

The Mission Accessible Near-Earth Objects Survey (MANOS): characterizing small NEOs

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The Mission Accessible Near-Earth Object Survey (MANOS) is an ongoing physical characterization survey to build a comprehensive catalog of physical properties. We will use this catalog to investigate the global properties of the small NEO population and identify individual objects that can be targets of interest for future exploration. MANOS began in 2013 as a physical characterization survey of newly discovered, sub-km, spacecraft accessible NEOs. We are building a large, uniform catalog of astrometry, photometry, and spectroscopy through queue, remote, and target of opportunity observations. Prior to MANOS, the state of knowledge of NEOs was limited to the largest, kilometer-scale objects.

OBSERVATIONS

MANOS uses a wide variety of telescopes (1-8m) in both the northern and southern hemispheres. We focus on targets that have been recently discovered and operate on a regular cadence of queue, remote, target of opportunity observations to enable rapid characterization of small NEOs. Targets for MANOS are selected based on three criteria: mission accessibility ($\Delta v < 7$ km/s), size ($H > 20$, $D \sim < 500$ m), and observability ($V < 22$ mag). With our resources, we observe 5-10 newly discovered sub-kilometer NEOs per month. The first generation of MANOS has observed ~600 objects since August 2013.

PHOTOMETRY

Photometric observations were obtained using Goodman on the Southern Astrophysical Research (SOAR) 4m telescope, the Large Monolithic Imager (LMI) on Lowell Observatory's 4.3m Discovery Channel Telescope (DCT), MOSAIC on the Kitt Peak Mayall 4m, and ANDICAM on the CTIO 1.3m. Initial results from our photometry observations are discussed in Thirouin et al. [1]. Among these are ultra-fast rotating asteroids with $20 > P < 10$ seconds that can set limits on asteroids cohesion and strength.

So far, MANOS has found 14 sub-km NEOs that are the most suitable candidates for future robotic or human exploration. If we assume that the MANOS results are representative of the sub-km NEO population then we estimate that 10,000 to 1,000,000 NEOs with diameters between 10m and 1km are expected to be viable mission targets.

SPECTROSCOPY

Visible wavelength spectra are obtained using DeVeney on Lowell Observatory's Discovery Channel Telescope (DCT), Goodman on the Southern Astrophysical Research (SOAR) telescope, and GMOS on 8m Gemini North and South. Over 300 NEO spectra have been obtained during our program.

An apparent compositional discrepancy exists between large (> 1 km) NEOs and the meteorite population [2]. We expected the small NEOs observed by MANOS to be direct precursors to the meteorite fall population and bridge the compositional divide previously observed. However, initial results suggest that small NEOs show a larger discrepancy with the meteorite population than their larger brethren [3].

REFERENCES

- [1] Thirouin A. et al. (2016) *AJ*, 152, 163.
- [2] Stuart & Binzel (2004) *Icarus*, 170, 295-311.
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