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Near-Earth Asteroids in Spitzer Observations

This is a brief discussion of near-Earth asteroid (NEA) counts in Spitzer Space Telescope observations. The approach is similar to a previous discussion of main-belt asteroids.

Background:

Spitzer will be remarkably sensitive to any NEA found in the field of its mid-infrared instruments, especially the IRAC 8 μm filter. It can detect an asteroid with a diameter as small as ≈ 10 meters at 0.2 AU from the Earth at 8 μm. However, it is unlikely to find a bright NEA in an arbitrary field as shown in the simulation below.

Size distribution:

We averaged recent estimates of the number of NEAs (Rabinowitz *et al.* 1994; Rabinowitz *et al.* 2000; Stuart 2001) and approximated the cumulative size distribution of the NEAs with a single power law:

$$\mathrm{N}(>\mathrm{D}) = 1000\ \left(\frac{1}{\mathrm{D}}\right)^{2.0}$$

where D(km) is the asteroid diameter. This should give numbers reliable to within a factor 6 down to a diameter of 10 meters.

The near-Earth asteroid simulation:

The positions and fluxes of 10^7 NEAs with diameters larger than 10 meters were simulated with a Monte Carlo model. The distributions of orbital elements a, e, and i were taken from Rabinowitz *et al.* (1994). The other orbital elements were randomly assigned.

Infrared fluxes were estimated with the standard thermal model for asteroids (Lebofsky and Spencer 1989). The adopted average Bond albedo was A= 0.05. The thermal emissivity was $\epsilon = 1.0$. The assumed infrared beaming factor was $\eta = 1.2$ (Harris 1998), which may be the most reasonable value for the small bodies of interest here.

Reflected light contributes moderately to the flux in the IRAC 3.6 μm band, and weakly at 4.5 μm. We assume an average geometric albedo of 0.1 (very uncertain) and a phase law like that at visible wavelengths (Bowell *et al.*, 1989).

The numbers of main-belt and near-Earth asteroids brighter than a given flux limit are shown in Figure 1 for a typical Spitzer field-of-view. Power-law fits to the results of the simulations are plotted to account for the numerical limitations of the simulations.

Though they are on average closer, hotter, and have a wider spread in inclination than main-belt asteroids, the fact that the NEAs are a factor ≈ 800 down by number makes them much less of a concern than main-belt asteroids, except at high ecliptic latitudes, where the numbers are low.

Also plotted are some typical rates of motion in ecliptic coordinates (Figure 2).

Credits:

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References:

Bowell, E., Hapke, B., Domingue, D., Lumme, K., Peltoniemi, J., and Harris, A. 1989, in *Asteroids II*, ed. R.P. Binzel, T. Gehrels, and M.S. Matthews, Univ. of Ariz. Press, Tucson, p. 524.

Harris, A.W. 1998, *Icarus*, **131**, 291.

Lebofsky, L.A. and Spencer, J.R. 1989, in *Asteroids II*, ed. R.T. Binzel, T.Gehrels, and M.S. Matthews, Univ. of Arizona Press, Tucson, p. 128.

Rabinowitz, D., Bowell, E., Shoemaker, E., and Muinonen, K. 1994, in *Hazards due to Comets and Asteroids*, ed. T. Gehrels, Univ. of Ariz. Press, Tucson, pp. 285-312.

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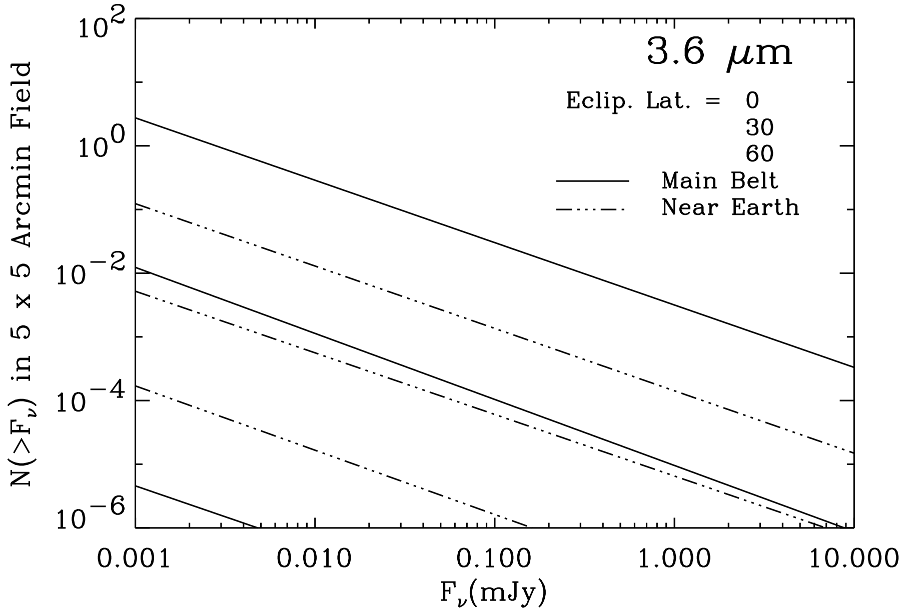

Fig. 1(a) - Cumulative main-belt (solid lines) and near-Earth (dash-dot lines) asteroids brighter than F_ν in a $5' \times 5'$ area for various ecliptic latitudes at a wavelength of 3.6 μm. Curves are power-law fits to the results of the Monte Carlo simulations.

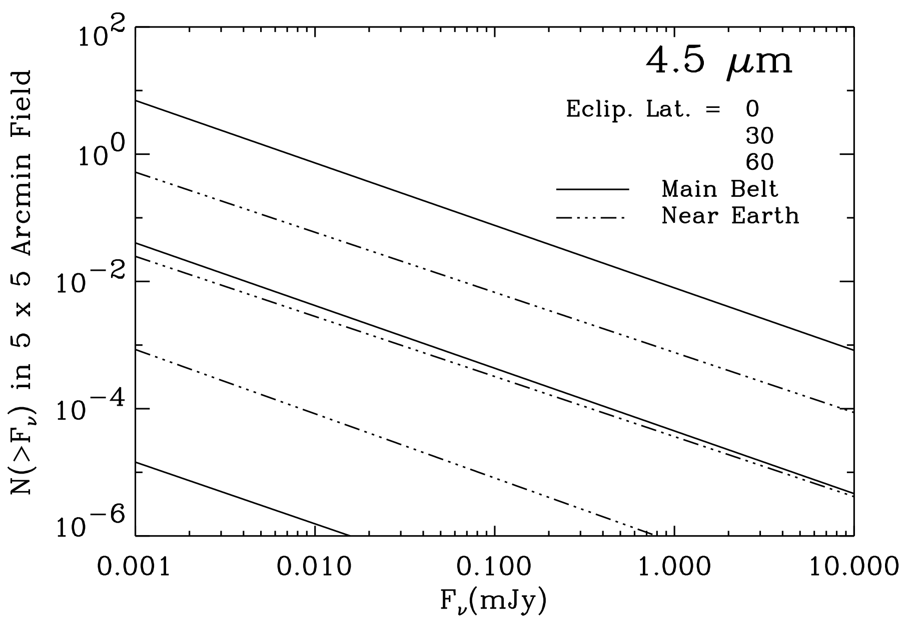

Fig. 1(b) - Same as Fig. 1(a) at 4.5 μm.

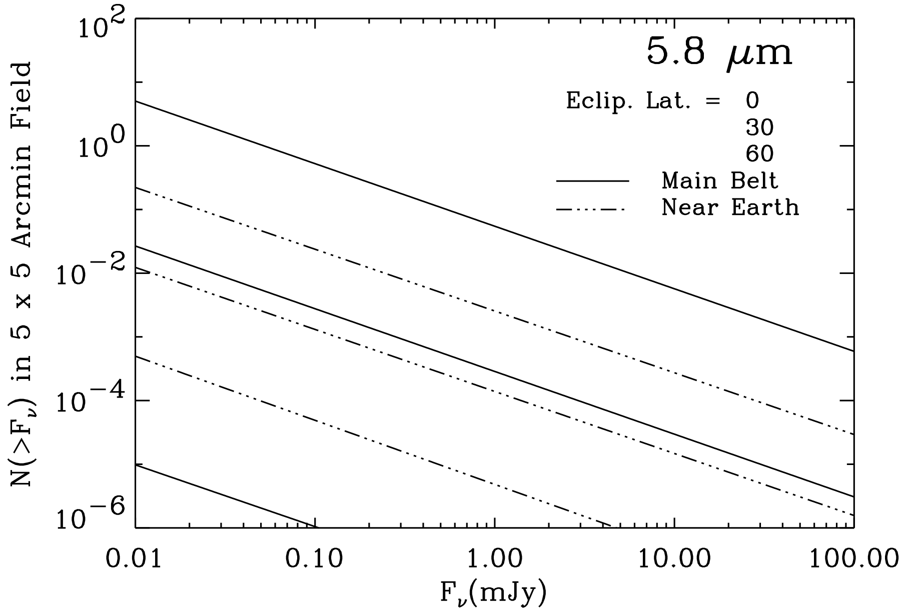

Fig. 1(c) - Same as Fig. 1(a) at 5.8 μm.

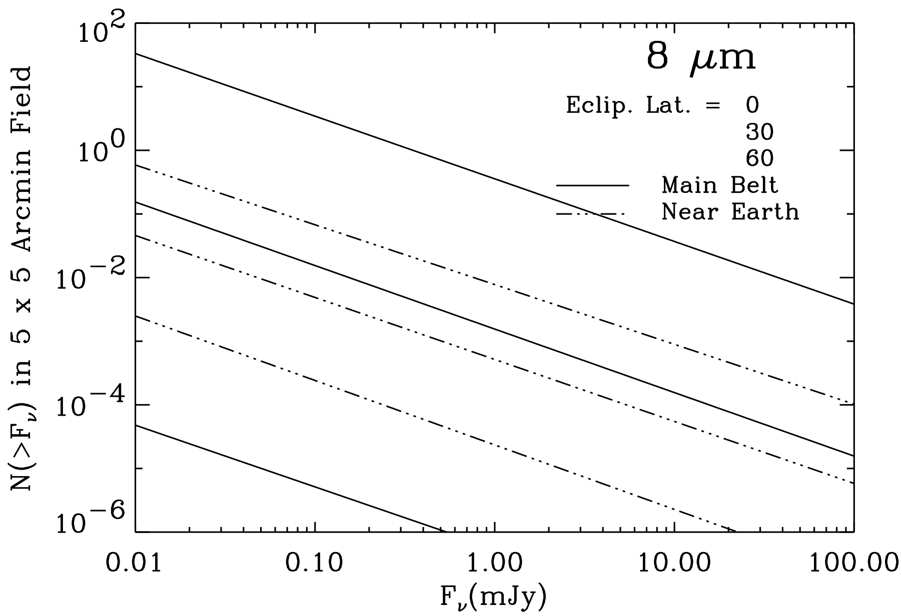

Fig. 1(d) - Same as Fig. 1(a) at 8 μm.

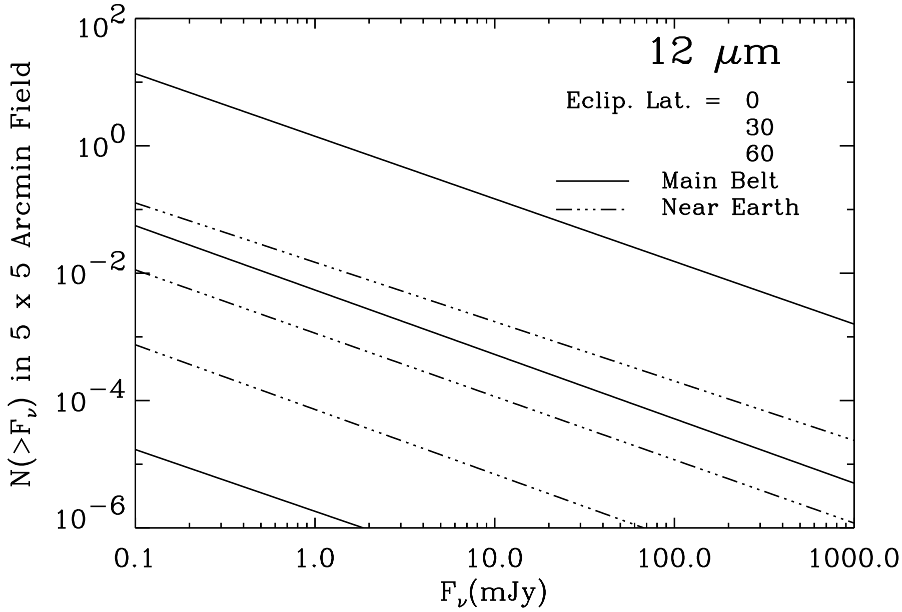

Fig. 1(e) - Same as Fig. 1(a) at 12 μm.

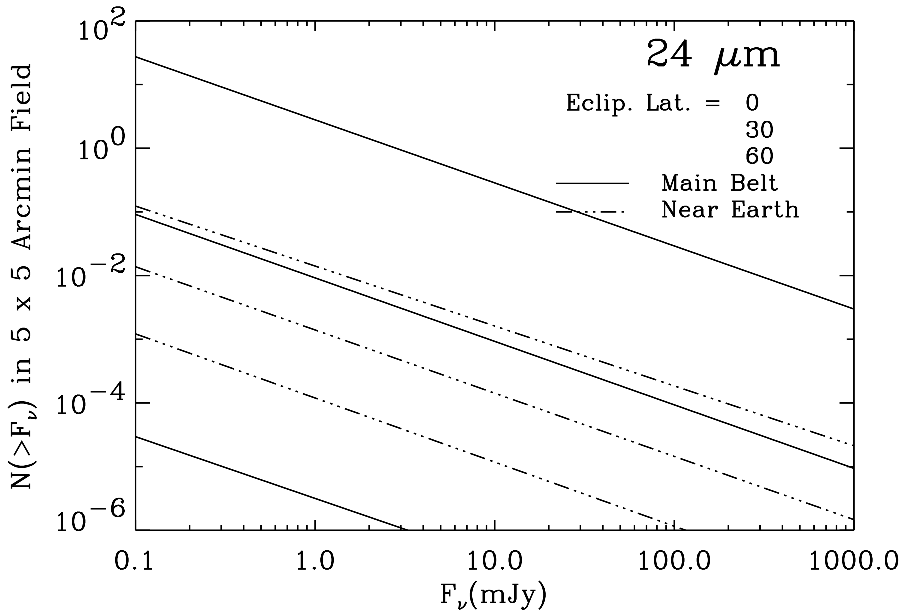

Fig. 1(f) - Same as Fig. 1(a) at 24 μm.

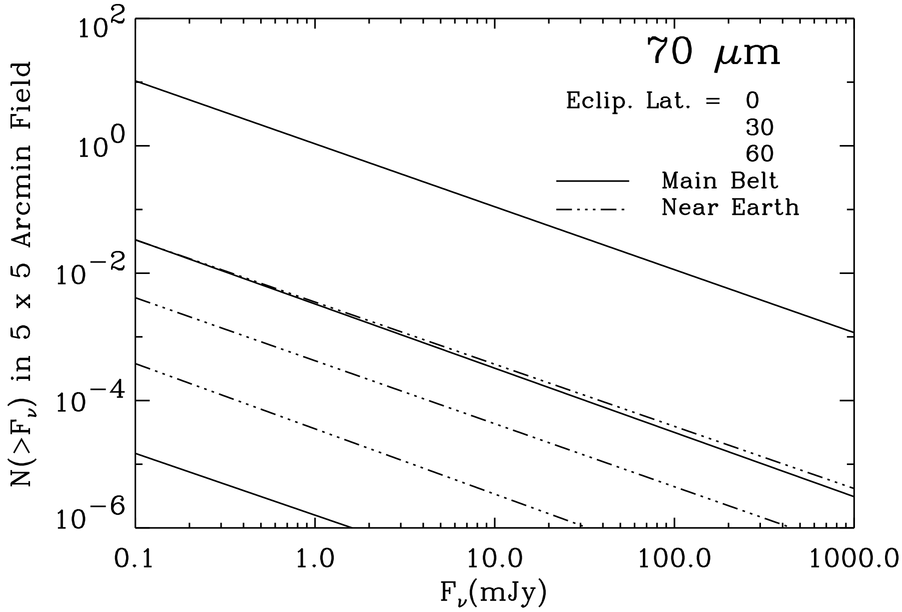

Fig. 1(g) - Same as Fig. 1(a) at 70 μm.

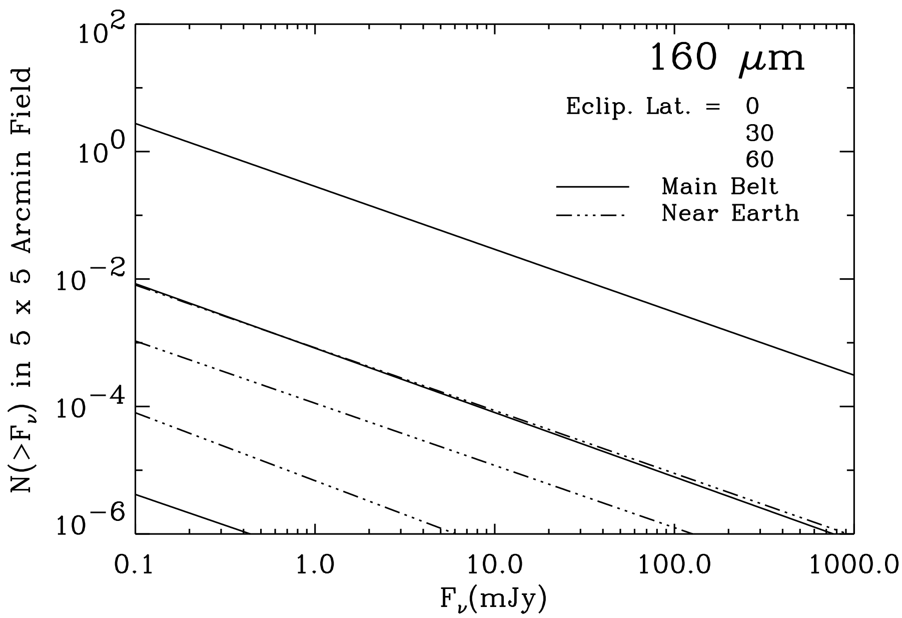

Fig. 1(h) - Same as Fig. 1(a) at 160 μm.

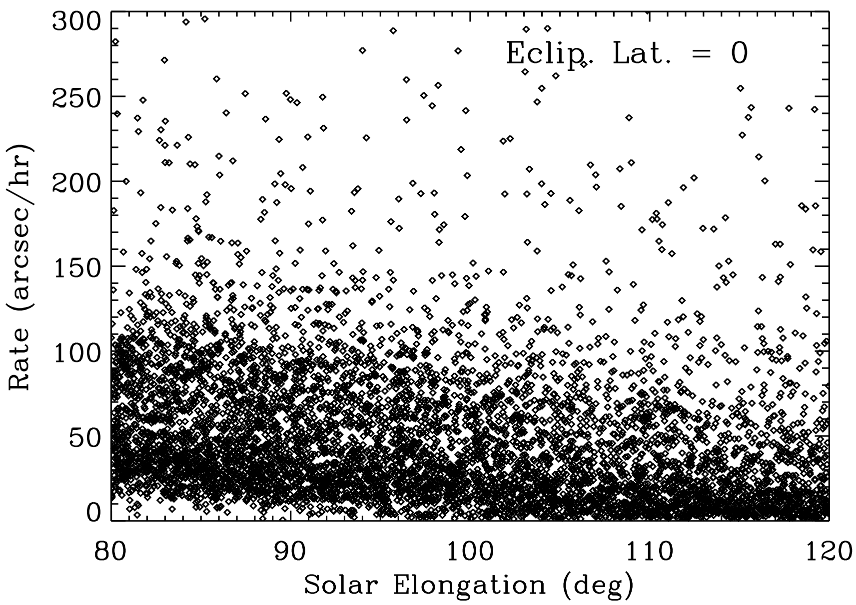

Fig. 2(a) - Simulation of the motions of near-earth asteroids in ecliptic coordinates as a function of solar elongation. Shown are 6390 objects with diameters greater than 60 m in a 5°-wide ecliptic latitude bin around 0°.

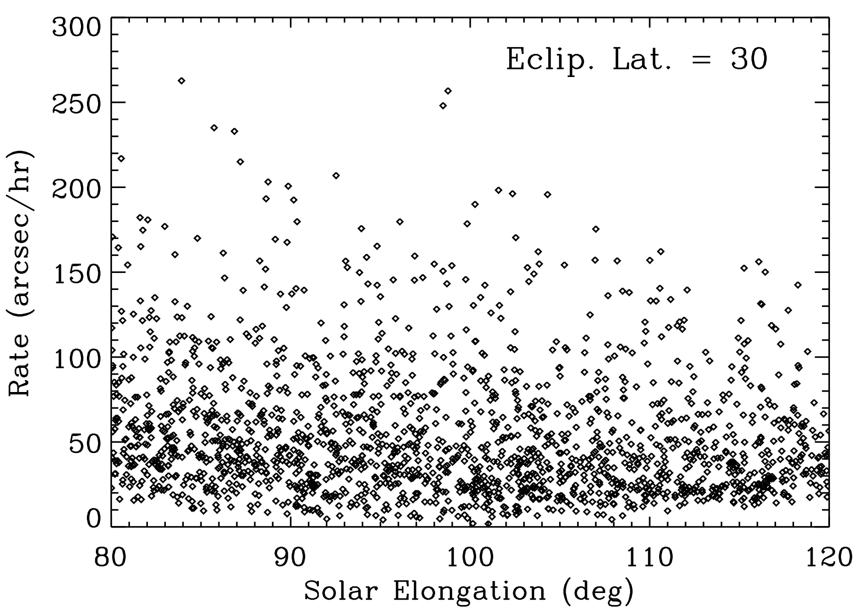

Fig. 2(b) - Same as Fig. 2(a) for 1745 objects in two 2.5°-wide ecliptic latitude bins around ±30°.