ARECIBO OBSERVATORY: SUPPORTING SOLAR SYSTEM EXPLORATION. F.C.F. Venditti[1], A. K. Virkki[2], N. Pinilla-Alonso[3], Y. Fernandez[4], S. Marshall[5], P.A. Taylor[6], E.G. Rivera-Valentín[7], S.S. Bhiravarasu[8], L.F. Zambrano-Marin[9], B. Aponte-Hernandez[10], [1,2,5,9]Arecibo Observatory, Arecibo, PR, [1,2,3,4,5,9] University of Central Florida, Orlando, FL, USA, [6,7,8,10]Lunar and Planetary Institute, Houston, TX, USA. (venditti@naic.edu)

We present how the Arecibo Observatory (AO) is a key facility to help in the exploration of near-Earth asteroids (NEAs), and in particular the resource-rich NEAs, the Moon and other small bodies in our vicinity.

Since April 2018, UCF manages AO for the National Science Foundation. Historically, the 2.38 GHz planetary radar system at the Arecibo, in Puerto Rico, has been offering unique contributions to the investigation of physical and dynamical properties of near-Earth objects (NEOs) and the exploration of the near-surface properties of the Moon. Every year more than 100 NEOs are observed with the 305-meter William E. Gordon radio telescope, including potentially hazardous asteroids (PHAs), which are priority of the NASA funded NEO planetary radar observation program at Arecibo. Planetary radar, especially when paired with additional VNIR observations, offers unparalleled imaging capabilities that can directly reveal the shape, surface concavities, spin, and asteroid satellites. Furthermore, radar data can reveal asteroid and lunar regolith's physical properties at rubble size scales (cm, dm, and m) that is particularly crucial, since we know that such rubble is abundant on many atmosphereless bodies. Radar characterization also supports small bodies exploration missions, frequently selecting targets that can be observed with radar prior to the mission. An example is the upcoming NASA's asteroid deflection mission DART [2] to the binary system Didymos (Fig. 1), and also JAXA's Destiny+, to asteroid Phaethon [3] (Fig. 2), linked to the Geminid meteor shower.

Although NEAs are the prioritized targets of the Arecibo's planetary radar program, it also supports observations of the Moon and planets. Arecibo has collaborated with NASA's Lunar Reconnaissance Orbiter (LRO) mission since 2012 to analyze radar scattering properties of the permanently shadowed regions near lunar poles, to contribute in the search for water ice, and to study the geology and evolution of the lunar surface [4]. Due to a malfunction in the Miniature Radio Frequency (Mini-RF) transmitter aboard LRO in 2010, the Mini-RF was no longer able to transmit, but relies on the Arecibo's S-band transmitter. The long wavelength of the radar signal (12.6 cm) allows to penetrate several decimeters into the lunar surface, revealing information that is invisible to shorter wavelengths.

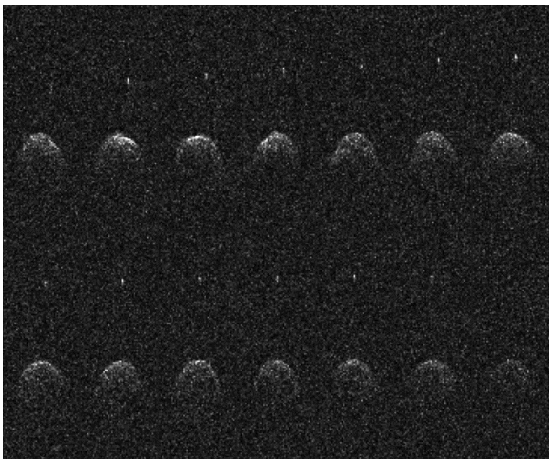

Figure 1: Arecibo radar images of the near-Earth asteroid (65803) Didymos and its satellite, taken on 23, 24 and 26 November 2003.

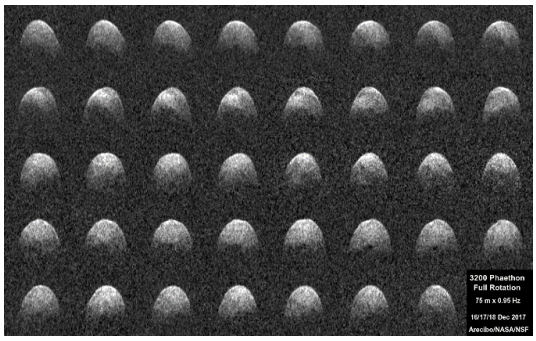

Figure 2: Arecibo radar images from 16-18 December 2017 showing the full rotation of asteroid 3200 Phaethon.

[1] Naidu, S. P. *et al*., 2016, The Astrophysical Journal, 152 - 99.
[2] Cheng, A.F *et al*., 2018, Planetary and Space Science, 157: 104-115.
[3] Taylor, Patrick. A., *et al*., 2019, Planetary and Space Science, (2019): 1-8.
[4] Patterson, G. W., *et al*., 2017, Icarus, 283: 2-19.