LIGHTCURVE FOR KORONIS FAMILY MEMBER (1389) ONNIE

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We have used east and west stationary point observations of (1389) Onnie to determine a definitive period of 23.044+/-0.001 h.

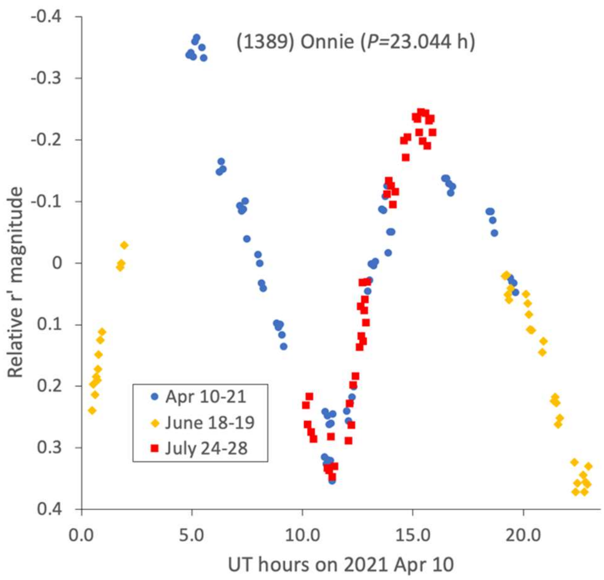
Koronis family member (1389) Onnie was observed by Binzel in 1983 as reported in Binzel (1987), which appears to contain the only published lightcurves. Although a complete lightcurve and unambiguous period could not be derived, the presence of two local maxima separated by 22.5 h provides a significant constraint. More recently, Hanuš et al. (2011; 2013) have reported sidereal periods and spin vectors. These analyses, as well as that of (Erasmus et al., 2020) use "survey sparse data" and are based on the adoption of the 22.5 h period value.

Given Binzel's 1983 dataset, and assuming an integer number of half-rotations during the 22.5 h interval between observed maxima, there are three candidate periods that produce self-consistent, folded composite lightcurves that are doubly-periodic: 45.0 h, 22.5 h, 15.0 h. The goal of our new observations is to resolve the period ambiguity and to obtain a complete lightcurve for the 2021 apparition (see also Slivan et al. (2023; this issue)).

All new observations in this work were conducted at the 0.61-m Ritchey-Chrétien Chi-1 in the Rio Hurtado Valley, Chile, operated by Telescope.Live. Observation planning used the Koronisfamily.com tool (Slivan, 2003). Exposures of 240 s in Sloan r' were binned 2×2, with image scale (0.62"/pix) and field of view 32'×32'. The observing campaign in April 2021 while Onnie was near its eastern stationary point, comprised 10 nights. We subsequently obtained observations on two consecutive nights in June, and 5 consecutive nights in July, when the asteroid was near the western stationary point.

Images were processed for bias, dark, and flat field corrections. We used *AstroImageJ* software (Collins et al., 2017) to perform photometry. Corrections for light travel time, unit distance and solar phase angle were made using ephemerides from NASA Horizons. A single pointing center allowed the use of the same on-chip comparison stars for all nights in April, for which only ~ half of a full rotational phase coverage was obtained. For July, the target was now near the west stationary point, again permitting a single field pointing center and the use of the same on-chip comparison stars for our 5 nights. The two nights in June were consecutive, again permitting the same on-chip comparison stars. Thus, in making a composite lightcurve of all of the April, June, and July observations, only two constant shifts in magnitude were required to put all observations onto a consistent relative scale.

As seen in our lightcurve, the rotational phase coverage of the two stationary point observations largely overlapped, and the majority of the remaining gap in coverage was filled by the two nights in June. Our observations were able to reject the candidate periods near 15.0 h and 45.0 h because they did not produce self-consistent composites. This conclusion was not sensitive to the assumed value of G. We obtained a best fit synodic period 23.044 +/- 0.001 h, which agrees with Binzel's inferred value 22.5+/-0.3 h within 2σ. The inferred amplitude (from trough to peak) is 0.70 +/- 0.03 mag.



Number	Name	yyyy mm/dd	Phase	L_{PAB}	B_{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
1389	Onnie	2021 04/15-07/22	*17.8,16.9	256	3	23.044	0.001	0.70	0.03	MB-Kor

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 extremum during the period. L_{PAB} and B_{PAB} are the approximate phase angle bisector longitude/latitude at mid-date range.

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SYNODIC AND SIDEREAL ROTATION PERIODS OF KORONIS FAMILY MEMBER (1389) ONNIE

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Lightcurve observations of (1389) Onnie during its 2022 apparition yield a secure determination of its synodic rotation period 23.038 ± 0.005 h, and an unambiguous count of sidereal rotations back to 2017 constrains the sidereal rotation period.

Asteroid (1389) Onnie appears to be the lowest-numbered Koronis family member lacking a secure determination of its rotation period having full lightcurve coverage and no ambiguity. Binzel (1987) recorded partial lightcurves of Onnie on three consecutive nights in 1983, each spanning about 4 to 5 hours. By assuming that either 0.5, 1.0, or 1.5 rotations elapse during the 22.5 h interval between the observed maxima, there are three candidate periods whose folded composite lightcurves are consistent with being doubly-periodic. 1.0 rotation for a 22.5 ± 0.3 h period was chosen as favored but the others could not be ruled out. Erasmus et al. (2020) refined the favored period based on ATLAS survey data “sparsely sampled” in time, but those observations share the same ~24-h cadence of the 1983 data and thus do not resolve the period ambiguity. Hanuš et al. (2011; 2013) have reported analyses of earlier sparsely-sampled data for sidereal periods and spin vectors. The new observations reported here were made with two specific objectives: to resolve the ambiguity in the rotation period (also see Wilkin et al. (2023; this issue)), and to obtain complete rotation coverage at its 2022 viewing aspect which is similar to that incompletely observed in 1983.

We observed Onnie mainly near its eastern stationary point in 2022 July to permit using the same on-chip field comparison stars over a series of nights. Nightly observing information is summarized in Table I, and instrumentation is detailed in Table II. Observations from June through August were made using telescopes at the MIT Wallace Astrophysical Observatory (WAO) in Westford, MA. Observations in September were made remotely using the CHI-2 telescope of Telescope Live in Rio Hurtado, Chile, for which the coverage was timed specifically to fill an unattractive straggler gap in rotation phase. Processing and measurement of the images were as described by Slivan et al. (2008), except that for the observations made using the smaller telescopes WAO-3 and WAO-4 the choices of synthetic aperture sizes for the on-chip relative photometry were guided by the experience of Howell (1989).

We reduced our observations for light-time and to unit distances, and for changing solar phase angle using $G = 0.23$ (Lagerkvist and Magnusson, 1990) as the slope parameter of the Lumme-Bowell model (Bowell et al., 1989). Composite lightcurves folded at the best-fitting periods corresponding to all three possible periods identified by Binzel (1987) confirm that the earlier favored solution is correct (Fig. 1) and rules out the two alias solutions (Fig. 2),