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The NEOWISE Project: Recent Results

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Abstract

The NEOWISE enhancement to the Wide-field Infrared Explorer (WISE) mission has resulted in detections of more than 157,000 minor planets in thermal infrared wavelength, representing an increase in the number of objects observed of nearly two orders of magnitude over the Infrared Astronomical Satellite (IRAS).[1,2] The survey encompasses near-Earth objects, comets, main belt asteroids, Hildas, Trojans, Centaurs and scattered-disk objects. We will summarize the scientific results of the survey to date, focusing on the combination of available visible and near-infrared ancillary data with NEOWISE as well as studies of near-Earth objects.

1. Introduction

The WISE mission is a NASA medium-class Explorer telescope designed to survey the entire sky in four infrared wavelengths: 3.4, 4.6, 12 and 22 μm (denoted W1, W2, W3 and W4 respectively). [3] While the primary scientific goals of the WISE mission were to find nearby cool stars and ultraluminous infrared galaxies, the NEOWISE project was funded by NASA's Planetary Sciences Division to facilitate solar system studies [4]. The goals of NEOWISE were two-fold: first, to archive and serve to the public all of the single exposures collected by the WISE spacecraft, along with a query tool for solar system objects; and second, to mine the WISE data stream for moving objects in real time through the creation of the WISE Moving Object Processing System (WMOPS). With WMOPS, we were able to carry out a "blind" search for minor planets regardless of whether or not they were previously known. This has largely freed the survey from many of the biases against low albedo objects inherent in visible light surveys. We can use these data to carry out population studies of asteroids throughout the solar system, allowing us to more accurately characterize their numbers, sizes, and albedos. We will describe recent work on population modeling with the NEOWISE dataset, with an emphasis on the near-Earth objects (NEOs). NEOWISE detected hundreds of NEOs during the fully cryogenic portion of the WISE mission, resulting in a highly uniformly sampled population that lends itself to debiased statistical studies. Furthermore, combining the NEOWISE thermal infrared dataset with other ancillary sources of visible and near-infrared photometry and spectroscopy has allowed comparison of albedos to taxonomic classifications.[5]

2. Albedos and Taxonomic Classifications

Determining the true compositions of asteroids would significantly enhance our understanding of the conditions and processes that took place during the formation of the Solar System. It is necessary to study asteroids directly as weathering and geological processes have tended to destroy the oldest materials on Earth and the other terrestrial planets. The asteroids represent the fragmentary remnants of the rocky planesimals that built these worlds, and asteroids in the Main Belt and Trojan clouds are likely to have remained in place for billions of years (subject to collisional processing).[6] Many attempts have been made to determine the minerological composition of asteroids by studying variations in their visible and near-infrared (VNIR) spectroscopy and photometry. [7,8,9,10,11] Efforts have been made to link asteroid spectra with those of meteorites. However, as noted by [12] and [13], space weathering can complicate the linkages between observed asteroid spectra and meteorites. Further, VNIR spectroscopic and photometric samples of higher-albedo objects are generally more readily attainable, as these bodies are brighter as compared with low albedo bodies with similar heliocentric distances and sizes. An important element in the development of asteroid taxonomic schemes has been albedo. For example, in the classification system developed by [7], the E, M and P classes have degenerate Eight-Color Asteroid Survey (ECAS) spectra and can only be distinguished by albedos. [9] All of these issues point to the need to a) obtain a large, uniform sample of asteroid albedos (and other physical properties such as thermal inertia) that can be compared with VNIR classifications, and b) expand the number of asteroids with VNIR classifications in order to bracket the full range of asteroid types and compositions.

With the NEOWISE project, thermal observations of more than 157,000 asteroids throughout the Solar System are now in hand. Thermal models have been applied to these data to derive albedos and diameters for which taxonomic classifications are available. We have shown that NEOWISE thermal data can be used with the near-Earth asteroid thermal model (NEATM; [14]) to produce diameters and albedos accurate to within 10% and 20% respectively for objects with good signal-to-noise measurements in multiple WISE bands. [15] We examine the comparison between NEOWISE-derived albedos and diameters for NEOs and Main Belt asteroids of various classification schemes based on visible and NIR spectroscopy and multiwavelength spectrophotometry. We also summarize comparisons between NEOWISE albedos to candidate classifications and visible/NIR colors found photometrically, such as with the Sloan Digital Sky Survey photometry. While a number of different asteroid classification schemes have been created, we turn our focus initially to three commonly used schemes, those defined by [7], [16], and [11].

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