RADAR AND LIGHTCURVE OBSERVATIONS OF BINARY NEAR-EARTH ASTEROID 2018 EB. Marina Brozovic[1], Lance A. M. Benner[1], Shantanu P. Naidu[1], Randall S. Hughes[1], Jon D. Giorgini[1], Brian D. Warner[2], Anne K. Virkki[3,4], Sean E. Marshall[3,4], Patrick A. Taylor[5], Edgard G. Rivera-Valentin[5], Timothy A. Lister[6], Joseph P. Chatelain[6], Joseph T. Pollock[7], Michael W. Busch[8]. [1]Jet Propulsion Laboratory/California Institute of Technology, 4800 Oak Grove Dr., MS 301-120, 91109 Pasadena, CA, marina.brozovic@jpl.nasa.gov. [2]Center for Solar System Studies (CS3), Landers, CA, [3]Arecibo Observatory, Arecibo, PR, [4]University of Central Florida, Orlando, FL, [5]Lunar and Planetary Institute, Houston, TX, [6]Las Cumbres Observatory, Santa Barbara, CA, [7]Appalachian State University, Boone, NC, [8]SETI Institute, Mountain View, CA.

Introduction: Near-Earth asteroid 2018 EB was discovered on 2018 March 1 by the NEOWISE spacecraft. This object has an absolute magnitude of H=21.8, and given the preliminary diameter estimate of ~240 m based on thermal observations (J. Masiero personal comm.), this implies an optical albedo of ~7%. The orbit of 2018 EB has ascending and descending nodes that are very close to 1 au, an eccentricity of 1.2%, and an orbital period that is close to one year. As a result, every few decades this object makes two close approaches to Earth annually in April and October. In 2018, this asteroid approached Earth within 0.027 au on April 4 and within 0.039 au on October 7. Radar observations occurred on April 7 and October 5-9 at Goldstone and on October 5-7 at Arecibo. Lightcurves observations were conducted at three sites: Cerro Tololo Inter-American Observatory in Chile on April 5, Center for Solar System Studies in the USA on April 8 and 9, and Las Cumbres Observatory site in Chile on October 18.

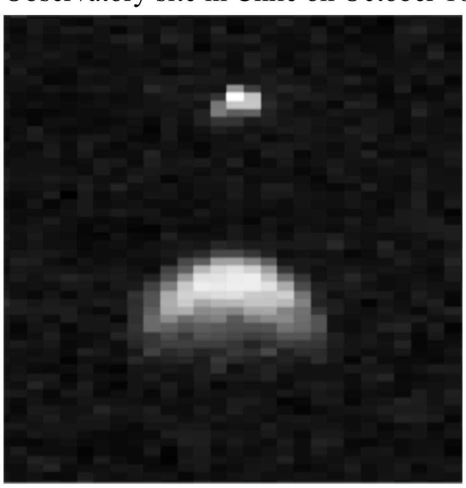

Figure 1. Sum of Arecibo radar delay-Doppler images of 2018 EB obtained on October 6 between 08:23–10:53 UTC. The distance from the radar increases toward bottom and Doppler frequency increases to the right. Image resolution is 15 m/pixel×0.2 Hz. The echo is slightly smeared in time-delay due to an uncompensated ephemeris correction.

Results: Goldstone imaging data from April 7 revealed that 2018 EB is a binary system but the ~45 minutes interval of images is insufficient to estimate the orbital parameters, mass, and bulk density. Radar observations in October were much more extensive and achieved significantly stronger signal-to-noise ratios (SNRs) at Arecibo and a resolution as fine as 15 m/pixel. The October observations (Figure 1) provide good orbital coverage for the satellite and thorough rotational coverage for the primary. Inspection of the images indicates that the size of the primary is consistent with the diameter estimated from NEOWISE data. The diameter of the moon is a few tens of meters in size and is among the smallest satellites discovered around any binary NEA. The maximum separation observed between the satellite and the primary was ~450 m. We do not yet have an estimate of the orbital period yet, but we suspect that it is at least 10 hours.

Lightcurves obtained by one of us (B. D. Warner) indicate that 2018 EB has a period in the realm of ~3 h and an amplitude of ~0.26 mag, Asteroid Lightcurve Database (LCDB), http://www.minorplanet.info/lightcurvedatabase.html [1]. The estimated period is consistent with a zeroth-order period derived from radar bandwidths and the nominal size. Lightcurves obtained from the southern hemisphere did not show any obvious amplitude change suggesting that the viewing geometry was close to pole-on.

We estimate a radar cross section of ~0.021–0.027 km^2 that, for a 240 m diameter, results in a very bright radar albedo of ~0.47–0.60. 2018 EB is at the high end of the observed radar albedo values for near-Earth and main-belt asteroids, and hints at a metallic composition.

Conclusions: More than 20,000 NEAs have been discovered to date, but only two that have been observed with radar, are known to be metallic: (6178) 1986 DA [2] and (29075) 1950 DA [3]. Finding another such object would be extremely important, and the fact that this could be the first metallic binary in the NEA population is an incredibly exciting possibility. Modeling is in progress to estimate the pole, rotation period and shape of the primary, orbital parameters and system mass. The bulk density will provide critical insight into the internal structure, composition, and origin.

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