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Physical Characterization Studies of Potentially Hazardous Near-Earth Objects

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ABSTRACT

The next step after the initial discovery of a Near-Earth Object (NEO) is to have researchers at a follow-up telescope facility obtain additional astrometric data to accurately define its orbit parameters. An NEO is designated as “potentially hazardous” when its orbit comes to within 0.05 AU of the Earth's orbit. Physical characterization studies of Near-Earth Objects (NEOs) that are cataloged as PHOs are very beneficial to any mitigation plan that might be devised if the risk of impact is high. After a well-defined orbit has been determined for a PHO, other physical parameters such as size, rotation rate, and composition are important. For the smallest potentially hazardous objects (PHOs) being discovered, observational efforts must commence at or near the time of discovery to ensure favorable parameters for data collection. Otherwise, subsequent optimal apparitions for an asteroid or comet may be decades away.

Researchers at the Magdalena Ridge Observatory (MRO) 2.4-meter telescope facility are well positioned to acquire real-time characterization data on PHOs since their ongoing NEO follow-up and characterization program collects data monthly throughout the year on the smallest, close-approaching NEOs being discovered. Over the past 4 years that this program has been in operation, spin rates for over 50 Near-Earth asteroids have been obtained, several of which are the fastest rotators in the Solar System. The rotation rate of an object can imply important information about its internal composition and degree of fracture, and thereby its collisional history. In particular, objects with sub-hour rotation periods are likely to have a non-negligible tensile strength. Knowing the material strength of a PHO has a direct bearing on any threat reduction plan.

Size is also an important parameter when assessing the threat from potential Earth impactors. Albedos are known for only a small fraction of the NEO population, leading to size estimates that can be uncertain by up to a factor of ~2. However, the albedo scatter within a particular taxonomic class is significantly smaller. Therefore, placing constraints on the taxonomic classifications of NEOs will lead to more accurate estimates of the NEA size distribution. Spectrophotometric and spectroscopic data can be acquired very readily to constrain albedo, resulting in lower uncertainties in the inferred diameters of discovered objects.

Combining optical measurements of PHOs with radar observations significantly enhances characterization efforts and allows precise orbit determinations. Further, radar is the only ground-based technique capable of spatially resolving surface features of near-Earth objects, directly providing shape, spin, and size data that complement any optically-derived physical information. However, radar shape and spin rate modeling is most effective in combination with optical lightcurve observations: radar imaging provides spatial resolution and the lightcurves provide a more accurate measurement of the asteroid's spin rate.

We will present new data obtained via photometric and spectroscopic techniques on the physical properties of several Earth-approaching asteroids that are potentially hazardous. We will discuss collaborative efforts with researchers using radar to characterize prospective targets, and outline the synergy and increased science return of such an endeavor. In addition, we will present characterization results (i.e., rotation rate) for OSIRIS-REx target and potentially hazardous asteroid 1999 RQ36. These data were collected during the 2011-2012 apparition of the asteroid, which was the last opportunity for ground-based studies before the spacecraft is launched.