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Extracting Additional Minor Planet Detections from NEOWISE by Stacking

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The Near-Earth Object Wide-field Infrared Survey Explorer (NEOWISE) mission is currently orbiting the Earth and searching for near-Earth objects (NEOs) in order to characterize their sizes, albedos, and thermal inertias [1]. Because of its survey cadence, NEOWISE typically collects ~10-12 observations of most minor planets in the inner solar system; its automated moving object detection software requires a minimum of five detections above SNR=4.5 to trigger. Using this automated pipeline, the NEOWISE project has reported detections of ~190,000 minor planets at thermal IR wavelengths, which in turns allows for diameters, albedos, and other physical properties to be determined.

This spacecraft began its life as the Wide-field Infrared Survey Explorer (WISE), with a primary mission objective to detect ultra-cool brown dwarfs and ultra-luminous infrared (IR) galaxies using 3.4, 4.6, 12, and 22 um channels [2]. Launched in December 2009, WISE exceeded its required mission duration of 7 months by several weeks, after which point the cryogen used to cool the two longest wavelengths was exhausted. By October 2010, the cryogen was fully depleted, resulting in the loss of operability of the 12 and 22 um channels. Operations currently continue using the 3.4 and 4.6 um channels.

Additional detections of minor planets can be mined from the data in all mission phases by stacking all of the available exposures in the co-moving reference frames of the objects. Combining exposures to form a single coadd can recover objects that were too faint to appear above the SNR cutoff in five of the ~10-12 exposures. To that end, we have performed stacking on the available catalog of minor planets from the Minor Planet Center using all of the data from all phases of the WISE/NOWISE mission, resulting in several million coadded exposures [3]. We employ an automated classification routine to facilitate searching these coadds for unconfused detections that are bright enough to be suitable for thermal modeling. An example of two objects that did not have diameters or albedos previously reported by NEOWISE during the 4-band fully cryogenic phase and the 2-band portion of the mission are shown in Figures 1 and 2.

We anticipate reporting additional diameters and albedos for tens of thousands of unique objects that have no prior NEOWISE detections reported.

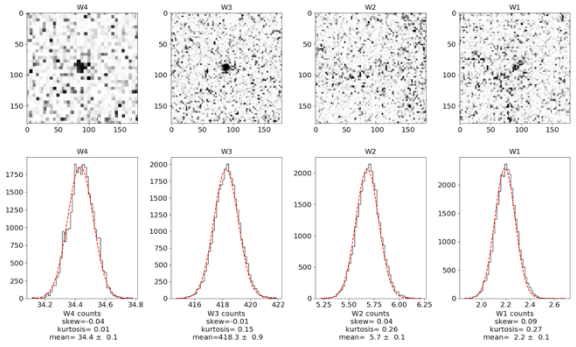

Figure 1: Main-belt asteroid (100023) 1990 SH5 was not previously detected by the automated NEOWISE pipeline, but is readily detected when all 19 available exposures are stacked in the 22, 12, 4.6, and 3.4 um channels respectively (denoted W4, W3, W2, and W1). Diameter and albedo can now be computed for this object. The histograms in the lower row represent the distribution of background signal; these data are useful inputs for the automated classifier.

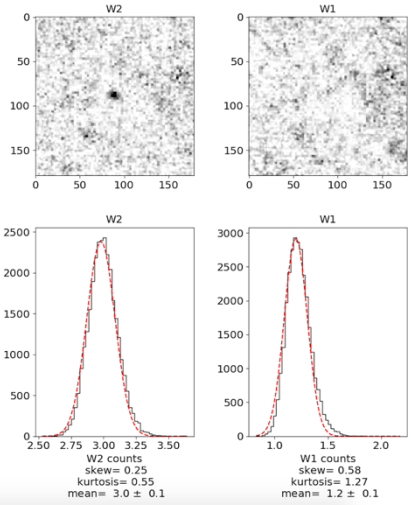

Figure 2: The NEO 2009 DQ4 has no reported NEOWISE detections using the automated processing pipeline, but when the 17 available frames that intersect with the object are combined in its comoving reference frame, an SNR=13 detection is obtained in the W2 (4.6 um) band.

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