EPSC Abstracts
Vol. 13, EPSC-DPS2019-554-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Radar observations of near-Earth asteroid 2003 SD220

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Abstract

We report radar observations of near-Earth Asteroid 2003 SD220 by the 32-m radio telescopes in Zelenchukskaya and Svetloe Observatories during its close approach to the Earth in December 2018. We obtained continuous wave echo power spectra in December 20 and 22 when Goldstone conducted international bistatic radar observations of 2003 SD220 with the 64-m Sardinia Radio Telescope. We revealed that the asteroid is elongated with a length of at least 2.7 km. Our estimates of the circular polarization ratio is 0.25 and radar albedo is 0.17 suggests S-class NEA.

1. Introduction

Asteroid 2003 SD220 was discovered on September 29, 2003 by the Lowell Observatory Near-Earth-Object Search (LONEOS) at Anderson Mesa Station. This Aten class near-Earth asteroid (NEA) is classified as a "Potentially Hazardous Asteroids" by the Minor Planet Center. Photometry reported by B. Warner [1] indicates a slow rotation period of 285 $\pm$ 5 h and a lightcurve amplitude of about 2 magnitudes, suggesting that this object is very elongated. 2003 SD220 was observed with radar at Goldstone and Arecibo in 2015. Radar images data revealed that this object is elongated with a long axis exceeding 2 km and extremely slow rotation period that is consistent with expectations from the lightcurves. Using visible and near-infrared observations D. Perna et al. [2] classified 2003 SD220 as an Sr-type asteroid in the Bus-DeMeo taxonomic system.

On December 22, 2018 this asteroid made a much closer approach to Earth within 0.0189 au (7.4 lunar distances) which was the closest encounter since its discovery. We had the opportunity to join the international bistatic radar observations of 2003 SD220 during December 20 and 22 in cooperation with the Goldstone planetary radar. Here we present radar observations of 2003 SD220 and a physical parameters derived from radar data.

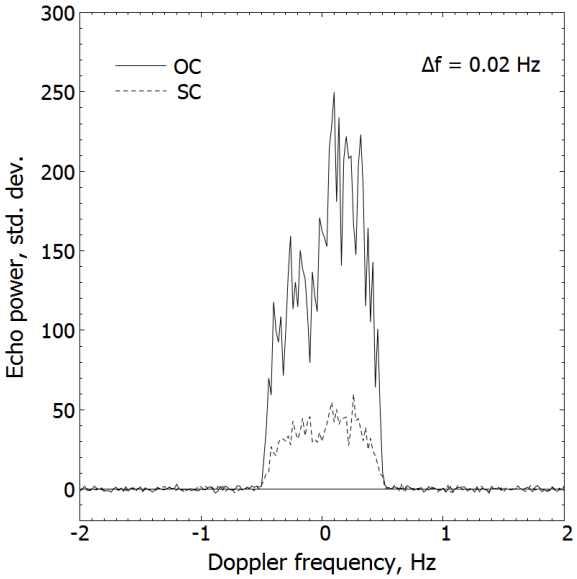

Figure 1: Continuous wave echo power spectra of 2003 SD220 obtained at Zelenchukskaya Observatory on December 20, 2018 from 13:10 to 13:35 UT.

2. Radar Observations

International bistatic radar observations of 2003 SD220 were conducted from December 17 to December 22, 2018 using Goldstone 70-m radar (DSS-14) to transmit and 64-m Sardinia Radio Telescope (SRT) to receive the echoes. DSS-14 transmitted 144 kW circular polarized continuous wave (CW) signal at 8560 MHz (3.5 cm) to the asteroid. Doppler shifts were compensated on the uplink such that SRT received the echo reflected back from the target at a fixed frequency of 8560 MHz.

We eavesdropped the echoes from 2003 SD220 using 32-m radio telescopes (RT-32) in Zelenchukskaya Observatory on December 20, 2018 from 13:10 to 13:35 UT and in Svetloe Observatory on December 22 from 14:40 to 14:50 UT. Echoes were recorded simultaneously in the same (SC) and opposite (OC) senses of circular polarizations as the transmission [3]. Tak-

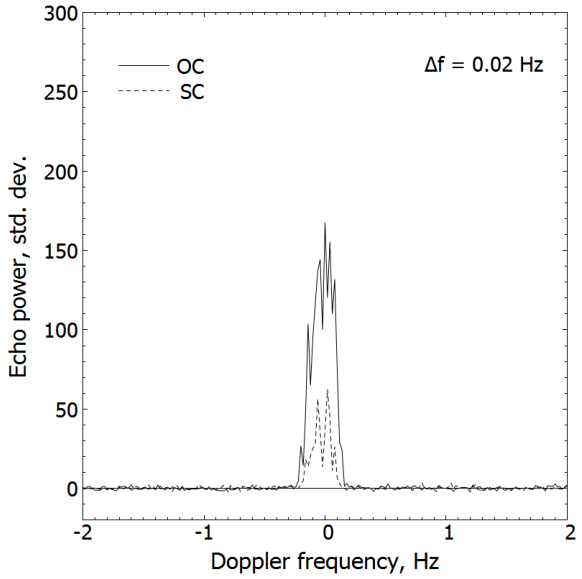

Figure 2: Continuous wave echo power spectra of 2003 SD220 obtained at Svetloe Observatory on December 22 from 14:40 to 14:50 UT.

ing into account the Doppler frequency as a function of time we applied the Fourier transform to the echo time series. As a result we obtained CW echo power spectra for both observation sessions with 0.02 Hz frequency resolution. In Fig. 1 and 2 you may see CW echo power spectra of 2003 SD220 obtained at Zelenchukskaya and Svetloe Observatories. Echo power is plotted in standard deviations of the noise versus Doppler frequency. Zero frequency in the figures corresponds to the frequency calculated for the asteroid's center of mass. Solid and dashed lines denote echo power in the OC and SC polarizations respectively.

3. Results

From the obtained spectra, we estimated the Doppler broadening or the spectra bandwidth of 0.95 Hz on December 20 and 0.39 Hz on December 22. Then taking into account the rotation period of 285 h we revealed the asteroid's equatorial breadth varies from about 2700 m to 1100 m during the observation interval.

By integrating the OC and SC spectra we obtained the radar cross sections. Radar albedo is equal to radar cross section divided by geometric cross section and indicates the radar reflectivity of the surface compared to a perfect metal sphere. We obtained the OC radar albedo of 0.17 for the both spectra.

The ratio of the integrated SC and OC signal is a measure of near-surface wavelength-scale roughness. We estimated the circular polarization ratio of 0.22 and 0.25 for Zelenchukskaya and Svetloe correspondingly, suggests S-class NEA [4], which is consistent with the results reported by E. G. Rivera-Valentin [5]

Acknowledgements

We thank L. A. Benner, S. Naidu, M. Brozovic and the technical staff at Goldstone for the help with the radar observations. This work was supported by the Russian Scientific Foundation grant No. 16-12-00071.

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