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Where do the primitive NEOs come from? A new asteroid family may be a primary source.

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Abstract

It has been claimed that low-albedo asteroid families of the inner asteroid belt ($a \leq$2.5 AU) with low orbital inclination ($i \leq$8 degrees) are the prominent sources of primitive, carbonaceous, low-albedo near-Earth objects (NEOs). However, another powerful source – if not the most important – of primitive NEOs may be the diffuse background of dispersed low-albedo asteroids with $a \leq$2.5 AU and $i \leq 8^\circ$ The low-inclination orbits lead to NEOs with Earth-like orbits - i.e. ideal targets for space missions.

Here we show that the dispersed background of low-albedo asteroids at low inclination is an ancient family. Arguably, this newly identified family is the most important one in the entire asteroid belt, as its large number of members and location near a NEO source region position it to be the dominant source of primitive NEOs. Our discovery also constrains the possible boundaries and members of the other major inner main belt primitive family (the Polana family), and it positively identifies the parent asteroid for each of these two families.

1. Introduction

The inner asteroid Main Belt (a<2.5 AU) is bound by the mean motion resonance (MMR) with Jupiter (centered at 2.5 AU) and by the secular resonance (SR) ν_6 at 2.15 AU (for low orbital inclination and low orbital eccentricity; see Fig. 1).

It is known that the orbits of 10-20 km sized asteroids are not stable over the age of the solar system: the Yarkovsky effect [1] causes a secular drift of the semi-major axis of the orbit due to the emission of the thermal radiation of the asteroid that carries off momentum.

The dynamical families of asteroids are groupings of these bodies in orbital element space [2]. Asteroid families are created during an asteroid collision, and though the collisional remnants' orbital elements remain close in orbital element space, they do spread out in semi-major axis over time due to the thermal forces of the Yarkovsky effect. Depending on the families' location and age, the smallest bodies may have time to drift into major resonances (such as the J3:1 MMR and the ν_6) instigating rapid and dramatic orbital change. This process can lead to the production of a NEO (see Fig. 1).

Low-albedo asteroid families have been claimed to be the primary source of some primitive and low-albedo NEOs [3, 4, 5]. However, [4, 5] has noted that the background is more efficient than the familes in delivering low-albedo asteroids to near-Earth space via the ν_6 resonance. However, the origin of the low-albedo background remain a mystery.

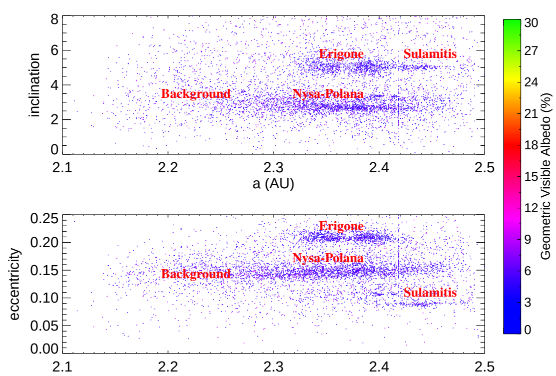

Figure 1: Low-albedo asteroids of the inner belt at low inclination. Note the clumpings corresponding to the familes and the population of dispersed asteroids.

2. Family identification among background asteroid

We have used the albedos from [6] to select all asteroids observed by the NASA WISE mission in the inner main belt with orbtial eccentricities between 0.11 and 0.19 and inclinations below 6°. This area is centered on the Nysa-Polana family (as defined by [7]). Figure 2 shows that the distribution of the absolute magnitude H as function of a has the typical "V" shape of asteroid families [7]. The V-shape is due to the size dependance of the Yarkovsky mobility of the family members. Two V-shapes are visible clearly indicating the presence of two familes of asteroids of low albedo in the region.

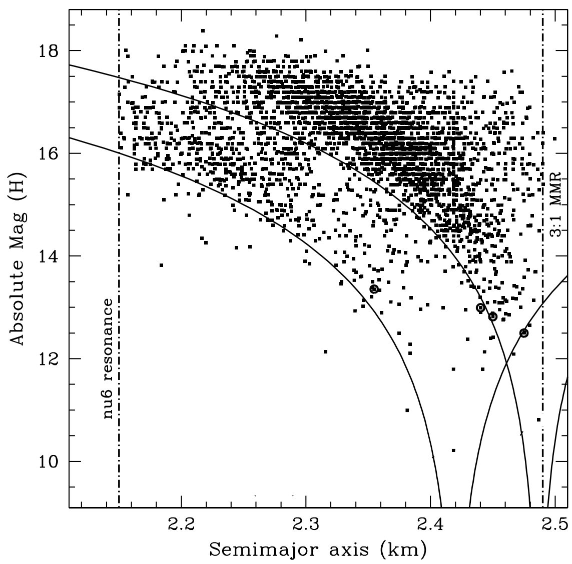

Figure 2: The absolute magnitude, H, for all WISE-observed asteroids with albedo below 0.1, eccentricities between 0.11 and 0.19 and inclinations below 6°, plotted as a function of their semi-major axes (AU). The parents of the two family are plotted with a square around their dot, and are centered in the Yarkovsky-drift curves that outline the shape of the two families.

3. Summary, Conclusions and Future works

We have identified a new family of low-albedo primitive asteroids. This family is placed closed to the (SR) ν_6 at 2.15 AU and should predominantly contribute to NEOs with low albedo, low orbital inclination.

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