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FAST ROTATING NEAR EARTH ASTEROIDS OBSERVED WITH THE ARECIBO PLANETARY RADAR SYSTEM

Abstract

Selection of mitigation response techniques for the case of an asteroid impact, depends primarily on the timeline available from discovery to event, and secondarily on the asteroid composition and structure. Using planetary radar systems is an unsurpassed ground-based technique for obtaining some of the basic physical and dynamical properties of these objects. The Arecibo Observatory planetary radar system (S-band, 2380 MHz, 12.6 cm) observed over 1000 near Earth Asteroids through its 44 yrs of history. It's transmitter power reached up to 1 MW (50% efficiency), during its peak performance time. Of interest to this work are the Fast Rotating Asteroids (FRAs) observed at Arecibo; FRAs are considered to be small bodies having a rotation period (P) which is above the spin barrier, starting at diameters (D) of less than 300 m. We selected Arecibo radar observed targets with $P < 0.13$ hr (8 min), $N = 20$. Some key measurements and calculations obtained from radar observations include: the rotation period, the circular polarization ratio, the radar albedo, astrometry corrections, and with enough signal-to-noise: delay-Doppler imaging of the object. Taking advantage of the radar derived rotation periods and diameters available, we compared these rotation periods with values from the Light Curve DataBase, finding a few cases where these two differ by several orders of magnitude. In such instances we place the radar derived period as the preferred value; the apparent rotation period indicated by the bandwidth can appear slower than the object's true rotation, but not faster, providing a limit to the true rotation period. Asteroid cohesion is dependent on rotation, composition and structure; we performed calculations for the cohesion (k) via the Drucker-Prager Cohesion criterion. Preliminary results place most of these objects needing a few to a few-hundred Pascals for k; however three cases stand out: 2014 TV, 2015 RF_{36} and 2017 EK, needing a k, of 4.2, 4.4 and 10.2 kPa respectively. In comparison, Earth mineral aggregates are 1 - 100 kPa for fractured rocks and up to a few MPa for crystalline rocks. A few are seen to be much larger than those calculated for some other near-Earth objects, but close to those measured on some areas of the lunar surface ($\sim$ 5 kPa). The loss of this instrument, in a time where we have an continuously growing amount of discovered objects to categorize, puts the planetary defense community at a great disadvantage in successfully mitigating a collision event.