Arecibo Radar and Multi-Wavelength Collaborations on Near-Earth Asteroids

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Arecibo radar observations of near-Earth asteroids are critical for identifying Earth impact hazards and detailed post-discovery physical characterization in terms of size, shape, spin, and surface-property (reflectivity, polarization, geologic features and sometimes composition and density) information. In fact, radar investigations are roughly equivalent, in terms of science content, to a spacecraft flyby, but cost orders of magnitude less and can study orders of magnitude more objects.

For objects known well in advance, we publish our target lists on our public webpage: www.naic.edu/~pradar to facilitate collaboration, most often with optical (lightcurve) and infrared observers, and to request optical recovery of objects with uncertain astrometry. Radar is a power detection technique, but is not an efficient means of discovering asteroids. As such, we rely on optical surveys to discover new near-Earth asteroids and reduce the optical plane-of-sky pointing uncertainties to the order of the Arecibo radar beam size of ~2 arcminutes. Roughly half of our radar detections are observed on their discovery apparition as part of our regularly scheduled survey nights: 8-hour blocks of telescope time reserved near new moon when optical surveys are most efficient, as targets of opportunity during other previously scheduled observations, or via urgent requests at the discretion of the observatory director. These new, often small, discoveries are typically detectable by Arecibo for only a few days after discovery announcement, when they make a close flyby of Earth, because of their inherent faintness, the fourth-power dependence of radar signal on distance, and the limited declination range of the telescope.

I will discuss recent radar observations of near-Earth asteroids with Arecibo and our companion radio telescopes: Goldstone, Green Bank, and the Very Long Baseline Array, as well as examples of multi-wavelength collaborations, e.g., optical lightcurves and visual and infrared spectroscopy, often on short timescales. One recent example, asteroid 2015 TC25, was discovered by the Catalina Sky Survey on 11 October 2015, was observed by Magdalena Ridge Observatory, the Discovery Channel Telescope at Lowell Observatory, and the NASA Infrared Telescope Facility on 12 October, and observed by Arecibo on 17 and 18 October (Reddy et al., in press). Together the observations suggest 2015 TC25 is a relatively rare E-type asteroid only about 2 meters in diameter and rotates once every 2 minutes. As with many of these small bodies, its discovery apparition was the best opportunity to characterize this object, as it will not make a comparable close approach to Earth in the foreseeable future. This underscores the need for discovery, reporting, and follow-up by observational assets at multiple wavelengths on timescales of hours to days to physically characterize Earth’s nearest neighbors that are both impact hazards and possible mission targets for science or for natural-resource extraction.