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Arecibo Radar Characterization of 138971 (2001 CB21), a Flyby Target for the DART Spacecraft

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ABSTRACT

138971 (2001 CB21), hereafter CB21, is an Apollo asteroid that makes frequent close approaches to both Venus and Earth. CB21 was recently selected as the target for a March 2022 flyby by the proposed DART spacecraft, while DART is en route to the asteroid 65803 Didymos.

On 2006 October 2, CB21 was 0.048 au from Earth and we observed it using the Arecibo Observatory planetary radar. We obtained continuous-wave radar echo spectra and delay-Doppler radar images with range resolution of 75 m/pixel.

CB21's radar echo bandwidth was 3.3 ± 0.6 Hz. The radar echoes had a range extent of 4 pixels or 300 m. This does not allow detailed shape modeling, but does allow us to estimate CB21's average diameter as twice the range extent; 600 ± 150 m. This is consistent with size estimates based on thermal radiometry (Mueller et al. 2011). Two possible rotation periods for CB21 have been reported from lightcurve observations: 3.302 hours and 4.953 hours (Galad 2005). For both candidate spin periods the echo bandwidth and visible range extent together indicate that Arecibo was not viewing CB21 from a high subradar latitude.

There was no significant variation in radar echo bandwidth or range extent over 2 hours of radar imaging, corresponding to either 60% or 40% of a rotational period. Accordingly, CB21 is at most modestly elongated (elongation < 1.3).

No satellites appear in the CB21 Arecibo radar data. We set an upper size limit of 75 m on any undetected satellites, assuming a minimum satellite rotation period of 2 hours.

CB21's spectral class is unknown. Its radar polarization ratio, $SC/OC = 0.20 \pm 0.02$, is consistent with a wide range of potential surface compositions but not with the E or V spectral classes (Benner et al. 2008).

Radar observations of CB21 will next be possible in 2022 February – March, using both Arecibo and the Goldstone Solar System Radar. Radar image resolution will be as fine as 15 m. The current best-fit to CB21's trajectory has 3-sigma position uncertainty of ± 500 km in 2022 March. Additional radar astrometry would decrease the trajectory uncertainties to roughly ± 10 km prior to DART's flyby.