in 1880 by J. Palisa. The first lightcurve was published by Carlsson and Lagerkvist (1981) in which they proposed a period of 6.432 ± 0.144 h. Harris and Young (1989) and multiple other investigators since then (Kryszczyńska *et al*., 1996; Fauerbach and Bennett, 2005; Shevchenko *et al*., 2016) reported more accurate periods which are closely corroborated by

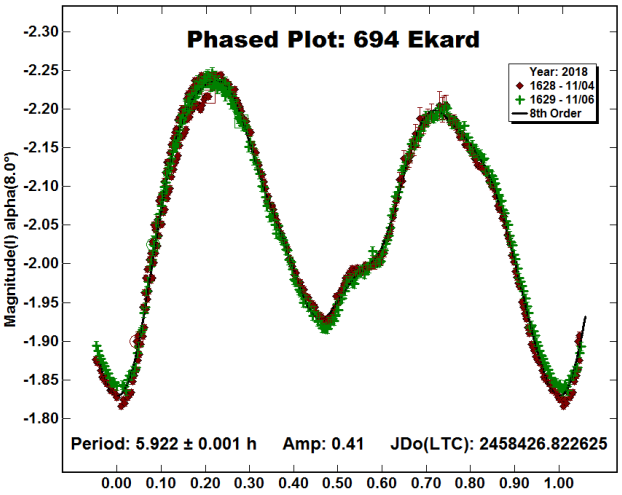
the period determined from the study reported herein. A physical model for 218 Bianca was derived by the lightcurve inversion method revealing its asymmetric shape (Ďurech *et al*., 2007). A total of 603 values (clear; 75 s) were acquired between Apr 23 2018 and May 13 2018 at UO. The best fit lightcurve corresponded to a synodic period of 6.339 ± 0.001 h. The minimum to maximum peak amplitude (A=0.23) was near the maximum range (0.05 – 0.27) previously observed for this system.



276 Adelheid is an intermediate size (~122 km) main belt X-type asteroid discovered in 1888 by J. Palisa. The first published rotational period assessment by Dotto *et al*., 1992 produced a value (6.328 ± 0.005 h) which is remarkably consistent with values reported by multiple investigators since then (Piironen *et al*., 1994; Di Martino *et al*., 1995; Pray, 2005; Sada, 2006). Physical models for 276 Adelheid were proposed by the lightcurve inversion method revealing its angular shape (Marciniak *et al*., 2007; Ďurech *et al*., 2011). During the 2017 apparition, the minimum to maximum peak amplitude (A=0.09) was near the minimum range of values (0.07 – 0.17) previously reported for this system. A total of 679 values (I_c; 75 sec) were acquired at DBO between Nov 25 2017 and Dec 9 2017. The best fit lightcurve corresponded to a synodic period of 6.320±0.001 h, a value consistent with published findings.



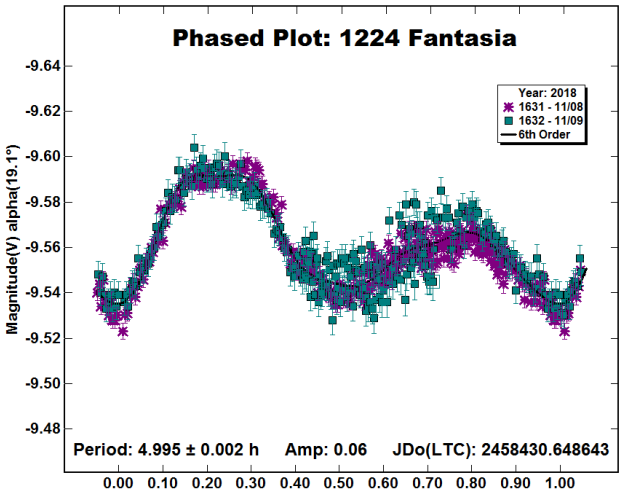
694 Ekard, a CP-type main belt asteroid (d=90.8 km), was discovered in 1909 by the American astronomer J. H. Metcalf. The first published rotational period assessment by Ziegler, 1984 produced a value (5.925 h) which has remained consistent with results reported by multiple investigators since then (Zeigler and Florence, 1985; Hainaut-Rouelle *et al*., 1995; Chiorny *et al*., 2007). A physical model for 694 Ekard was initially proposed by De Angelis, 1995 but then further refined using the lightcurve inversion method (Torppa *et al*., 2003). A total of 626 values (I_c; 75 s) were acquired at DBO between Nov 4 2018 and Nov 6 2018. The best fit lightcurve corresponded to a synodic rotational period of (5.922±0.001 h), a value consistent with published findings. The minimum to maximum peak amplitude (A=0.41) during the 2018 apparition, was closer to the maximum range of values (0.2 – 0.5) previously reported for this system.



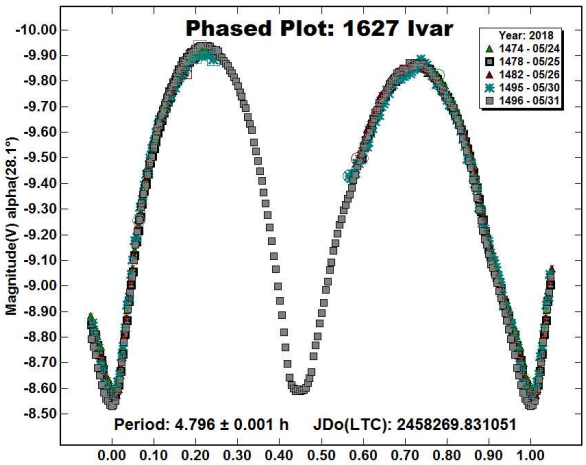
1224 Fantasia, a small (13.8 km) but rather bright (p_V=0.264) S-type main belt asteroid, was co-discovered in 1927 by S. Belyavskij, S. and N. Ivanov. The first published lightcurve (Barucci *et al*., 1984) was highly variable and did not produce a reliable value for the rotational period. Other than lightcurve and period data posted at the Observatoire de Genevè (http://obswww.unige.ch/~behrend/page3cou.html#001224) no other data on this system have been published in the literature. A total of 570 values (clear; 75 s) were acquired at DBO between Nov 8 2018 and Nov 9 2018. The best fit lightcurve corresponded to a synodic rotational period of (4.995±0.002 h), a value consistent with findings from the Observatoire de Genevè. During this apparition, the lightcurve peak amplitude (A=0.06) was less than the minimum range of previously observed values (0.09 – 0.47).

Number	Name	mm/dd/yy	Pts	Phase	L_{PAB}	B_{PAB}	Period (h)	P.E.	Amp	A.E.	Grp
216	Kleopatra	08/30/17-09/07/17	275	16.2, 18.3	303	16	5.386	0.001	0.50	0.02	MB-O
218	Bianca	04/23/18-05/13/18	603	19.9, 23.4	168	3	6.339	0.001	0.23	0.02	EUN
276	Adelheid	11/25/17-12/09/17	679	10.4, 14.2	34	-5	6.320	0.001	0.09	0.02	MB-O
694	Ekard	11/04/18-11/06/18	626	8.0, 8.8	31	6	5.922	0.001	0.41	0.02	MB-M
1224	Fantasia	11/08/18-11/09/18	570	19.1, 19.5	19	9	4.995	0.002	0.06	0.02	FLOR
1627	Ivar	05/24/18-05/31/18	733	28.1, 33.0	227	19	4.796	0.001	1.34	0.02	NEA

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 family/group (Warner *et al.*, 2009).



1627 Ivar (1929 SH) is an S-type near-Earth asteroid (d=9.12 km) discovered in 1929 by E. Hertzsprung. The first published rotational period assessment by Harris and Young, 1985 produced a value (4.8 h) which is consistent with results produced by multiple investigators since then. This includes investigations by Chernova et al., 1995; Kiss *et al*., 1999; Skiff *et al*., 2012; and Warner, 2014; 2015. A "somewhat banana-shaped" physical model for 1627 Ivar was proposed by Kaasalainen *et al*., 2004 and then later refined using radar and lightcurve shape modeling (Crowell *et al*., 2017). A total of 733 values (clear; 75 s) were acquired at DBO between May 24 2018 and May 31 2018. The best fit lightcurve corresponded to a synodic rotational period of (4.796±0.001 h), a value consistent with other published findings. The minimum to maximum peak amplitude (A=1.34) during the 2018 apparition, was closer to the maximum range of values (0.25 – 1.4) previously reported for this system.



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