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89.

ROTATION PERIODS OF THREE ASTEROIDS THROUGH DIFFERENTIAL PHOTOMETRY

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Lightcurves and rotation periods were determined for three main belt asteroids. The rotation periods found for each asteroid were: 5.778 ± 0.006 h for 3519 Ambiorix, 2.788 ± 0.001 h for 4569 Baerbel, and 5.632 ± 0.004 h for 7468 Anfimov.

In order to create lightcurves and determine rotation periods for each of the chosen asteroids, data were collected over the course of several nights. The asteroids studied were: 3519 Ambiorix, 4569 Baerbel, and 7519 Anfimov.

Asteroid 3519 Ambiorix has a semi-major axis of 2.17 AU and an orbital eccentricity of 0.176. It was discovered in 1984 by H. Debehogne at the La Silla Observatory (JPL, 2023). Asteroid 4569 Baerbel has a semi-major axis of 2.59 AU and an orbital eccentricity of 0.0621. It was discovered in 1985 by C.S. Shoemaker at the Palomar Observatory (JPL, 2023). Asteroid 7468 Anfimov has a semi-major axis of 3.04 AU and an orbital eccentricity of 0.120. It was discovered in 1990 by L.I. Chernykh at the Crimean Astrophysics Observatory (JPL, 2023).

The asteroids used in this study were selected on the basis of several specific criteria: the opposition date, the declination at the time of observing, and the magnitude. Objects that were in opposition 2-3 weeks prior to the current date were chosen so that by sunset, the asteroid would already be around 20° above the horizon. A declination greater than -15° is ideal when observing in the northern

hemisphere. Accounting for both opposition date and declination serves to ensure the longest viewing interval per night. Observed objects possessed a magnitude of 16 or less to achieve the maximum signal-to-noise ratio.

The aforementioned parameters were used with the Collaborative Asteroid Lightcurve Link (CALL) database (Warner, 2021). After selecting possible targets, each asteroid's position for that particular night was then found using *TheSkyX* software program (Diffraction Limited). Depending on the time, date, and the observatory's location, the software provided a detailed chart of the asteroid's position against the night sky. Finally, asteroids which traveled too close to many stars were filtered out.

Methods

Images of the field containing the target asteroid as well as several possible reference stars were taken using 180 second exposures. All data were taken through a Luminance 3 filter, which is permeable to visible light while preventing infrared and UV light. The telescope was focused hourly.

At a latitude of 33° N, the 0.7-meter CDK 700 Planewave telescope belonging to the Texas A&M University-Commerce was utilized for all asteroids. Attached to the telescope is an Andor iKon-XL CCD Camera, which was thermoelectrically cooled to -20°C .

After raw data were collected, they were then processed using three kinds of calibration frames which were acquired each night prior to the light images: bias, dark, and flat frames. Flat frames were taken against the twilight sky each night. The image processing program *Maxim DL* (Diffraction Limited) was utilized to produce calibrated images as well as aligning all the images. Differential photometry was performed on these calibrated and aligned images using the software MPO Canopus v10.8.1.1 (Warner, 2019).

For each calibrated image the brightness of five reference stars was determined and these reference stars were chosen based on their magnitude and position on the field. The software then compared the brightness of the asteroid with the average brightness of the

Number	Name	yr mm/dd	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
3519	Ambiorix	2023 06/16-06/17	12.9, 13.5	247.2	-0.3	5.778	0.006	0.24	0.04	MB
4569	Baerbel	2023 07/19-07/20	14.3, 14.5	272.4	18	2.788	0.001	0.17	0.02	MB
7468	Anfimov	2022 12/14-12/14	6.0, 6.4	69	-1.2	5.632	0.004	0.51	0.02	MB

Table I. Observing circumstances and results. The phase angle is given for the first and last date. If preceded by an asterisk, the phase angle reached an extrema during the period. 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). Additional data is from *MPO Canopus* v10.8.1.1. (Warner, 2019).

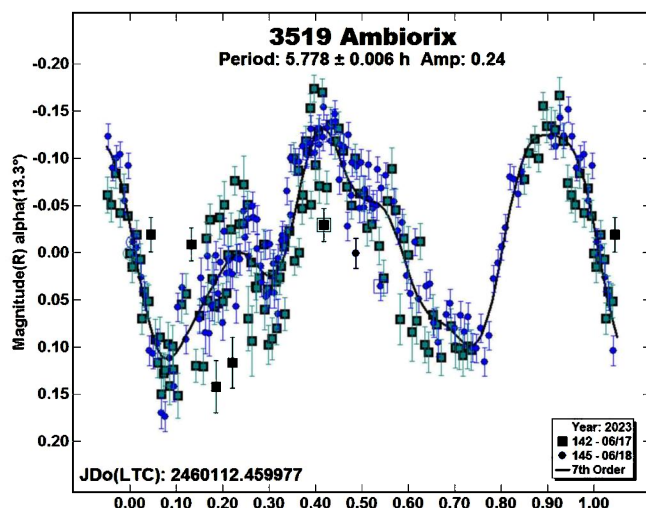
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Available on line <http://www.minorplanet.info/MPB/mpb.php>

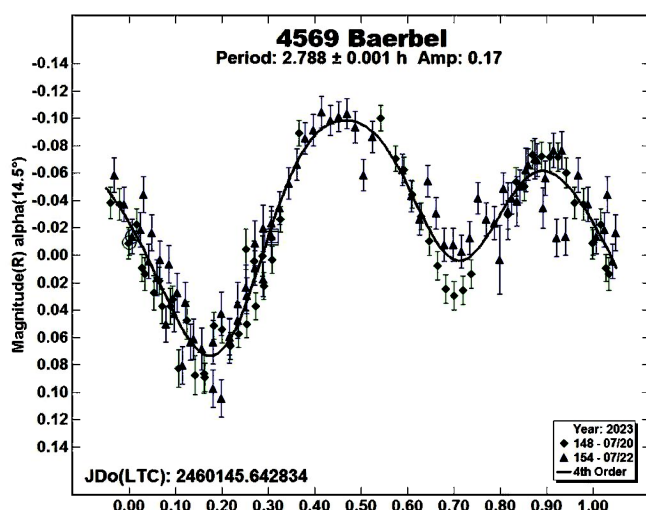
comparison stars. The variation of the brightness versus time allowed the creation of a lightcurve. The light frames taken when the target moved in proximity of a star were eliminated to increase accuracy. Lastly, a Fourier transform of the lightcurve was used to determine the target's rotation period and associated error.

Results

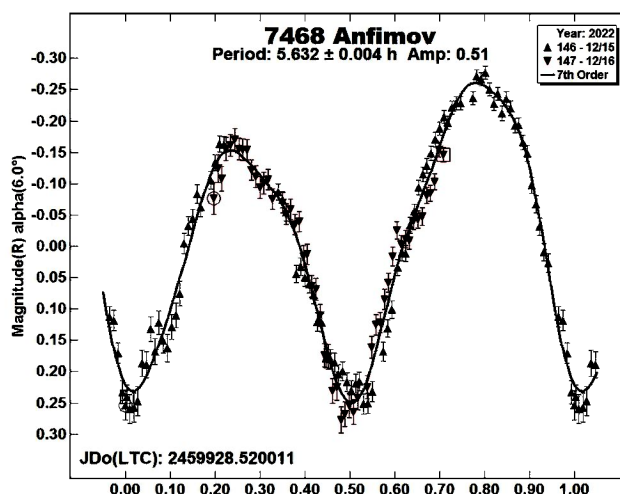
3519 Ambiorix. Two nights were spent observing 3519 Ambiorix; 175 images were taken on 2023 June 16 and 171 on 2023 June 17. The resulting lightcurve yielded a rotation period of 5.778 ± 0.006 h with an amplitude of 0.24 mag. Colazo et al. (2021) determined a similar period of 5.78 ± 0.03 h with an amplitude of 0.29 mag.



4569 Baerbel. This asteroid was observed over two nights; 67 images were taken on 2023 July 19 and 90 on 2023 July 21. The resulting lightcurve yielded a rotation period of 2.788 ± 0.001 h with an amplitude of 0.17 mag. Brinsfield (2010) obtained a similar period of 2.737 ± 0.001 h with an amplitude of 0.24 mag.



7468 Anfimov. Asteroid 7468 Anfimov was observed over two nights; 100 images were taken on 2022 December 14 and 69 on 2022 December 15. The resulting lightcurve yielded a rotation period of 5.632 ± 0.004 h with an amplitude variance of 0.51 mag. Casalnuovo (2023) reports a period of 6.40 ± 0.01 h with an amplitude of 0.67 mag.



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