A PHOTOMETRIC STUDY OF 371 BOHEMIA

Robert K. Buchheim
Lockheed Martin Corp
Altimira Observatory (G76)
18 Altimira, Coto de Caza, CA 92679 USA
rbuchheim@compuserve.com

Matthieu Conjat
408, chemin de Saint Jean Pape
F-06530 Cabris, France

René Roy
Blauvac Observatory (627)
F-84570 St-Estève, France

Philippe Baudoin
51, rue Robert Ancel
F-76700 Harfleur, France

Raoul Behrend
Geneva Observatory (517)
CH-1290 Sauverny, Switzerland

(Received: 21 May Revised: **)

The lightcurve of asteroid 371 Bohemia indicates a rotation period of 10.7391 ± 0.0002 hours, with amplitude of 0.15 mag. The measured color indices of the asteroid are (B-V)= 0.84 ± 0.06 and (V-R)= 0.49 ± 0.03. A detailed search for changes in V-R color with rotation angle was negative within ± 0.03 mag.

Introduction and Observing Procedures

Observations of 371 Bohemia were made during the 2003/4 apparition at Altimira Observatory (V-band) and Blauvac Observatory (unfiltered). This study also used unfiltered observations from amateur observatories at Cabris and Harfleur, France, taken respectively in 2001 and 2002.

Altimira Observatory, located in southern California, used a 0.28-m Schmidt-Cassegrain (Celestron NexStar-11), operating at f/6.3, with an SBIG ST-8XE NABG CCD and Johnson-Cousins B, V and R filters. Blauvac Observatory is located in France (5°13' East longitude, 44°3' North latitude), and used a 310mm f/3.4 Newtonian telescope, with an Audine CCD camera equipped with a KAF-402ME chip. M Conjat made measurements from Cabris, France (6°56' East longitude, 43°38' north latitude) using a 200mm f/4 Newtonian telescope, and a ST4 CCD camera. Ph. Baudoin used a 200mm f/4.0 Newtonian telescope, and an Audine CCD camera equipped with a KAF-400 CCD chip to make measurements from Harfleur, France (0°12' East longitude, 49°31' North latitude).

Observational Results

Previous studies have reported quite a wide range of lightcurve periods for this object. Mohamed et al (1995) observed it during the 1993 apparition and reported a period of 3.792 hours, with an ~0.15 mag. amplitude. However, their published lightcurve shows wide scatter in the data after it is wrapped to the indicated period, and their result depends very heavily on a single night's observations. Also during the 1993 apparition, Riccioli et al (1995) observed on three nights, and inferred a period of 12.48 hours, with amplitude > 0.16 magnitude. However, their data is very sparse, and they observed only a single maximum, leaving open the possibility that a more-complete lightcurve would show significantly different features.

We obtained 9 nights of data from 2003-12-27 to 2004-03-09 UT. All lightcurves were corrected for light-travel time to the asteroid. This data set provides a dense and complete coverage of the lightcurve. The data set consisting of Altimira filtered observations and Blauvac unfiltered observations, was analyzed with methods based on Fourier polynomials, using both Brian Warner's MPO Canopus and CourbRot (Behrend, 2001), with very similar results: 10.7391 ± 0.0002 hour rotation period. A photometric slope parameter G=0.15 was used in these computations, as described see below. The resulting lightcurve is shown in Figure 1.

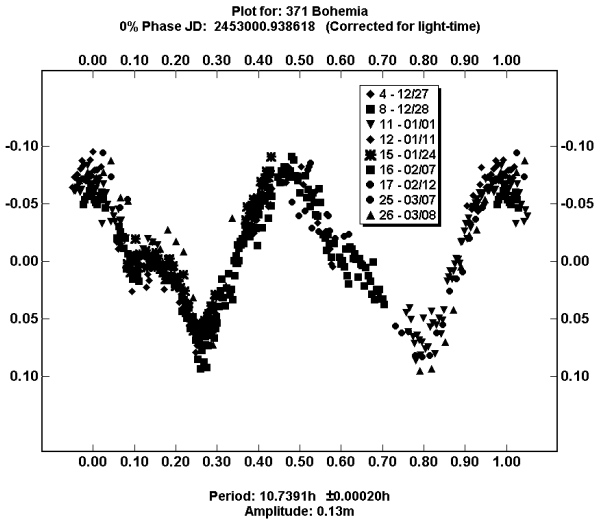

Figure 1: Lightcurve of 371 Bohemia, using 2003-4 data wrapped to P= 10.3791 hrs

Note the presence of a tertiary maximum at rotational phase ≈ 0.15 in Figure 1. This feature appears in several nights' data, and so is almost certainly a real feature of this asteroid's shape. This feature may have been a contributing factor in the previously reported, discordant lightcurve periods. We searched for consistent periodic lightcurves with periods in the range 1 hour to 1 day, giving special attention to previously reported periods; we found nothing except the 10.7391h periodicity. This value is also consistent with the observations taken during the 2001 and 2002 apparitions. Figures 2 and 3 present lightcurves from these apparitions constructed with the 10.7391h period. The variability of Bohemia was around 0.10-0.15 mag for all studied oppositions, and all lightcurves presented similar shapes. Thus, Bohemia's equator is probably not very far from the ecliptic, rendering future work to model its 3D shape difficult.

The Planetary Data System Small Bodies Node reports a color index of B-V = 0.822 for this asteroid. Ricciolo et al (1995)

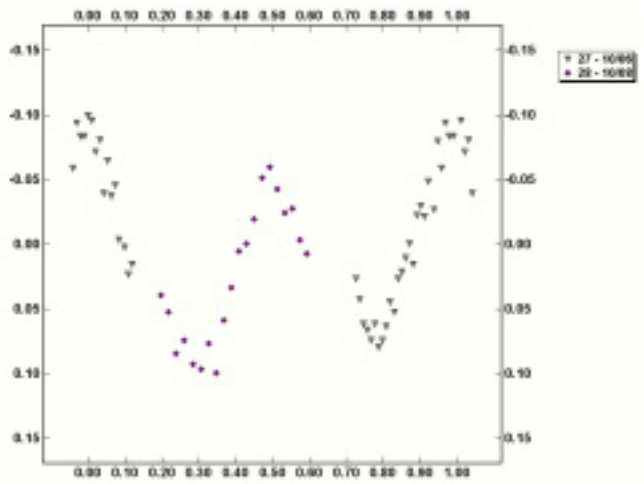

Figure 2: 371 Bohemia observed at Harfleur Observatory in 2002, compiled using P=10.7391 h.

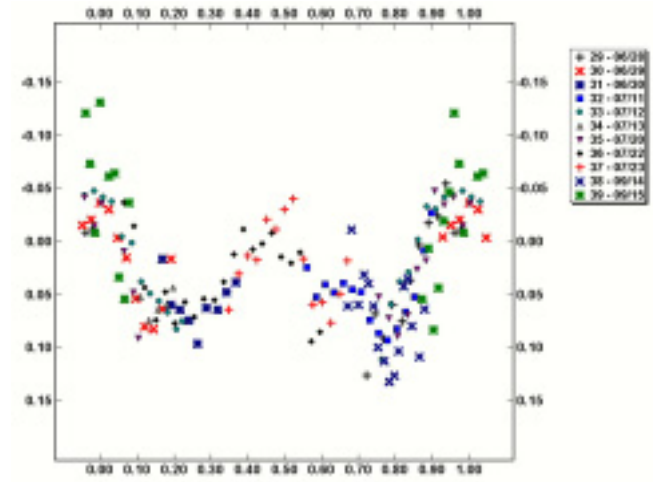

Figure 3: 371 Bohemia observed at Cabris Obsevatory in 2001, compiled using P=10.7391 h.

reported B-V = 0.91, and their observations found no variation in color index with rotational phase angle. Altimira Observatory made observations on two nights using 2 minute exposures in V- and R-band, and 4 minute exposures in B-band (giving signal-to-noise ratio ≈ 50:1 in B-band), to determine the asteroid's color index. Landolt standard fields were used to determine transformation coefficients. Atmospheric extinction was determined using the Hardie method (Hardie, 1962). In the case of B-V results reported here, we applied first order extinction corrections, but not second-order corrections.

In each band, three exposures were made, and the resulting instrumental magnitudes averaged before further reductions. The resulting color indices were: B-V = 0.84 ± 0.06 and V-R = 0.49 ± 0.03. Detailed studies of the V-R color made at Altimira Observatory on the night of 1/11/2004 UT showed a constant V-R color to within ± 0.03 magnitude over rotational phases from 0.05 to 0.55 (referring to Figure 1).

Finally, we made an attempt to discriminate between two reported values for the absolute magnitude (H) and slope parameter (G) for this asteroid. Figure 4 shows the reduced magnitude (in V-band) vs. phase angle, using 2003-4 data from Altimira Observatory. The raw data have been adjusted to account for the asteroid's rotational phase angle at the time of measurement, so that this data set reflects the "average" or "ΔM = 0" line on Figure 1. The Small Bodies Node reports H= 8.72, and uses the "default" value of G=0.15 for this asteroid. Tedesco (1989) reports H= 8.79 and G= 0.25. Unfortunately, the smallest observed phase angle (1.6 degrees) did not clearly show the opposition effect, and the present data cannot differentiate between these two reported values.

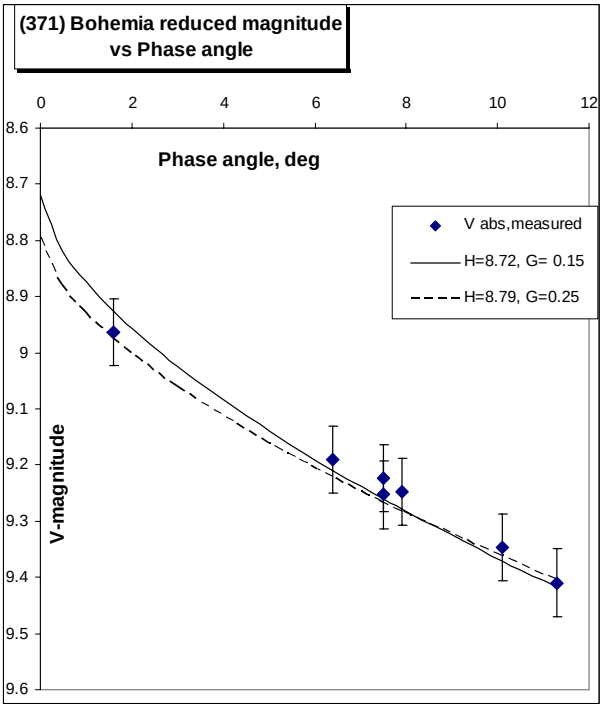

Figure 4. Reduced magnitude vs. Phase angle.

Acknowledgements

Altimira Observatory's transformation coefficients, lightcurves, and color indices were calculated using Brian Warner's MPO Canopus and PhotoRed programs. European observers used IRAF and Prism. AstOrb and MPCOrb online databases were used as sources of orbital elements. Very special thanks to Eileen Buchheim, who sacrificed a portion of her garden for the construction of Altimira Observatory.

References

Behrend, R., "Réduction d'une courbe de rotation/de lumière", Orion, 304, 12-15, 2001.

Hardie, R. H., "Photoelectric Reductions" in Hiltner W. A, ed *Astronomical Techniques*, Univ. of Chicago Press, 1962.

Mohamed, R. A., et al, "Light curves and rotation periods of asteroids 371 Bohemia, 426 Hippo, 480 Hansa, and 735 Marghanna", *Astronomical Journal*, Vol 109, No 4, 1995.

Planetary Data System Small Bodies Node at http://pdssbn.astro.umd.edu

Riccioli, D., et al, "Lightcurves and rotational periods of main belt asteroids, III", *Astronomy and Astrophysics Supplement Series*, v 111, 297-303 (1995).

Tedesco, "Asteroid Magnitudes, UBV colors, and IRAS albedos and diameters", in Binzel, R. P. et al, (eds) *Asteroids II*, University of Arizona Press, 1989.