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ARECIBO RADAR OBSERVATIONS OF POTENTIALLY HAZARDOUS ASTEROIDS

Patrick A. Taylor[(1)], Anne K. Virkki[(2)], Edgard G. Rivera-Valentín[(3)], Flaviane C. F. Venditti[(4)], Sriram S. Bhiravarasu[(5)], Sean E. Marshall[(6)], Luisa F. Zambrano-Marin[(7)], and Betzaida Aponte-Hernandez[(8)]
[(1)(3)(5)(8)]*Lunar and Planetary Institute, Universities Space Research Association, 3600 Bay Area Blvd., Houston, TX 77058, ptaylor@usra.edu*
[(2)(4)(6)(7)]*Arecibo Observatory, University of Central Florida, HC 3 Box 53995, Arecibo, PR 00612*

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ABSTRACT

The unmatched sensitivity of the planetary radar system at Arecibo Observatory in Puerto Rico allows for powerful post-discovery orbit refinement and physical characterization of near-Earth asteroids that is surpassed only by spacecraft flybys. At Arecibo, observational emphasis is placed on objects deemed potentially hazardous to Earth. Since the Planetary Defense Conference held in Tokyo, Japan in May 2017, Arecibo has observed more than 30 potentially hazardous asteroids. We will present highlights of those recent radar observations and place them in the context of planetary defense and impact mitigation. Highlights will include asteroids (3122) Florence, (3200) Phaethon, (66391) 1999 KW4, and 2017 YE5. Any interesting results from after the time of this writing, such as the close flyby of (163899) 2003 SD220 in December, will also be included.

Radar observations of (3122) Florence revealed it to be a triple-asteroid system, only the third such system known among the near-Earth asteroid population. All three have been characterized with the Arecibo planetary radar system. The two satellites are less than one-tenth the size of the primary body, too small to be detected by any other ground-based technique, and would present additional challenges to any impact mitigation scenario.

Radar observations revealed, for the first time, the true size of (3200) Phaethon. At more than 6 km in diameter at the equator, Phaethon is much larger than previously estimated. The shape of Phaethon is likely similar to (101955) Bennu, target of the OSIRIS-REx mission, despite a volume difference of three orders of magnitude. Arecibo radar observations will be invaluable for planning the proposed flyby of Phaethon by JAXA's DESTINY^{+} spacecraft.

Binary asteroid (66391) 1999 KW4 has been considered the prototypical binary near-Earth asteroid since its discovery in 2001. Until NASA's DART spacecraft reaches (65803) Didymos, 1999 KW4 will likely be the best-studied binary near-Earth asteroid. Multiple detections with radar since 2001 may yield a Yarkovsky detection, which can provide an independent mass estimate for the system.

Radar observations of 2017 YE5 (Fig. 1) revealed it to be an equal-mass binary asteroid, where two objects of similar size are in orbit about their mutual center of mass. 2017 YE5 is only the fourth such system known among the near-Earth asteroid population and all four have been characterized with the Arecibo planetary radar system. Though relatively rare, an equal-mass binary would present a difficult impact mitigation task. In the case of 2017 YE5, optical observations did not show evidence of a binary system until more than a month after radar established its unique properties.

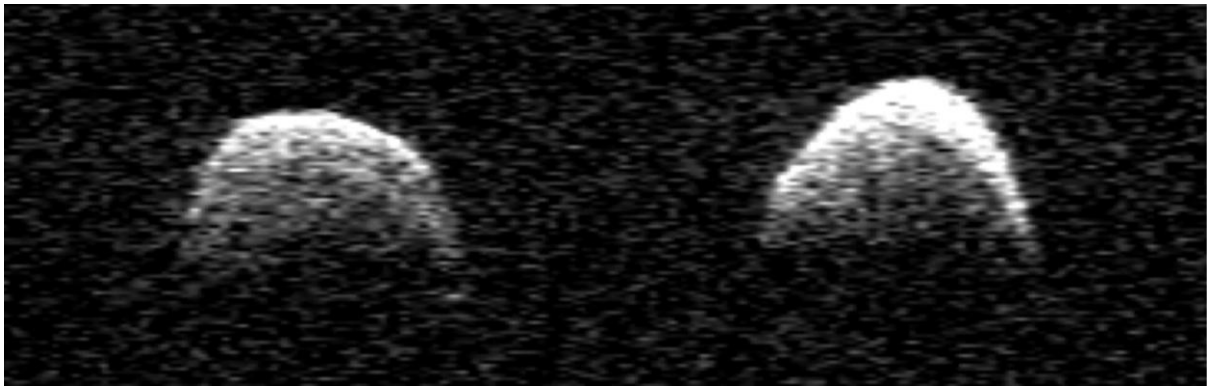

Figure 1. Radar showed 2017 YE5 is actually two objects of similar size in mutual orbit. Resolution of the image is 7.5 meters per pixel vertically and 0.01 Hz per pixel horizontally. This particular observation involved Arecibo transmitting the signal and the Green Bank Telescope receiving the echo to improve the frequency resolution.

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