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ExploreNEOs: The Warm Spitzer Near Earth Object survey

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Abstract

We are carrying out the ExploreNEOs project in which we observe more than 600 near Earth Objects (NEOs) at 3.6 and 4.5 microns with Warm Spitzer. For each NEO we derive diameter and albedo. We present our results to date, which include studies of individual objects, results for our entire observed sample, and, by extrapolation, results for the entire NEO population. We also present several avenues of future work.

1. Introduction

Near Earth Objects (NEOs) are the Earth's nearest neighbors in the Universe. NEOs have short dynamical lifetimes, which indicates a constant replenishing of material from elsewhere in the Solar System. By studying the physical properties of NEOs, we are studying small body populations throughout the Solar System as well as the processes by which material migrates dynamically to near-Earth space. We are also helping to quantify and constrain the risks present from NEO impacts.

We are carrying out the ExploreNEOs program, a 500 hour Warm Spitzer Cycle 6 "Exploration Science" project. We are observing 600+ NEOs at 3.6 and 4.5 microns. For each object we derive albedo and diameter using the Near Earth Asteroid Thermal Model [3]. As of May, 2011, around 500 NEOs in our program have been observed and modeled. Here we present some results to date and describe some avenues of future work.

2. Results

The ExploreNEOs program is described in detail in [9]. Our latest data release is presented in [10]. We show albedo and diameter for the 500 NEOs observed to date in our program in Figure 1.

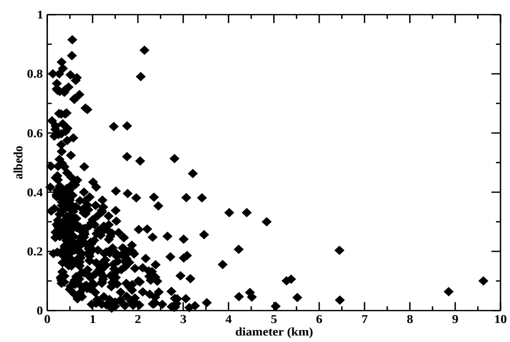

Figure 1: Diameter and albedo for the 500 NEOs observed in our sample to date (May, 2011). More than half of our objects are smaller than 1 km, with the smallest object having a diameter around 70 meters.

In [4] we showed that our uncertainties on model-derived albedo and diameter are nominally 50% and 25%, respectively, though in some cases these uncertainties can be quite a bit smaller. In [6] we presented albedos for 65-low delta-V NEOs — potential spacecraft targets — and identified those that, by low albedo and low historical temperatures, are most likely to be primitive bodies.

In [5] we calculated the density for binary asteroid (85938) 1999 DJ4, and presented general methods for estimating bulk densities for other binary asteroids observed with Warm Spitzer or other platforms. In [7] we calculated the mean albedos for six taxonomic types (C, D, Q, S, V, X) present within our sample.

In [10] we present a preliminary debiased size distribution for the entire NEO population. This size distribution is derived from directly measured diameters, not conversions from (poorly measured) H magnitudes.

3. Future work

We are working on a number of other projects with ExploreNEOs data. (1) We are investigating the mean albedo of low Tisserand objects to constrain the fraction of NEOs that may be dead comets. (2) We are measuring the mean albedos for objects from various source regions elsewhere in the Solar System (3:1 resonance, ν_6 resonance, outer Solar System, etc.) as a tracer of compositional and dynamical mixing in the Solar System. (3) A number of targets have been or will be observed multiple times. From some of these observations—those that span a wide range of phase angles—we will check assumptions made in the thermal modeling. From others of these observations—those in which asteroids are targeted continuously for many hours—we will derive thermal lightcurves for comparison to optical lightcurves in order to derive thermal intertia. We will also continue to study the ensemble properties of our sample to better inform models of the evolution of the inner Solar System as well as the impact hazard risk for the Earth.

4. Ancillary data

We are also carrying out significant ground-based observing programs in support of our Warm Spitzer observations. We have made high quality optical photometric observations of more than 100 of our NEOs in order to derive calibrated Solar System absolute magnitudes (H) (and calibrated errors for these objects). [2] presents these new observations as well as the updated results from our thermal modeling (that is, revised albedo and diameter values) based on the new H magnitudes. We are also carrying out a spectroscopic campaign to characterize our Spitzer-observed NEOs. Results of this spectroscopic work are presented in [8] and [1].

5. Conclusions

We are carrying out the ExploreNEOs Warm Spitzer program in which some 600 NEOs will be studied. To date, we have studied individual properties of NEOs as well as properties of our entire sample and, by extrapolation, the NEO population. We have a number of avenues of future work to continue these investigations.

Acknowledgements

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