

ROTATIONAL PERIOD, H_R -G PARAMETERS, COLOR INDEX, AND DIAMETER ESTIMATION FOR 473 NOLLI

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Photometric measurements for asteroid 473 Nollie were performed from two observatories during its 2014 favorable opposition. The synodic rotation period was found to be 3.0785 ± 0.0001 h, the lightcurve amplitude was 0.19 ± 0.02 mag, the absolute R-band magnitude was 11.500 ± 0.029 mag, the slope parameter was 0.253 ± 0.047 , and the V-R color index was 0.453 ± 0.034 mag. These led to an estimated diameter of 13 ± 3 km.

473 Nollie is a main-belt asteroid discovered in 1901 by M. Wolf at Heidelberg (Germany). It appeared on the CALL web site as an asteroid photometry opportunity due to it reaching a favorable apparition in 2014 and having no defined lightcurve parameters.

Observations by Álvarez were made at Observatorio Los Algarrobos, Salto, Uruguay (OLASU, MPC Code I38) in 2014 from February 8 to April 9, with a 0.30-m Meade LX-200R telescope and QSI 516wsg CCD, guided, 2x2 binning, clear, V and R filter, and 120 to 150 second exposures. Observations by Pilcher were made at the Organ Mesa Observatory (MPC code G50) in 2014 from January 29 to February 19, with a 0.35-m Meade LX200 GPS telescope and SBIG STL-1001E CCD, unguided, clear filter, and 60-second exposures.

Our computers were synchronized with atomic clock time via Internet NTP servers at the beginning of each session. All images were dark and flat-field corrected and then measured using *MPO Canopus* software (Bdw Publishing) version 10.4.3.16 with a differential photometry technique. The data were light-time corrected. Night-to-night zero point calibration was accomplished by selecting up to five comp stars with near solar colors according to recommendations by Warner (2007) and Stephens (2008). Period analysis was also done with *MPO Canopus*, which incorporates the Fourier analysis algorithm developed by Harris (Harris *et al.*, 1989).

Almost 50 hours of effective observation and more than 1,200 data points were required in order to solve the lightcurve (Figure 1). Over the 70-day span of observations, the phase angle varied from -14.29° to -1.31° and from $+1.26^\circ$ to $+16.97^\circ$, the phase angle bisector ecliptic longitude from 159.1° to 162.0° , and the phase angle bisector ecliptic latitude from 0.0° to -5.1° . The rotation period for 473 Nollie was determined to be 3.0785 ± 0.0001 h along with a peak-to-peak amplitude of 0.19 ± 0.02 mag. The lightcurve showed a typical bimodal shape, with the maxima virtually identical in magnitude, and the minima differing by only a small – although noticeable – amount. In spite of its short (potentially favorable) period no evidence of binary companion was seen in the lightcurve.

The absolute R -band magnitude (H_R) and slope parameter (G) were found using the H-G Calculator tool of *MPO Canopus*, which is based on the FAZ algorithm developed by Alan Harris (1989). Six pre- and five post-opposition data were used (Figure 2), all of them representing the maximum of the curve for each observing session. The absolute R -band magnitude was determined to be 11.500 ± 0.029 mag and the slope parameter 0.253 ± 0.047 , typical of intermediate albedo asteroids (Lagerkvist and Magnusson, 1990).

The color index was found to be $V-R = 0.453 \pm 0.034$ mag (mean of 34 values found from the session of March 8). By adding the mean $V-R$ color index to the H_R value, we obtained an absolute visual magnitude $H = 11.953 \pm 0.063$ mag. In agreement with the systematic offset of H catalog values for small asteroids recently reported by Pravec *et al.* (2012), our H value is slightly larger than those published at the JPL Small-Body Database ($H = 11.6$ mag) and at the Minor Planet Center's MPCORB catalog ($H = 11.7$ mag).

According to Shevchenko and Lupishko (1998), our measured $V-R$ color index is halfway between those corresponding for taxonomical types S (0.49 mag) and M (0.42 mag). For those basic compositional types of asteroids, the geometric albedo on the Johnson V band (p_V) respectively are 0.20 and 0.17. By assuming an intermediate $p_V = 0.185$, the formula by Pravec and Harris (2007) for the asteroid diameter (D) in kilometers

$$D = \frac{1329}{\sqrt{p_V}} 10^{-0.2H}$$

gives an estimated diameter of $D = 13 \pm 3$ km.

Our study now leaves only three asteroids numbered below 500 for which no rotation parameters are currently found in the literature. They are 299 Thora, 398 Admete, and 457 Alleghenia. Among the asteroids numbered from 501 to 1000, 23 still have no period that we could find. This is a dramatic reduction from two years ago (Alvarez, 2012), thus leaving only 26 among the first 1000 numbered asteroids with no previously reported rotation period. However, even in cases where low numbered asteroids do have reported lightcurve parameters, not all of these period determinations are secure (i.e., many have $U < 3$) and ongoing investigations to verify, refine, or revise their values remains an important and pending endeavor.

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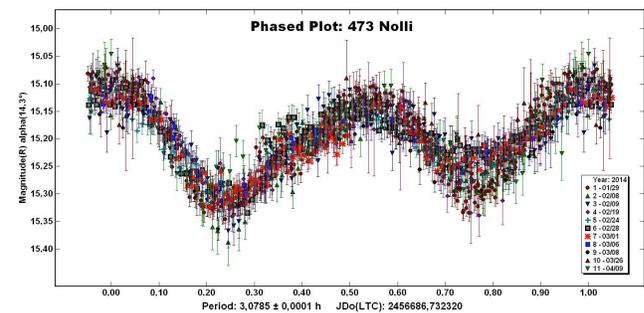


Figure 1. Composite lightcurve of 473 Nollis.

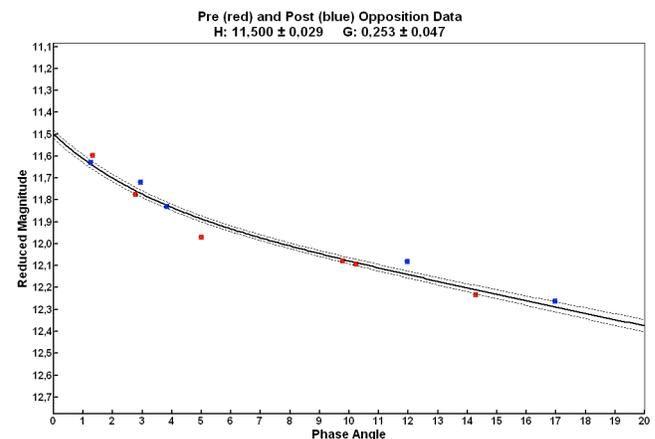


Figure 2. H-G plot in R-band magnitude for 473 Nollis.