

LIGHTCURVE ANALYSIS AND ROTATION PERIOD FOR PHA 2020 XR

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Lightcurve observations of the potentially hazardous asteroid (PHA) 2020 XR during its closest approach to Earth in 2024 yielded a synodic rotation period of 10.70 ± 0.04 h. This result should not be considered secure given a large number of other periods of similar RMS fit found by the Fourier analysis.

2020 XR is a small asteroid whose orbit crosses the orbit of Earth. It has been classified as a potentially hazardous asteroid (PHA) due to its predicted future close passes with Earth. It orbits the sun every 1,440 days (3.94 years), coming as close as 0.97 au and reaching as far as 4.03 au from the Sun (JPL, 2024). Based on its absolute magnitude ($H = 19.9$) and depending on the albedo, the estimated diameter is between 0.28 and 0.62 km.

Observations were made at the OARU Observatory (X33) in Manaus, Brazil, from 2024 Dec 2-11, which was during the asteroid's most recent close approach. A 0.2-m $f/5$ reflecting telescope equipped with an ASI 294 MC Pro camera was used for the unfiltered observations. Exposure times varied from 10-30 s. All the observations were made with 2×2 binning, which gave a plate scale of 1.91 arcsec/pixel.

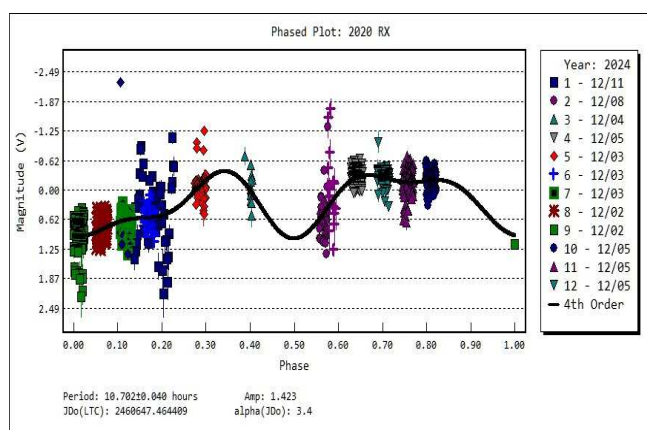
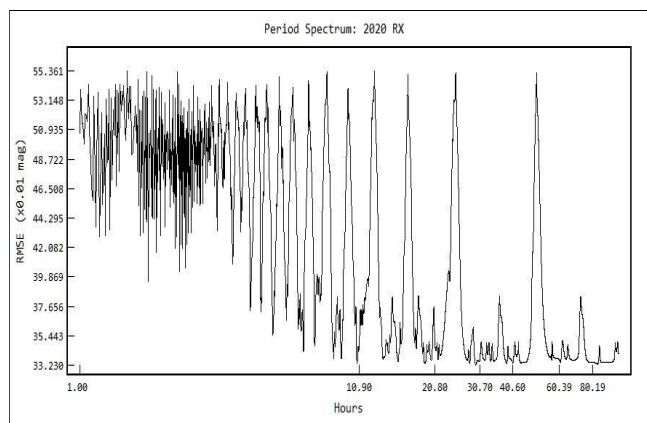
Data reduction and period analysis were performed with *Tycho Tracker Pro* v11.7.8 (Parrott, 2024). The asteroid and seven comparison stars were measured for differential photometry. The comparison stars were selected with color indices within the range of $0.5 < B-V < 0.95$, aligning with the typical color range of asteroids.

The lightcurve suggests a rotation period of 10.70 ± 0.04 h. The amplitude is about 1.42 mag, which is most likely the result of a significantly elongated shape. This is a relatively short period, but it is compatible with the vast majority of asteroids in the asteroid's size range (Warner et al., 2009).

A look at the period spectrum generated by the Fourier analysis shows that the period 10.70 h is far from secure. Numerous other solutions with nearly the same RMS fit are also present. These represent *rotational aliases*, i.e., periods that correspond to integral half-rotations of the one associated with the adopted period.

The asteroid lightcurve database (LCDB; Warner et al., 2009) listed no previously reported periods. In addition, no other lightcurve data for this object was found in the Asteroid Lightcurve Data Exchange Format (ALCDEF) database (<https://alcdef.org>) or in the *Minor Planet Bulletin*.

More studies will be necessary to complement and accurately determine the rotation period of this asteroid, whose next closest approach to Earth will occur in 2028 November.



Acknowledgments

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References

- Harris, A.W.; Young, J.W.; Scaltriti, F.; Zappala, V. (1984). "Lightcurves and phase relations of the asteroids 82 Alkmene and 444 Gyptis." *Icarus* **57**, 251-258.
- JPL (2024). NASA JPL Small Bodies Lookup website. https://ssd.jpl.nasa.gov/tools/sbdb_lookup.html
- Parrott, D. (2024). Tycho Tracker Software. <https://www.tycho-tracker.com>
- Warner, B.D.; Harris, A.W.; Pravec, P. (2009). "The Asteroid Lightcurve Database." *Icarus* **202**, 134-146. Updated 2024 Oct. <http://www.minorplanet.info/lightcurvedatabase.html>

Number	Name	yyyy mm/dd	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
2020	XR	2024 12/02-12/11	*3.4, 9.2	257	-1	10.70	0.04	1.42	0.33	PHA

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).