FAST ROTATOR MINOR PLANET 2020 UA FROM CLUJ AND BERTHELOT OBSERVATORY

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We have observed minor planet 2020 UA during an exceptional close approach and determined that it is a fast rotator. For two data sets, taken 2 hours apart, our measurements suggest two different rotational periods: 0.0440 ± 0.0006 h and 0.0293 ± 0.0002 h.

Small (H = 28.44) minor planet 2020 UA, discovered on 16 October 2020 at G96 Mt. Lemmon Survey, had an extremely close approach on 21 October, 02 UT, at 0.000297 AU (44.498 km). It was shown (Thirouin et al., 2016; Kwiatkowski et al., 2010) that very small asteroids usually have elongated shapes (i.e., large brightness variations), very fast rotations and tumbling states, which made 2020 UA an interesting object to observe, with unknown rotational parameters.

As small minor planets in the vicinity of Earth are rarely observable, and because the observing circumstances were favorable, we undertook the observation of the object, with the goal of determining the rotational period and other characteristics regarding the rotation.

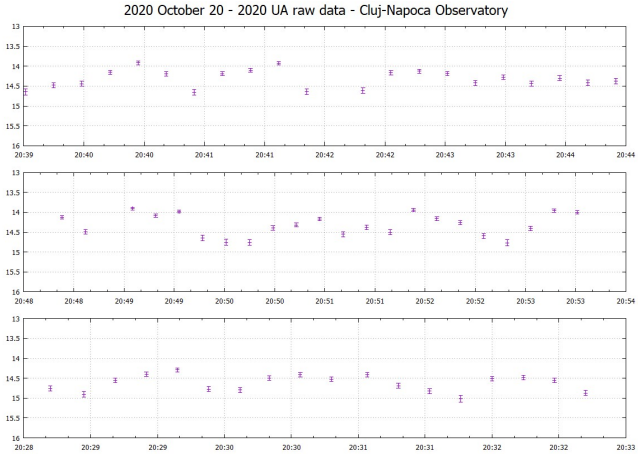
Observations were made from Cluj-Napoca and Berthelot Observatory (IAU MPC L54 code), branches of The Astronomical Institute of the Romanian Academy. Cluj-Napoca Feleacu Observatory operated a Plane Wave CDK24, f/6.5 telescope equipped with the SBIG STL-6303 CCD Camera (23.9×15.9 arcmin field of view) operating at bin 2×2. Berthelot Observatory operated the OGS RC 14.5, f/8 telescope equipped with a SBIG STL-11000M CCD Camera (44×30 arcmin of field of view), operating in binning 2×2.

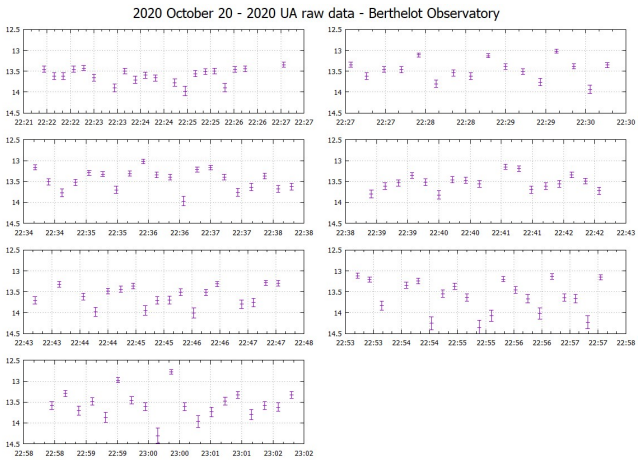
We observed the asteroid on the night of 20/21 Oct. 2020, for 30 minutes, starting with 20:30 UT, from Cluj, and for 36 minutes starting at 22:24 UT, from Berthelot. The exposure time was 2 sec for Berthelot. The exposure time of 5 sec was used by Cluj Observatory, which recorded the asteroid as a trail. Observing circumstances are presented in Table 1.

The raw images were calibrated with bias, flats, and darks using the standard procedures of *Maxim DL* (2016) software. Data processing and period analysis were made using *MPO Canopus* software (Warner, 2015). Differential photometric measurements were performed using the Comp Star Selector (CSS) procedure in *MPO Canopus*, which allowed selecting three reference stars with a near solar color. The comp star magnitudes were taken from the CMC-15 catalog (*http://svo2.cab.inta-csic.es/vocats/cmc15/)*.

The sky motion of 2020 UA during the observations spans the interval between 203 arcsec/min and 563 arcsec/min. Thus, during the observations the asteroid crossed several CCD fields. We organized the images and performed photometry in each field, were we identified the solar type reference stars, being able to combine the photometric measurements. Elliptical apertures were used to measure the brightness of the asteroid and circular ones for reference stars.

In every set of observations, the asteroid presented brightness variations of over 1 magnitude, as can be seen below, in the raw data plots made with data from both observatories.

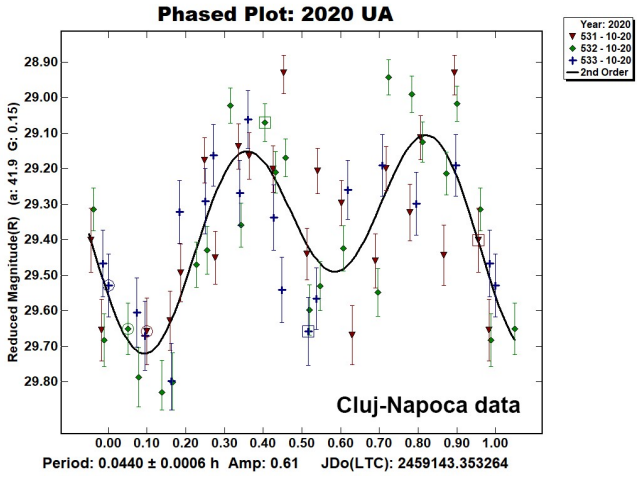




Number	Name	yyyy mm/dd	Phase	L_{PAB}	B_{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
	2020 UA - Cluj-Napoca	2020 10/20	33	43.5	-4.9	0.0440	0.0006	0.61	0.2	ATEN
	2020 UA - Berthelot	2020 10/20	42	47.9	-4.0	0.0293	0.0002	0.47	0.15	ATEN

Table I. Observing circumstances and results for Cluj-Napoca Feleacu Observatory (first line) and Berthelot Observatory (second line). 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 (see Harris et al., 1984). Grp is the asteroid family/group (Warner et al., 2009).

We used the period finding tool included in MPO Canopus, in order to find the rotational period of the asteroid. We found that the s form Berthelot and Cluj-Napoca could not be fitted with the same period, although we could find a common period for sessions from the same observatory. For Berthelot we found a period of 0.0293 ± 0.0002 h with an amplitude of the Fourier fit of 0.47 mag. We mention that the real amplitude is variable from one cycle of rotation to another. For Cluj-Napoca data we found a rotational period of 0.0440 ± 0.0006 h with an amplitude of 0.61 mag. We noticed that for Cluj-Napoca data another solution of 0.022 hours is available, but for a monomodal lightcurve, and the result was discarded.



The discrepancy between the two periods found is 0.0147 hours, over 66% of the shortest period found. Although our data show a decrease in the rotational period, we need to verify if the change is real, which if correct, indicates a tumbling asteroid.

The lightcurve amplitude roughly of half magnitude suggest an elongated body. Also, for such a short period lightcurve internal strength is necessary and usually interpreted as a monolithic object.

Cluj-Napoca data were taken two hours earlier than Berthelot's, a time period during which the asteroid made 45 rotations (computed using the period 0.044 h). We can verify if the period found at Cluj-Napoca can be used to fit the data from Berthelot by propagating a calculated period and its associated error to the time of the second observation (Berthelot), using Eq. 3 in (Kwiatkowski, T., 2010), where the parameter ΔN, computed using the found period, it's error and the time difference between observations must be lower than 0.25 for a match between lightcurves. For our data we found that ΔN = 0.0012, which means that the period of 0.044 h could be a good match for data taken 2 hours later. This period enforced on Berthelot data showed no meaningful result, and therefore we conclude that a change in the rotational period is possible.

We also checked for a secondary period, using Dual Period tool in MPO Canopus, but we could not find a significant result. But, when taking in consideration the shape and the variable amplitude of the light curve, we could not exclude a tumbling solution for this asteroid. search of the Asteroid Lightcurve Database did not find any previously reported results for asteroid.

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