

PERIOD DETERMINATION FOR 4527 SCHOENBERG

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The main-belt asteroid 4527 Schoenberg (1982 OK) has been observed between June 28 and July 1, 2012 at Maidanak astronomical observatory of the Ulugh Beg Astronomical Institute (UBAI), Uzbekistan Academy of Sciences. On the basis of data analysis it is found a synodic rotation period of 2.6928 ± 0.0384 hour (0.1122 ± 0.0016 day) and lightcurve amplitude of 0.31 ± 0.05 mag.

4527 Schoenberg (1982 OK) was discovered at Anderson Mesa station on Jul 24, 1982 by E. Bowell and named after Austrian composer Arnold Schoenberg. This object is a main-belt asteroid with an orbital period of 3.35 years (MPC, 2013). However in the minor planet lightcurve database (LCDB; Warner *et al.*, 2009), there is no reference to it.

All observational data reported here were obtained using the Maidanak observatory's 60-cm Zeiss-600 telescope. Observations were carried out for period June 28 – July 1, 2012. We have used 1kx1k FLI IMG1001E CCD camera with resolution of 0.67 arcsec/pixel and FOV – $10.7' \times 10.7'$ and Bessel R filter. The temperature of the camera was set at -30°C . Image acquisition was done with *MaxIm DL*. All images were reduced with master bias, dark, and flat frames. All calibration frames were created using *IRAF* (Image Reduction and Analysis Facility). And all instrumental star magnitudes were also obtained using *IRAF*. Asteroid's magnitudes have been corrected to 'unity distance' using by $\text{Mag}(\text{reduced}) = \text{Mag}(\text{observed}) - 5 \cdot \log(r/R)$, where r and R is geocentric distance and heliocentric distance to the asteroid and differential magnitudes were calculated using reference stars from the UCAC2 catalog.

LS periodogram (Scargle J.D., 1982) was used for period analysis of the photometric data. Analysis of the data provided a synodic rotation period of $P = 2.6928 \pm 0.0384$ h with an amplitude of 0.31 ± 0.05 mag.

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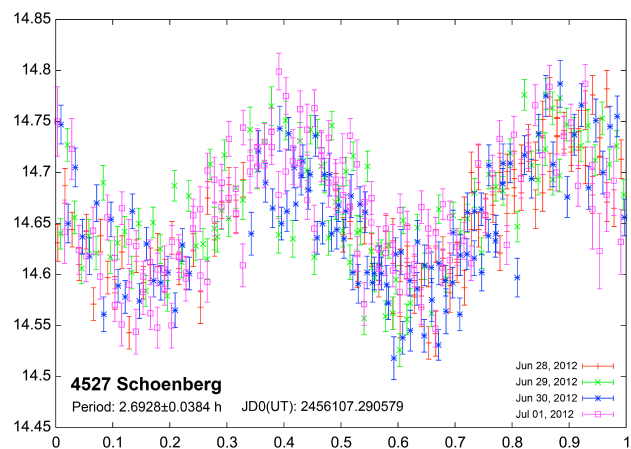
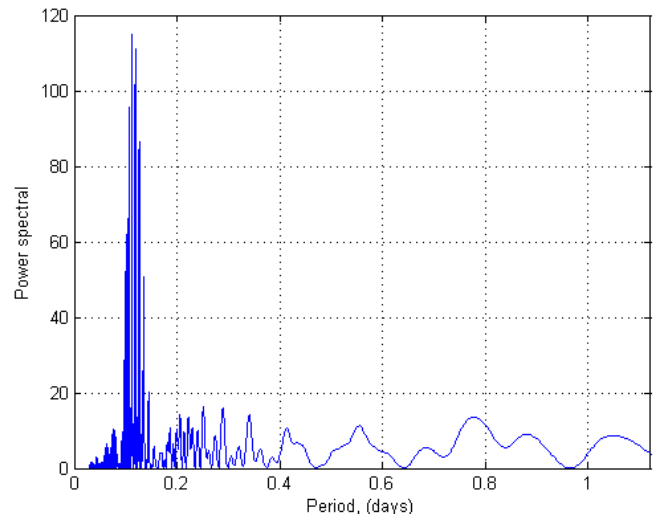
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INVERSION MODEL CANDIDATES

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We present lightcurves for ten asteroids that were selected because they are potential candidates for lightcurve inversion modeling.

The observations of asteroid lightcurves were obtained at the Etscom Campus Observatory (ECO, 2013). We used 3 Celestron 14-inch SCT telescopes on Software Bisque Paramount ME mounts (SB, 2013). Two of the telescopes used SBIG STL 1001E CCDs

that have 1024 x 1024 24 micron pixels. The third C-14 used a SBIG ST10xme with an Optic 0.5x focal reducer. The ST10xme is binned 2x2 providing an image of 1092 by 736 13.6 micron pixels. The pixel size for the STL 1001E cameras is 1.25 arc seconds/pixel. This provides a 22 x 22 arc minute field of view. The ST10 XME pixel size is 1.28 arc seconds/pixel. This provides a 20 x 16 arc minute field of view. The asteroid images were obtained through either an R or clear filter. Exposure times varied between 3 and 5 minutes depending on the brightness of the object. Each evening a series of 11 dome flats were obtained and combined into a master flat with a median filter. The telescopes were controlled with Software Bisque's TheSky6 (SB, 2013) and the CCDs were controlled with CCDsoft V5 (SB, 2013). The images were dark subtracted and flat field corrected using image processing tools within MPO Canopus version 10.4.1.9 (BDW 2013). The multi-night data sets for each asteroid were combined with the FALC routine (Harris et. al., 1989) within Canopus to provide synodic periods for each asteroid.

Inversion Model Candidates

We have observed 10 asteroids suggested in the papers by Warner et. al. (2013a, 2013b) that would benefit from another lightcurve at a new set of solar phase angle bisectors. The results from the last 3 months worth of observations are given below. The information about discovery and designations were taken from the JPL Small-Body Database Browser (2013). The individual sessions for each lightcurve will be placed in the Minor planet Center lightcurve data base (ALCDEF, 2013).

158 Koronis is a main-belt asteroid discovered by V. Knorre at Berlin on 1876 Jan 04. It is also known as 1955 HA1, A893 PA and A911 HB. It was observed on 8 nights between 2013 Apr 15 and 2013 May 03. We obtained a synodic period of 14.206 ± 0.002 h and an amplitude of 0.31 ± 0.03 mag. According to the lightcurve database several observers have reported periods ranging between 14.18 and 14.218 hours (LCDB, 2013). Our synodic period is in agreement with the work of Slivan et.al. (2003).

461 Saskia is a main-belt asteroid discovered by M. Wolf at Heidelberg on 1900 Oct 22. It is also known as 1900 FP, 1955 CT, A917 XE and A924 DB. It was observed on 10 nights between 2013 Apr 24 and 2013 May 30. We obtained a synodic period of 7.348 ± 0.001 h with an amplitude of 0.26 ± 0.05 mag. Others have obtained synodic periods of 7.34 h (Buchheim, 2006) and 7.349 h (Behrend 2007).

604 Tekmessa is a main-belt asteroid discovered by J. H. Metcalf at Tranton on 1906 Feb 16. It is also known as 1906 TK, A894 BA, A911 BC and A915 WG. It was observed on 6 nights between 2013 May 08 and 2013 May 26. We obtained a synodic period of 5.560 ± 0.001 h with an amplitude of 0.49 ± 0.05 mag. Others have obtained synodic periods of 5.55959 h (Behrend, 2006) and 5.5596 h (Baker et. al., 2011).

966 Muschi is a main-belt asteroid discovered by W. Baade at Bergedorf on 1921 Nov 09. It is also known as 1921 KU. It was observed on 7 nights between 2013 Apr 16 and 2013 Jun 03. We obtained a synodic period of 5.348 ± 0.0001 h with an amplitude of 0.44 ± 0.05 mag. Others have obtained synodic periods of 5.355 h (Stephens, 2004), 5.35531 h (Durech, 2009), 5.3558 h (Behrend, 2009)

1378 Leonce is a main-belt asteroid discovered by F. Rigaux at Uccle on 1936 Feb 21. It is also known as 1936 DB, 1958 FG,

1962 KB, A915 RC and A915 WA. It was observed on 6 nights between 2013 Apr 28 and 2013 May 12. We obtained a synodic period of 4.325 ± 0.001 h with an amplitude of 0.63 ± 0.05 mag. Others (Behrend, 2002 and 2007) have obtained synodic periods of 4.3250 h and 4.3586 h.

1396 Outeniqua is a main-belt asteroid discovered by C. Jackson at Johannesburg on 1936 Aug 09. It is also known as 1936 PF, 1930 XV, 1933 SL, 1949 HG1, 1950 TO2, 1957 WE1, 1977 TB4 and A912 HF. It was observed on 3 nights between 2013 Apr 20 and 2013 Apr 28. We obtained a synodic period of 3.082 ± 0.001 h with an amplitude of 0.47 ± 0.05 mag. Others have obtained synodic periods of 3.081 h (Warner, 2006) and 3.08158 h (Behrend, 2006).

1860 Barbarossa is a main-belt asteroid discovered by P. Wild at Zimmerwald on 1973 Sep 28. It is also known as 1973 SK, 1935 GG, 1943 FD, 1948 PE1, 1948 QE, 1951 EA2, 1952 OC1, 1960 MA, 1971 BM1, 1972 JO and A911 QA. It was observed on 6 nights between 2013 May 07 and 2013 May 26. We obtained a synodic period of 3.255 ± 0.001 h with an amplitude of 0.35 ± 0.05 mag. Others have obtained synodic periods of 3.255 h (Di Martino, 1994) and 3.254 h (Behrend, 2005).

2276 Warck is a main-belt asteroid discovered by E. Delporte at Uccle on 1933 Aug 18. It is also known as 1933 QA, 1948 TY, 1951 MB and 1977 RK3. It was observed on 7 nights between 2013 May 07 and 2013 Jun 04. We obtained a synodic period of 4.435 ± 0.001 h with an amplitude of 0.25 ± 0.10 mag. Rene Roy obtained a period of 4.054 (Behrend, 2002).

2911 Miahelena is a main-belt asteroid discovered by H. Akikoski at Turku on 1938 Apr 08. It is also known as 1938 GJ, 1928 DL, 1952 HQ1, 1952 HZ1, 1971 HK, 1975 EF2 and 1977 TE6. It was observed on 5 nights between 2013 May 19 and 2013 Jun 04. The sessions (32 and 37) done on the UT night of 2013 May 19 were done with two different telescopes and CCDs. The lightcurves overlap perfectly. We obtained a synodic period of 4.202 ± 0.001 h with an amplitude of 0.62 ± 0.05 mag. Brinsfield (2008) obtained synodic period of 4.19 h.

3332 Raksha is a main-bet asteroid discovered by L. Chernykh on 1978 Jul 04. It is also known as 1978 NT1, 1936 FT, 1950 TC4, 1952 CB, 1962 TH, 1970 PP, 1974 OR and 1878 RF1. We observed it for 6 nights from 2013 Apr 16 through 2013 May 23. We obtained a period of 4.806 ± 0.002 h and an amplitude of 0.36 ± 0.07 mag. It has been observed by P. Antonini who obtained a period of 4.806456 ± 0.0006 h. (Behrend, 2009). Our period of 4.806 $\pm$ 0.002 h is in good agreement. Our amplitude of 0.36 $\pm$ 0.07 mag. is slightly larger than Antonini's value of 0.31 mag.

In order to compare our results with other epochs of observation, the table below lists the solar phase angle bisectors PABL and PABB for the observations presented in this paper.

asteroid	dates (2013)	PABL	PABB
158 Koronas	04/15-05/03	194	-1.2
461 Saskia	04/24-05/30	230	1.7
604 Tekmessa	05/08-05/26	190	-0.4
966 Muschi	04/16-06/03	185	16.2
1378 Leonce	04/28-05/12	201	1.4
1396 Outeniqua	04/20-04/28	189	-1.9
1860 Barbarossa	05/07-05/26	197	12.0
2276 Warck	05/07-06/04	219	0.6
2911 Miahelena	05/19-06/04	231	12.6
3332 Raksha	04/16-05/23	154	7.7

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