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Investigating Main Belt asteroids with WISE/NEOWISE

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Abstract

We present the first look at Main Belt asteroids using the Wide-field Infrared Survey Explorer (WISE) all-sky survey. Thermal modeling allows us to fit diameters for over $157,000$ Solar system objects, of which the majority were Main Belt asteroids (MBAs). Literature visible light data allow us to determine albedos for most of these objects as well. Using this data we can investigate diameter and albedo distributions of the Main Belt as a whole as well as look at correlations of albedo within asteroid families. The WISE dataset provides a unique method of determining physical properties of a large number of MBAs.

1. Introduction

The Wide-field Infrared Survey Explorer (WISE) is a space telescope designed to perform an all-sky thermal infrared survey at four wavelengths. WISE was launched on 14 December 2009 and began surveying 14 January 2010 [7]. The WISE bandpasses cover the infrared with central wavelengths in each band of 3.4 μm, 4.6 μm, 12 μm and 22 μm (W1, W2, W3, W4, respectively). Although designed initially as a mission to observe ultraluminous galaxies and brown dwarfs, the WISE bandpasses are ideal for observing Solar system objects as well. NEOWISE, an extension to the WISE mission, allowed for the identification and reporting of detections of both previously known and new Solar system objects [3].

2. Data

WISE surveyed the entire sky in four thermal infrared wavelengths over the course of its first 6 months of operation. A second pass survey of the sky was carried out in all four bands until the loss of cryogen. The survey then continued as the Post-Cryogenic Mission, using the two shortest wavelengths to discover new near-Earth objects, complete the detection of the largest MBAs, and finish the second pass of the inertial sky. Over the entire survey, moving objects were identified using the WISE Moving Object Processing System (WMOPS), and detections were reported to the Minor Planet Center (MPC). We use the detections accepted and recorded by the MPC as our master list of verified WISE detections of moving objects. We focus this work on the MBAs that were observed during the fully cryogenic portion of the WISE mission. This subset of the full population includes thermal infrared observations of $129,750$ unique MBAs.

3. Modeling

In order to convert our infrared flux measurements into effective diameters, we apply a faceted spherical Near-Earth Asteroid Thermal Model (NEATM) [1] to our data. Visible light measurements were available for over $112,000$ MBAs observed during the fully cryogenic portion of the mission, allowing us to determine their albedo as well. For objects with thermal-emission-dominated detections in multiple bands, we allow the beaming parameter η to vary, while for those asteroids with NIR reflected light observed in the shorter wavelength bands we find the ratio of reflectances between NIR and visible wavelengths. Calibration of the zeropoints and color corrections has shown that systematic errors in diameter and albedo are no greater than 10% and 20% respectively for nearly spherical objects with observations in multiple WISE wavelengths at good signal-to-noise ratios [4, 7].

4. Asteroid Families

Using previously identified members of 55 asteroid families [6], we measure the observed albedo and diameter distributions for asteroid families. The WISE dataset contains albedo measurements for more than 20 members of 48 asteroid families, enough to investigate the distribution of albedo and diameter. Asteroid colors and reflectance spectra are strongly correlated within families, consistent with an origin of a catastrophic breakup of a single parent body [2]. As such we would expect albedo to be uniform across the population of family members as well. Conversely, disparate albedos may indicate contamination by background objects in the family identification.

5. Summary

Using data from WISE we are able to investigate a range of physical properties of Main Belt asteroids, from diameter distributions to surface property characterization [5]. This dataset represents a new era of infrared studies of small Solar system bodies, and has only begun to be explored.

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