Physical Characterization of Asteroids in the *Spitzer* Taurus Legacy Survey

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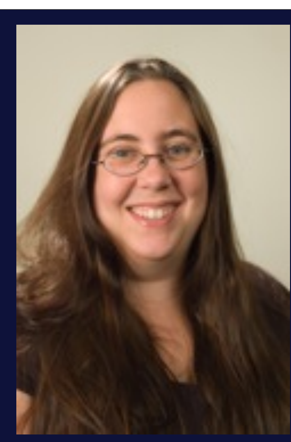

Abstract: Statistical studies of the albedo and size populations of main belt asteroids have been limited in the past to asteroids with diameters > 10 km using the MSX and IRAS asteroid catalogs. To extend studies to asteroids with smaller diameters, one can now use the wealth of data in the Spitzer Space Telescope archive and examine the serendipitious observations of asteroids. We use multi epoch data from the IRAC and MIPS instruments in the Taurus Legacy programs to distinguish asteroids from background sources and match them to known asteroids. The sensitivity of the MIPS instrument paired with the Galactic background limits our detections at 24 micron to asteroids with diameters > 1 km, while the IRAC detection limit at 8 micron limits detections to asteroids with diameters > 0.4 km. We present analysis of the albedo properties of ~1000 small main belt asteroids from the Taurus survey and our published MIPSGAL results, and the size frequency distribution based on combined visual and mid-IR data.

Taurus Legacy Program:

The Taurus Legacy programs were designed to detect protostars in addition to studying the Galactic dust distribution using IRAC [1] and MIPS[2]. Because protostars have similar temperatures to asteroids (~250 K), color selection techniques do not work for asteroid rejection. Observations for these programs were therefore designed using multiple epochs which could be used for asteroid rejection, or in our case identification and tracking of asteroids based on their movement between subsequent observations

Asteroid detection and Photometry

Previous studies [3] have indicated that reflected light is a major contributor to the amount of measured light from asteroids at the shortest two wavelengths of the IRAC camera. With this in mind, photometry was only done on asteroids using the 2 longest IRAC wavelengths, 5.8 and 8.0 microns, and at 24 microns with the MIPS data. The time separation between the IRAC and MIPS observations is less than 1 week. During this period, the asteroid distances from the Sun and from *Spitzer* vary by less than 0.1 AU allowing us to use both the IRAC and MIPS data for thermal model fitting where possible. Due to interest in using a warm *Spitzer* to derive diameters and albedos of Near Earth Asteroids, we also tested the validity of thermal fits based only on IRAC data on the Wien side of the thermal distribution.

Data presented in those poster only represents half the total data available in the Taurus survey. From this data we detect 233 asteroids in the IRAC data and 361 asteroids in the MIPS data. Of these asteroids, 110 have both IRAC and MIPS data available for thermal modelling.

Determination of Diameters and Albedos of Known Asteroids:

By combining 5.8, 8.0 and 24 micron flux measurements with optical photometry and orbital elements we can determine the size and geometric albedo (percent surface reflectance) of a known asteroid. To do this, we use the Near Earth Asteroid Model (NEATM)[4]. H values used in the modelling are those reported by Horizons and G assumed to be a default of 0.15 if not reported.

To determine the geometric albedo and diameter of each asteroid we use chi-squared minimization technique to fit the fluxes in both the optical and infrared. The distribution of albedos is seen in Figure 1 and the distribution of diameters is seen in Figure 2.

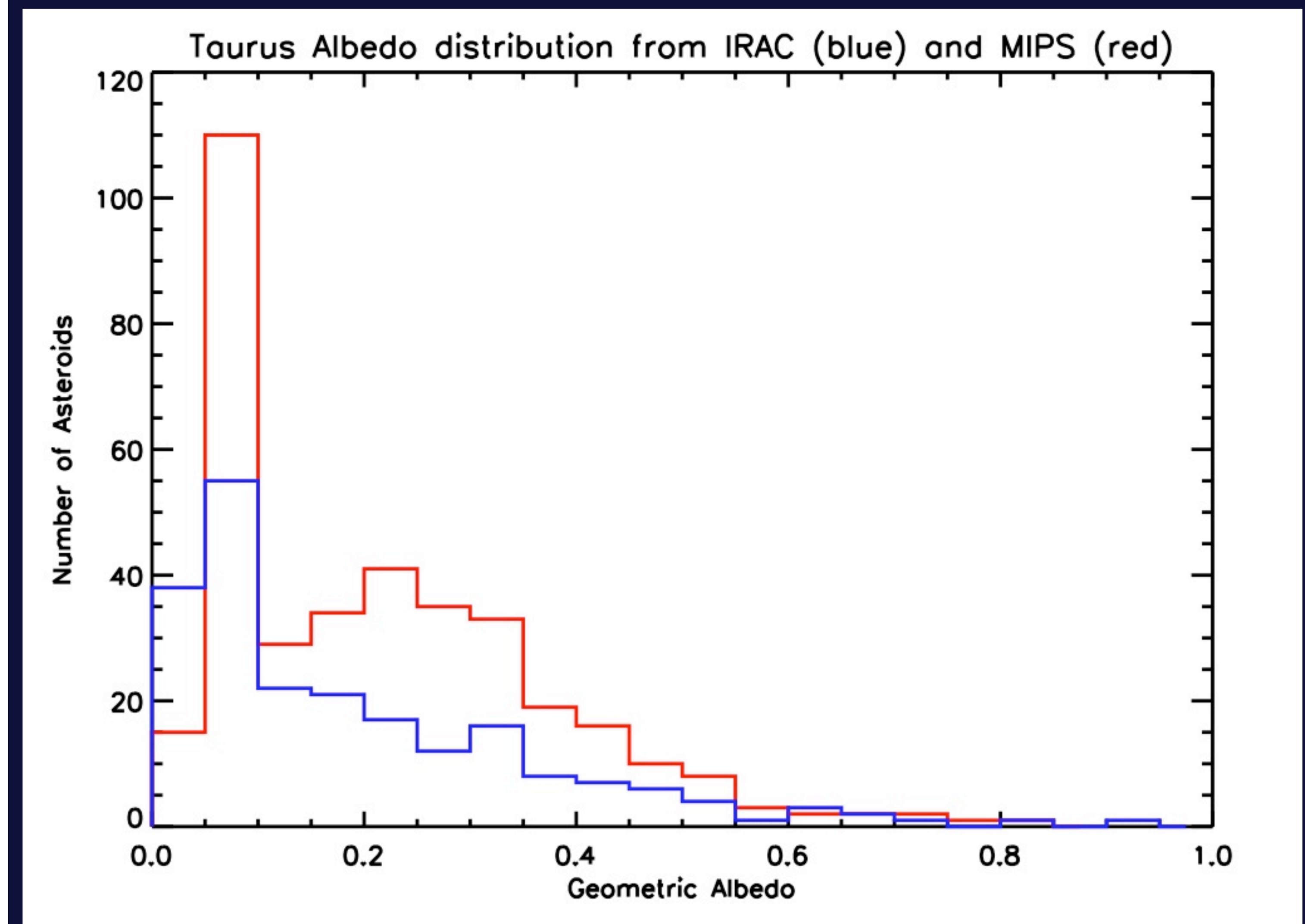

Figure 1: The geometric albedo distribution for the asteroids in IRAC and MIPS Taurus data. The asteroids from both datasets show a clear signal near dark asteroids which have a low albedo. This result is also true in the MIPSGAL asteroid survey [5] and the MSX infrared survey asteroid data as well [6]. The distribution for asteroids detected in IRAC data is shown in blue while the distribution for asteroids detected in MIPS data is red. While the MIPS distribution is bimodal just like the distribution from the IRAS survey[7], the IRAC data does not show this signature. Without detailed analysis it is unclear if this decrement of high albedo asteroids with IRAC is due to incompleteness or errors in doing thermal fits with only data from the Wien side of the blackbody curve.

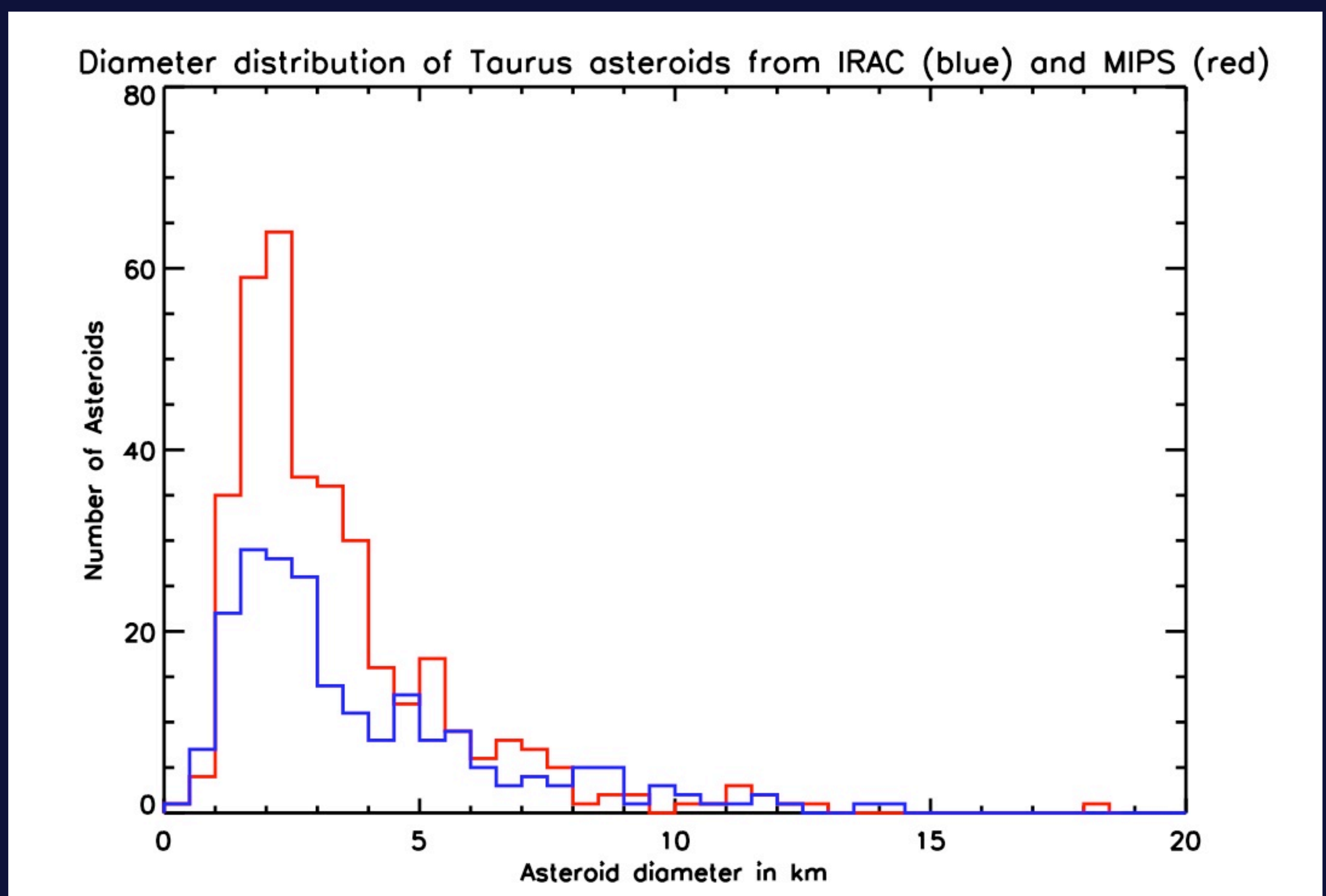

Figure 2: The diameter distribution for asteroids in the IRAC and MIPS Taurus data. The two diameter distributions are comparable as the effective depths of the data are similar.

Comparing thermal fits

For 110 asteroids, photometry is available at both the IRAC and MIPS wavelengths. The figures below show the thermal fits as derived using only IRAC data (dotted line), only MIPS 24 microns (dashed line) and the IRAC and MIPS data (dot-dashed line). These plots illustrate how poorly IRAC only thermal fits reproduce the whole SED.

When compared to the thermal fits derived with the combined IRAC and MIPS data, the relative error of the MIPS only determinations of albedo is ~9% which is within the 10% photometry error. The relative albedo error of the IRAC only determinations is ~40%, indicating that using only data points on the Wien side of the curve for thermal modelling is not advisable.

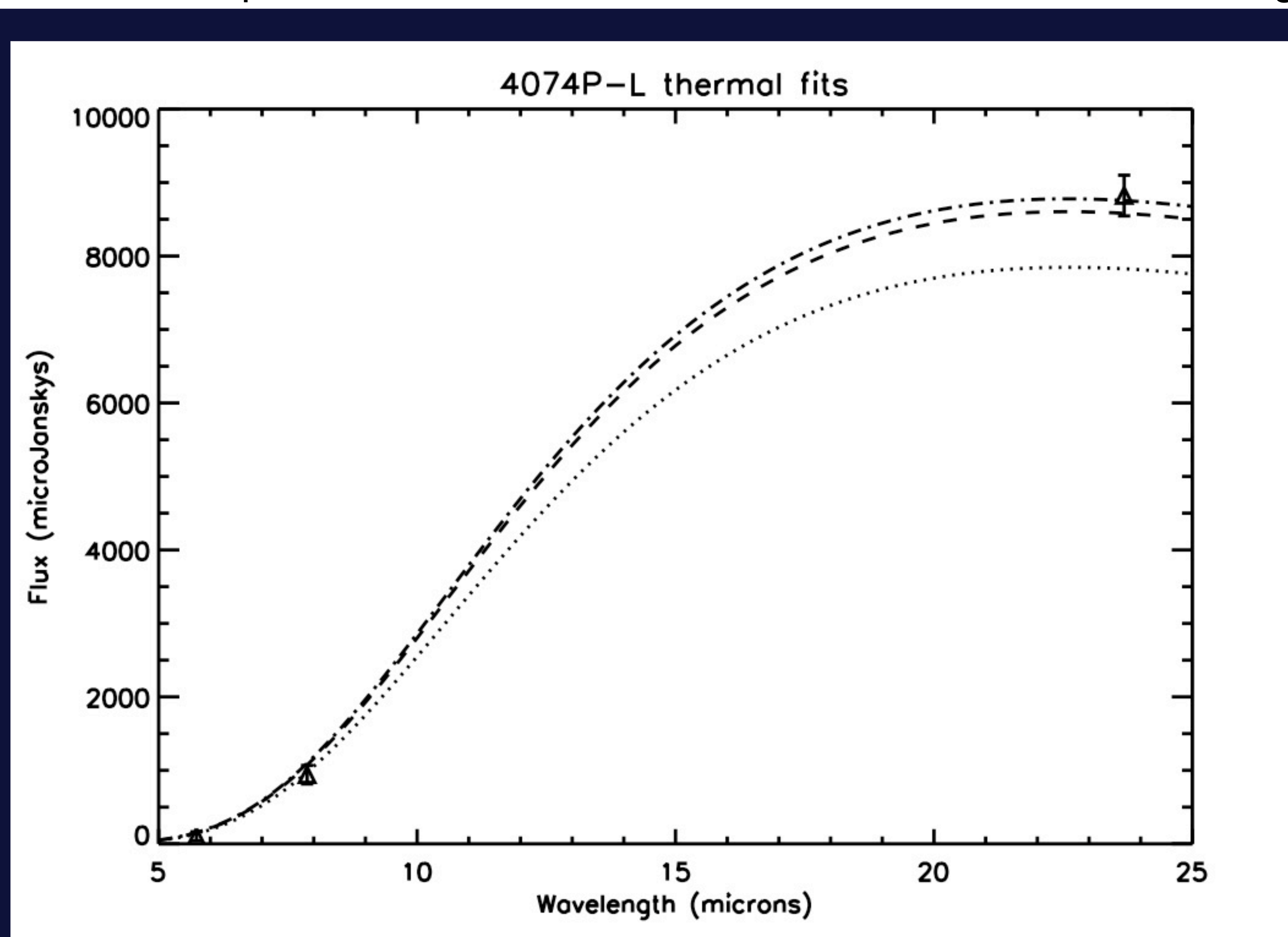

Figure 3: Asteroid 4074 P-L This asteroid has a semimajor axis of 2.66 AU and an inclination of 3.08 degrees.

The best fit for this asteroid gives a geometric albedo of 0.084 and a diameter of 2.52 kilometers.

The IRAC solution gives a geometric albedo of 0.093 and a diameter of 2.39 km whilst the MIPS solution gives an albedo of 0.085 and a diameter of 2.50 kilometers.

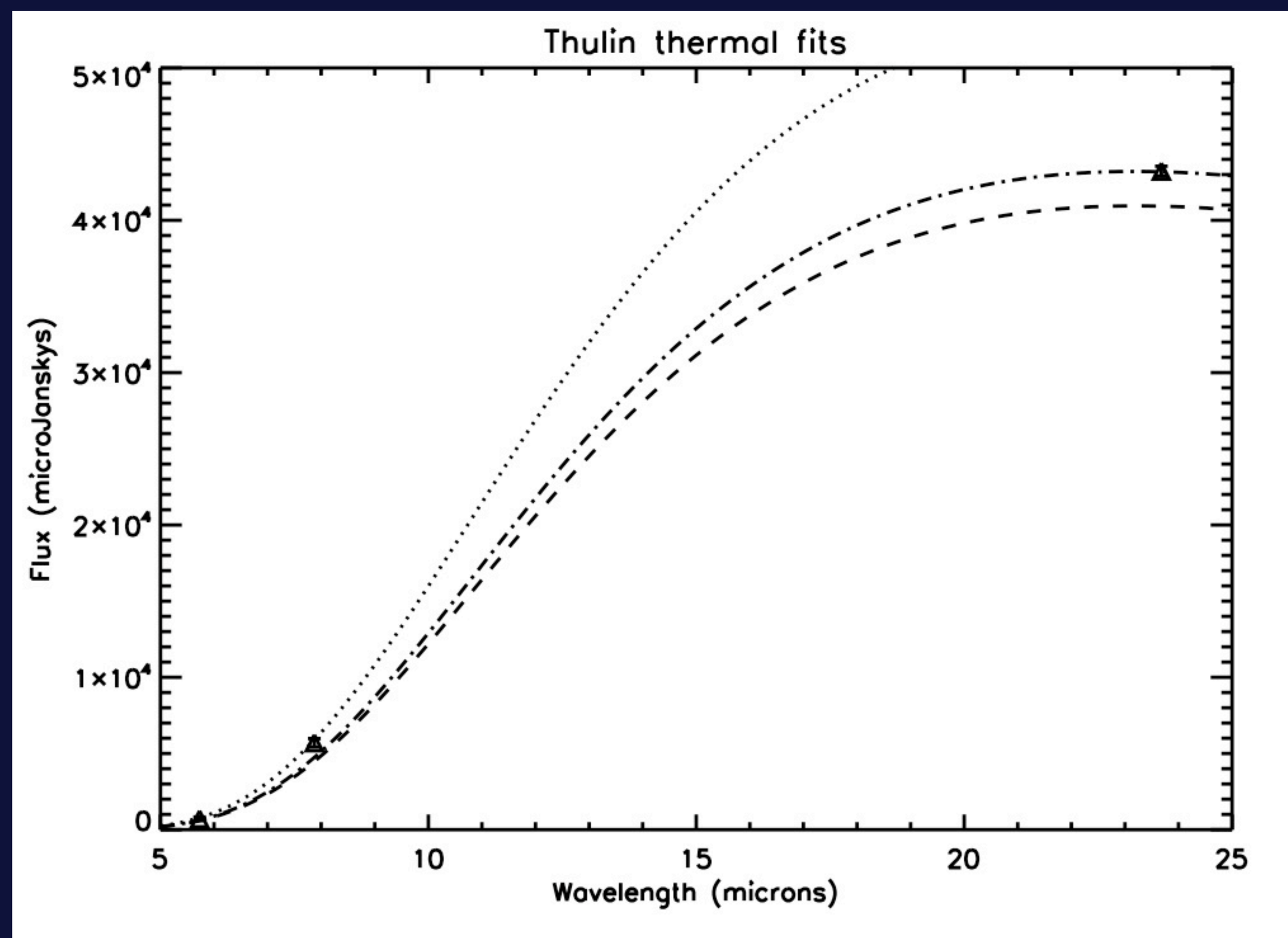

Figure 4: Asteroid Thulin This asteroid has a semimajor axis of 2.70 AU and an inclination of 3.42 degrees.

The best fit for this asteroid gives a geometric albedo of 0.139 and a diameter of 6.19 kilometers.

The IRAC solution gives a geometric albedo of 0.114 and a diameter of 6.84 kilometers whilst the MIPS solution gives an albedo of 0.146 and a diameter of 6.04 kilometers.

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