ORIGIN OF THE NEAR-ECLIPTIC ZODIACAL DUST BAND. D. Nesvorny[1] , W. F. Bottke[1], D. Vokrouhlicky[2], M. Sykes[3], D. J. Lien[3] and J. Stansberry[4], [1]Southwest Research Institute, 1050 Walnut St., Suite 300, Boulder, CO 80302, [2]Institute of Astronomy, Charles University, V Holesovickach 2, CZ-18000, Prague, Czech Republic, [3]Planetary Science Institute, 1700 E. Ft. Lowell, Suite 106, Tucson, Arizona 85719, [4]California Institute of Technology, Spitzer Science Center, 1200 East California Boulevard, Pasadena, CA 91125

The Zodiacal Cloud (ZC) is a thick circumsolar disk of dust particles produced by asteroid collisions and comets that contribute to it in unknown proportions. Important clues to the origin of ZC are provided by structures known as the zodiacal dust bands that were discovered using observations from the Infrared Astronomical Satellite (IRAS) [1]. The alpha, beta and gamma bands form small-scale latitude features in the zodiacal light. They are thought to be produced by thermal emission of three pairs of circumsolar rings of dust particles near inclinations i=1.4, 2.1 and 9.3 deg, respectively [2][3].

These dust rings were originally proposed to be sustained by on-going collisional grinding of fragments in the prominent Themis, Koronis and Eos asteroid families [4] because these large families, remnants of ancient catastrophic asteroid collisions, have roughly the right orbital inclinations. More recently, it was found that the gamma band does not arise from the Eos family, but instead traces the slightly smaller orbital inclination of the Veritas family, which is a remnant of the catastrophic breakup of a diameter D>150 km asteroid ~8.2 Ma [5]. Moreover, the Karin family, which formed by breakup of a D~40-km Koronis family member about 5.8 Ma, was shown to produce the beta band [6][7]. These findings raise the possibility that the near-ecliptic alpha dust band can also be linked to a recent asteroid disruption.

We used the Spitzer Space Telescope to observe the diffuse thermal emission of the ZC near the ecliptic. Four sets (A,B,C,D) of four parallel scans (1,2,3,4) were obtained with the 24 micron MIPS array. The scans were 5.4 arcmin wide and went from +10 deg down to -10 deg in the ecliptic latitude, b. Individual scans in each set are roughly parallel to each other across the ecliptic and are separated by 1.5 deg in ecliptic longitude. By co-adding all 128 pixels cross-scan, the MIPS images were used to generate 'noodles' with a 6.4 arcsec in-scan resolution that show profiles of the diffuse infrared flux in the 24 micron wavelength as a function of b. We then used a Fourier filter to enhance small-scale structures in the noodles. The best results were obtained for scan set D where parallax from the high solar elongation of observations resulted in the clear separation of the alpha and beta bands in b.

We numerically modeled the collisional and orbital evolution of asteroid particles and used our Synthetic InfraRed Telescope code (SIRT) [7] to test whether the location and width of the observed alpha-band peaks can be matched by the thermal emission of dust from various asteroidal sources. We found that none of the known suspected sources with i~1.4 deg, including the Themis and Massalia families [5], provides a satisfactory match.

By analyzing the newest AstDyS catalog of asteroid orbits [8] we have serendipitously discovered a new asteroid family with mean i=1.34 deg. The new family is located at a=3.157 AU near the orbit of D=53-km Themis-family asteroid (656) Beagle. This large asteroid may not be a real member of the family due to a slight eccentricity offset of its orbit from other identified fragments. Despite this problem, we refer to the new family as the Beagle family, a name pending revision when the exact family membership becomes more secure.

In total, we identified 65 dynamical members of the Beagle family. The total volume obtained by combining estimated volumes of all identified fragments indicates a D>20 km disrupted parent object (or D>65 km if (656) Beagle is a member). The Beagle family has a tight spread in a (~0.013 AU). This suggests that it must have formed very recently. We estimate that the Beagle family is probably less than ~15 My old.

The model IR signal of dust particles produced in the Beagle family shows an excellent fit to our Spitzer observations of the alpha dust band. The key factor in obtaining this result was the tight inclination spread of the Beagle family, ~0.05 deg. In contrast, the wide Themis family would produce the IR emission signal that would be much broader in latitude than the observed one. This shows that the recently-formed Beagle family, and not the old Themis family, is the real source of the alpha dust band. The recent formation of all principal asteroid dust bands implies a significant time variability of the Zodiacal Cloud.

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