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WISE/NEOWISE Observations of the Hilda and Jovian Trojan Populations

T. Grav (1), A. K. Mainzer (2), J. Masiero (2), J. Bauer (2,5), T. Spahr (3), R. S. McMillan (4), R. Cutri (5), E. Wright (6) and the WISE Team
(1) Dept. of Physics and Astronomy, Johns Hopkins University, Baltimore, USA, (2) Jet Propulsion Laboratory, California, USA, (3) Minor Planet Center, Harvard-Smithsonian Center for Astrophysics, Cambridge, USA, (4) Lunar and Planetary Laboratory, University of Arizona, Tucson, USA (5) Infrared Processing and Analysis Center, California Institute of Technology, USA, (6) UCLA Astronomy, Los Angles, USA

Abstract

The Wide-field Infrared Survey Explorer (WISE) observed 1023 Hildas and 1739 Jovian Trojans detected during the cryogenic part of its survey. This represents an increase in the number of objects with thermal models in the two populations by an order of magnitude compared to previous surveys. In this paper we discuss the results of the thermal modeling of these observations and its implications for two populations. We derive albedo and size-frequency distributions and present a method for deriving taxonomic classifications based on the visible albedo and the relative reflectance in the 3.4 and 4.6μm bands.

1. Introduction

WISE is a National Aeronautics and Space Administration (NASA) medium-class Explorer mission designed to survey the entire sky in four infrared wavelenghts, 3.4, 4.6, 12 and 22 μm (denoted W1, W2, W3 and W4 respectively)[1, 2]. NEOWISE (Near-Earth Object WISE) is an extension to the main WISE mission allowing for both known and new moving objects to be detected and reported to the Minor Planet Center (MPC) within ten days of observation. The survey collected over 2 million observations for more than 157,000 asteroids, including Near-Earth Objects (NEOs), Main-Belt Asteroids (MBAs), comets, Hildas, Jovian Trojans, Centaurs and scattered disk objects [3]. With this sample, WISE has collected infrared measurements of nearly two orders of magnitude more asteroids than its predecessor, the Infrared Astronomical Satellite (IRAS) [4]. The survey started on 2010 January 14 and exhausted its secondary tank cryogen on August 2010 August 5. Exhaustion of the primary tank cryogen occurred on 2010 October 1, but the survey was continued until 2011 February 1, as the NEOWISE Post-Cryogenic Mission using only bands W1 and W2.

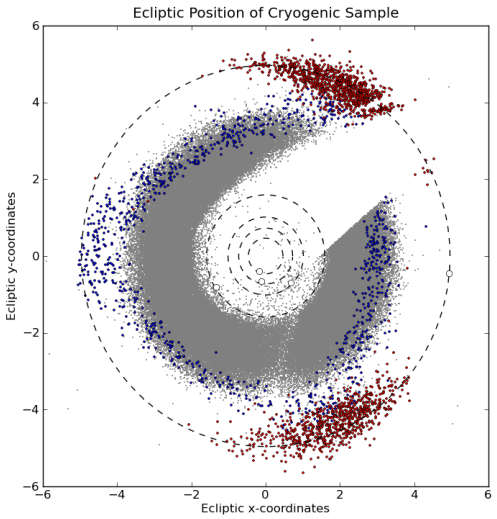

Figure 1: The ecliptic x and y position on 2010 August 10 of the Hildas (in blue), Jovian Trojans (in red) and the Main Belt (gray) detected by NEOWISE during the cryogenic portion of the WISE survey.

Preliminary thermal models for each of the Hildas and Jovian Trojans detected by NEOWISE during the cryogenic portion of the survey and using the First-Pass Data Processing Pipeline (version 3.5) have been computed using the near-Earth asteroid thermal model (NEATM) [5]. The NEATM introduced the so-called beaming parameter η to account for cases intermediate between zero thermal inertia (the standard thermal model with $\eta = 0.756$ used by IRAS) and infinite thermal inertia (the fast rotating model with $\eta = \pi$). In the NEATM the beaming parameter, η is a free parame-

ter that can be fitted if two or more thermal bands are available, which is the case for 747 Hildas and 1534 Jovian Trojans.

For the Hildas and Jovian Trojans bands W1 and W2 are generally dominated by reflected light. The flux due reflected sunlight was computed using the International Astronomical Union phase curve collection [6]. In order to compute the fraction of total luminosity due to reflected light, the relative reflectance at bands W1 and W2, dubbed p_{IR}/p_V, was introduced. 72 of the Hildas and 100 of the Jovian Trojans have observations in W1 and/or W2, making it possible to determine p_{IR}/p_V.

2. The Hilda Population

1028 objects with observational arcs larger than 18 days, thus having orbits securely associating them to the Hilda population, were detected by NEOWISE in the cryogenic part of the WISE survey. 923 objects were associated with previously known objects, while 105 objects were new discoveries that have subsequently been linked to incidental astronomy in the MPC one-night database or have received optical follow-up after the object was reported to the MPC. Enough observations were available to compute thermal models of 1023 of these objects. 747 of these have observations in two thermal bands, allowing for the fitting of the beaming parameter, and 72 objects have p_{IR}/p_V computed. We present the size, albedo and beaming distributions of this population and show how p_V and p_{IR} can be used to derive taxonomic classification for these objects. We also observed 219 of the 360 members of the Hilda collisional family and 112 of the 232 members of the Schubart collisional families and will present their distributions and how they compare or differ from each other and the background population.

3. The Jupiter Trojan Population

1751 objects with observational length-of-arcs larger than 18 days, thus having orbits securely associating them with the Jovian Trojan population, were detected by the NEOWISE in the cryogenic part of the WISE survey. A little less than 10% of these, 140 objects in total, were new discoveries. In addition there were 349 objects detected that lack optical follow-up, but for which the observed W3-W4 color and sky-plane velocity are consistent with the longer-arc Jovian Trojans. 1739 of the Jovian Trojans with longer observational arc lengths have observations allowing us to derive thermal models. 1534 of these objects have detections in two thermal bands, allowing for the derivation of the beaming value, while 100 objects have detections in band W1 and/or W2 allowing us to derive p_{IR}/p_V. We present the size, albedo and beaming distributions of this population. Both the leading and trailing clouds were covered during the cryogenic part of the survey, allowing for a comparison of the size and albedo distributions, as well as determination of the relative abundance of objects in the two clouds.

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