Near Earth Objects Sources Astrometric Program

Sergio Foglia
UAI Minor Planets Section Recorder
Serafino Zani Obs., Lumezzane, MPC 130
F. Bisleri 11, I-20148 Milano, Italy
s.foglia@libero.it

1. NEOs source region

According to Morbidelli et. al. [1] Near Earth Objects (NEOs) come mainly from 5 sources with the following contributions to the population:

- The ν_6 resonance region at the inner border of the asteroid main belt: 37 ± 8 %
- the 3:1 resonance region in the middle of the asteroid main belt: 23 ± 8 %
- the Intermediate Mars-Crossing (IMC) population: 25 ± 3 %
- the Outer Belt (OB) population: 8 ± 1 %
- the population of dormant Jupiter Family Comets (JFC): 6 ± 4 %

1.1. the ν_6 resonance region at the inner border of the asteroid main belt

Resonance that occurs when the precession frequency of the asteroid's longitude of perihelion is equal to the sixth secular frequency of the planetary system. The latter is related to the mean precession frequency of Saturn's longitude of perihelion, but it is also relevant in the secular oscillation of the eccentricity of Jupiter.
Fig. 1 shows the domain of this region, fig. 2 gives the time evolution of semi-major axis and eccentricity of an object coming from this region.

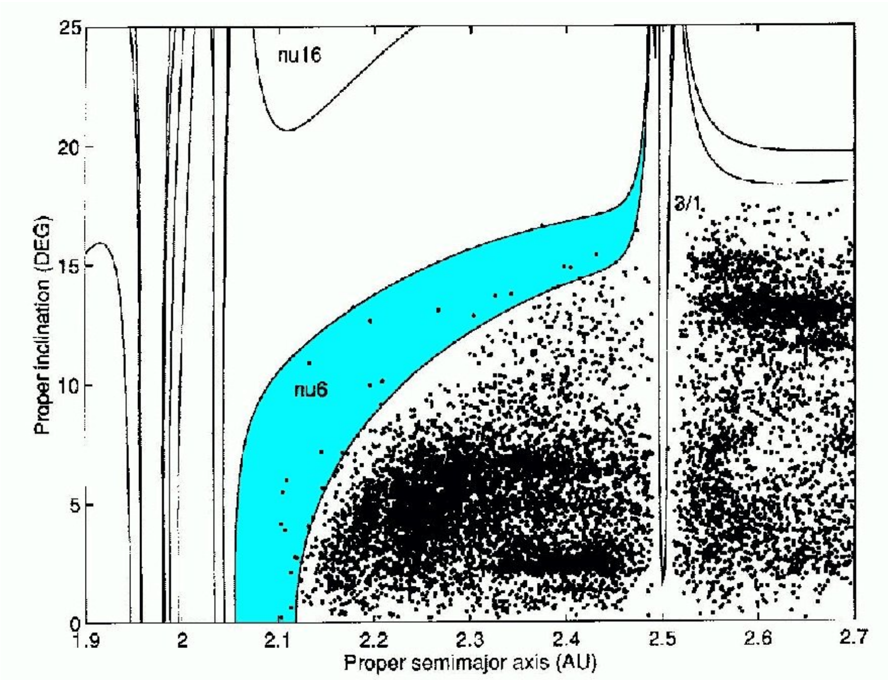

Figure 1: domain if the ν_6 secular resonance

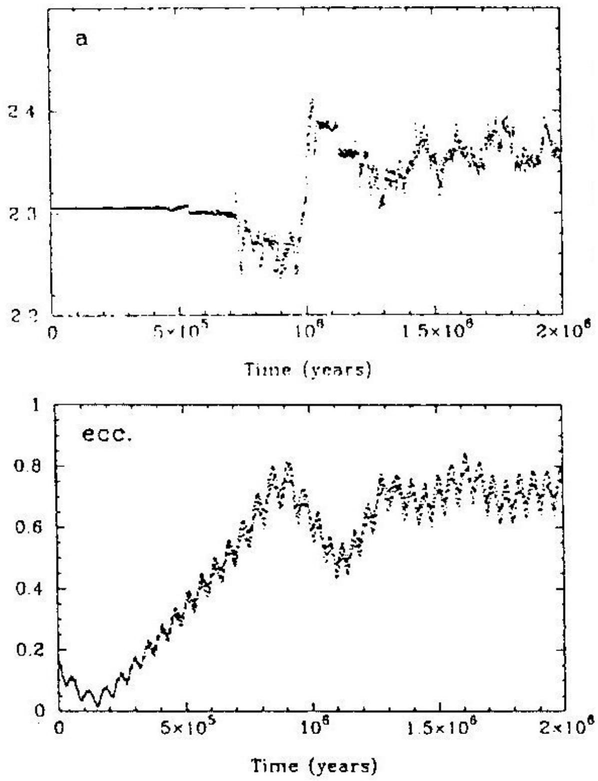

Figure 2: time evolution of an asteroid coming from this region

1.2. the 3:1 resonance region in the middle of the asteroid main belt

Resonance that occurs at 2.5 AU, where the orbital period of the asteroid is one third of that of Jupiter. Fig. 3 shows the domain of this region, fig. 4 gives the time evolution of semi-major axis, inclination and eccentricity of an object coming from this region.

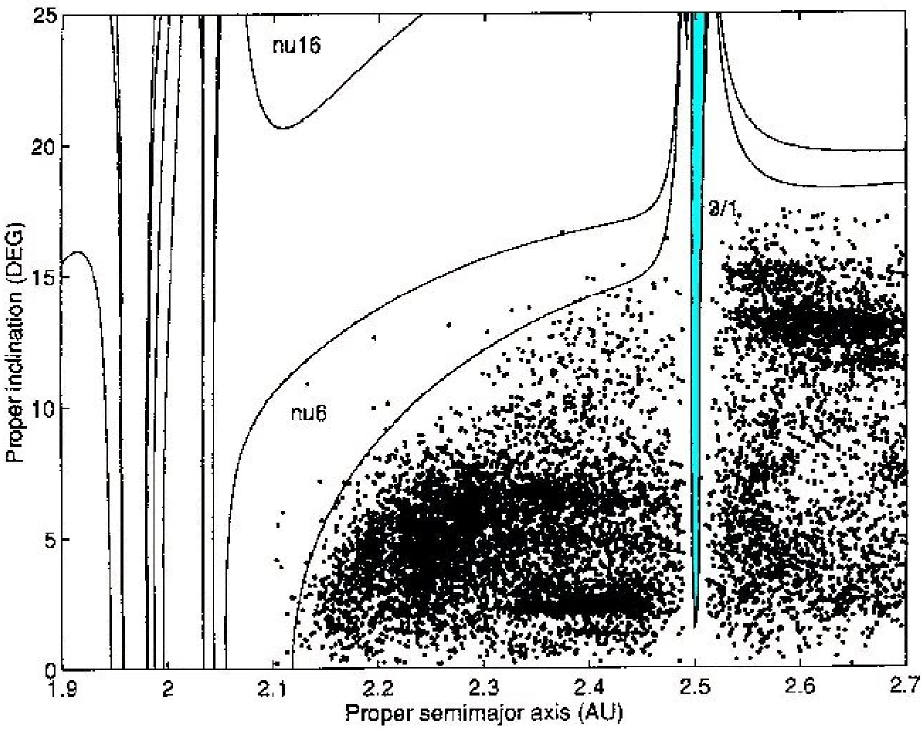

Figure 3: domain if the 3:1 mean motion resonance

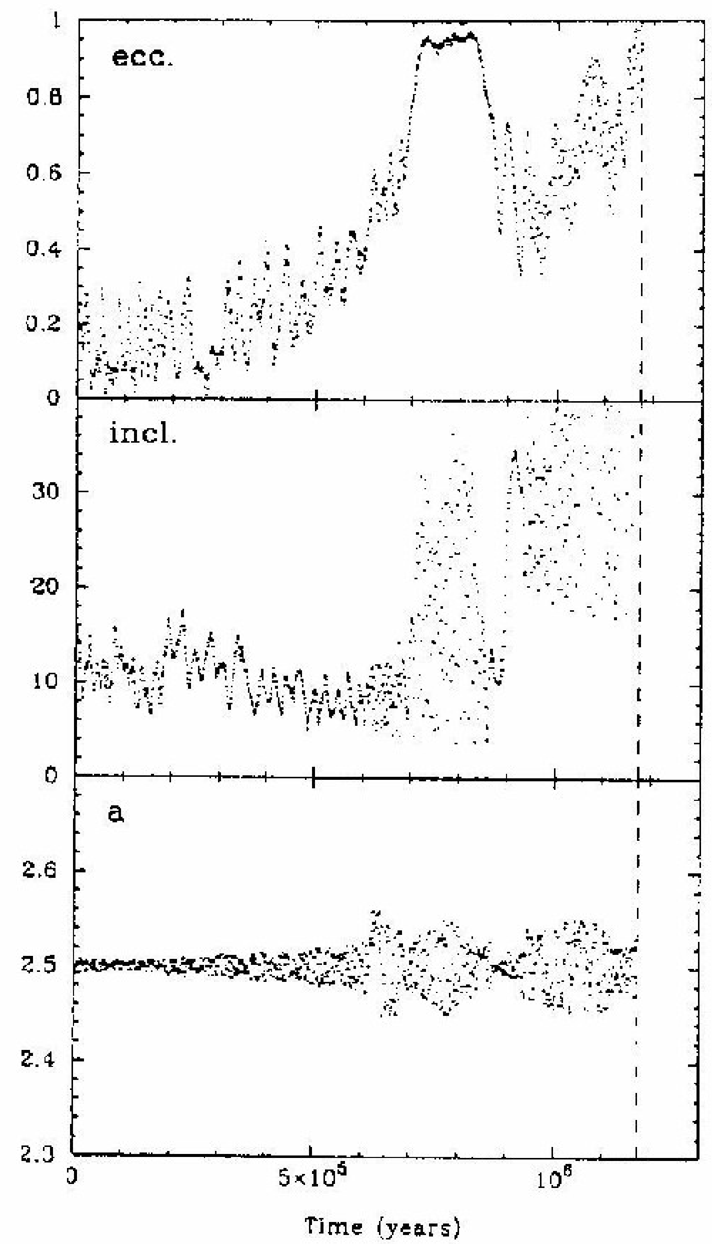

Figure 4: time evolution of an asteroid coming from this region

1.3. the Intermediate Mars-Crossing (IMC) population

Asteroid population with perihelion distance larger than 1.3 AU, semi major axis between 2.06 and 2.8 AU, inclination below the location of the ν_6 resonance, and crossing the orbit of Mars during a secular oscillation cycle of their eccentricity. Many asteroids in the IMC population become NEOs on a timescale of several tens of million years. Nevertheless the IMC population does not shrink in number, because it is directly replenished by an extensive network of resonances that continuously transport asteroids from the main belt into the IMC region.

1.4. the Outer Belt (OB) population

Asteroids with semi major axis larger than 2.8 AU and perihelion distance smaller than 2.4 AU. Like the asteroids in the IMC population, also bodies in the OB population become NEOs on a timescale of several tens of million years.

1.5. the population of dormant Jupiter Family Comets (JFC)

Population of short periodic comets with low inclination, on Jupiter-crossing or quasi-crossing orbits. They are believed to come from the populations situated beyond the orbit of Neptune: the Kuiper belt and the Scattered disk.

Figure 5 shows the asteroid main belt and the different NEOs source regions.

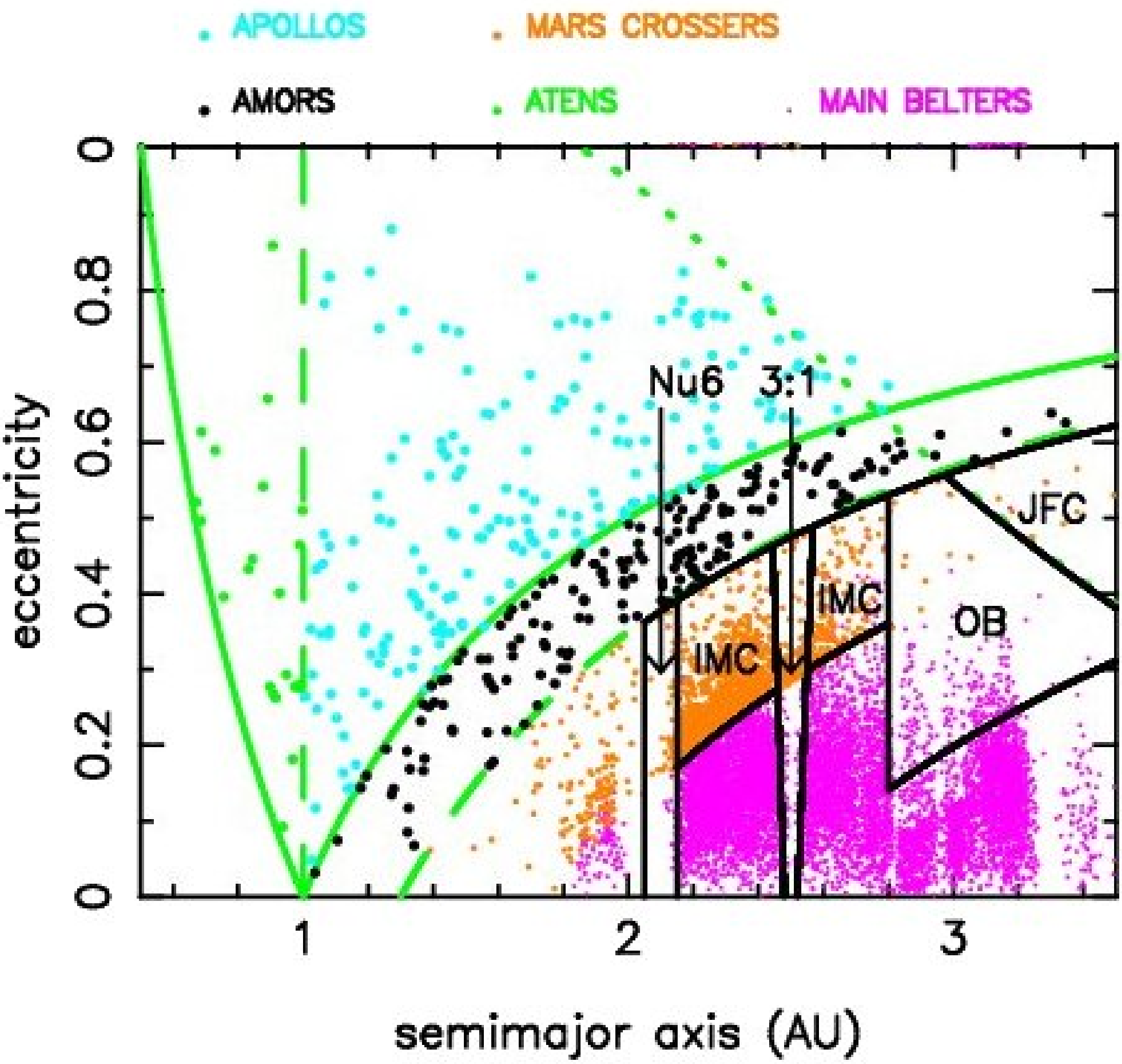

Figure 5: NEOs source region

2. NEOSAP program

Astrometric measurements of objects in these source regions would be very useful to increase knowledge about the NEOs source population and Solar System dynamics. Thus a new astrometric program for NEOs source bodies involving amateur astronomers is suggested. For this program, most objects are usually brigther than 18.0 V magnitude and thus are within the range of equipment for many observers to obtain good measurements.

Our goal is to suggest an observing program named Near Earth Objects Source Astrometric Program (NEOSAP) involving the following objects:

- Mars Crosser having q < 1.52 and Q > 1.52, where q and Q are the perihelion and aphelion distances in AU;
- asteroids in the ν_6 secular resonance;
- asteroids nearby to the 3:1 mean motion resonance with Jupiter.

Interested observers will find ephemeris and some information at the following URL:
http://www.uai.it/sez_ast/neosap.htm

Astrometric measurements must be sent to the Minor Planet Center in the usual way; no action is required by observers and suggested URL serves only to provide information and ephemerides for recommended targets.

Figures 6 to 9 show several distribution of these objects where all asteroids with semi-major axis greather than 2.0 AU and less than 6.0 UA and inclination between 0° and 90° are shown as dots; light grey bordered rectangles are the Mars Crosser asteroids, dark grey bordered rectangles are objects in the nu6 secular resonances, filled rectangles are asteroids nearby to the 3:1 mean motion resonance with Jupiter. Distributions are the following: semi-major axis (a) versus inclination (i), semi-major axis (a) versus eccentricity (e), eccentricity (e) versus inclination (i), longitude of perihelium (w+O) versus semi-major axis (a).

Table 1 gives numbers of NEOSAP asteroids in the different categories: JR refers to asteroids nearby to the 3:1 mean motion resonance with Jupiter, MC are the Mars Crossers, NU are objects in the ν_6 secular resonance.

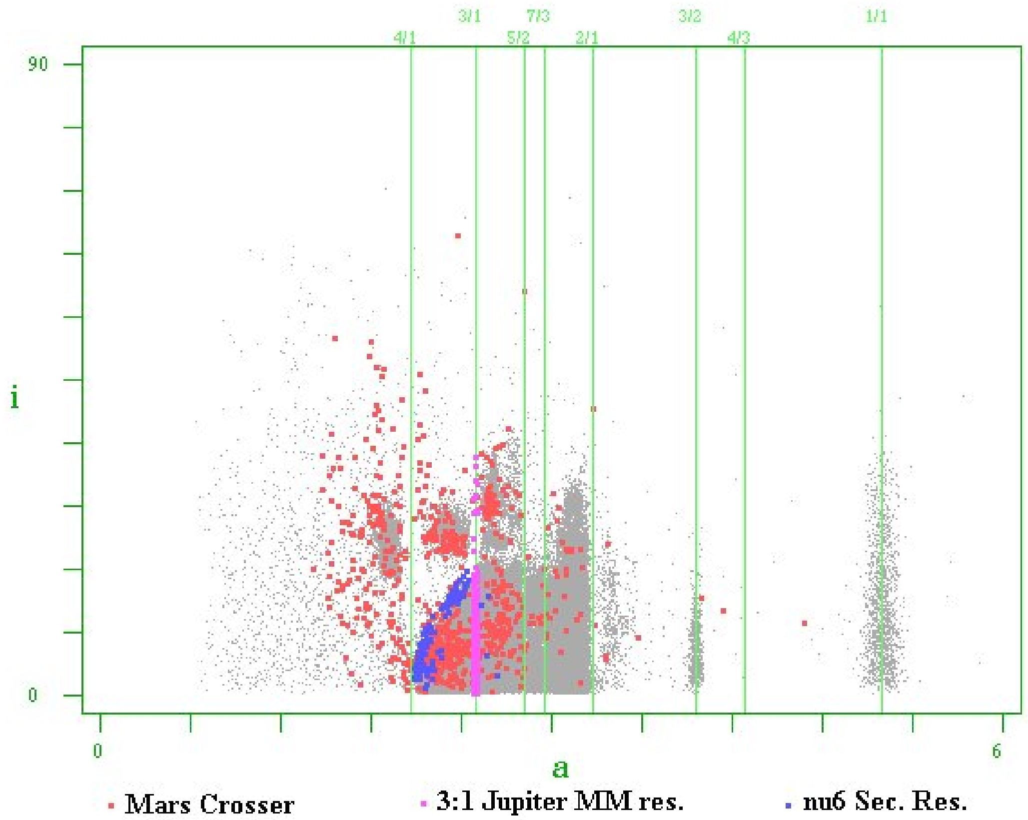

Figure 6: semi-major axis (a) versus inclination (i)

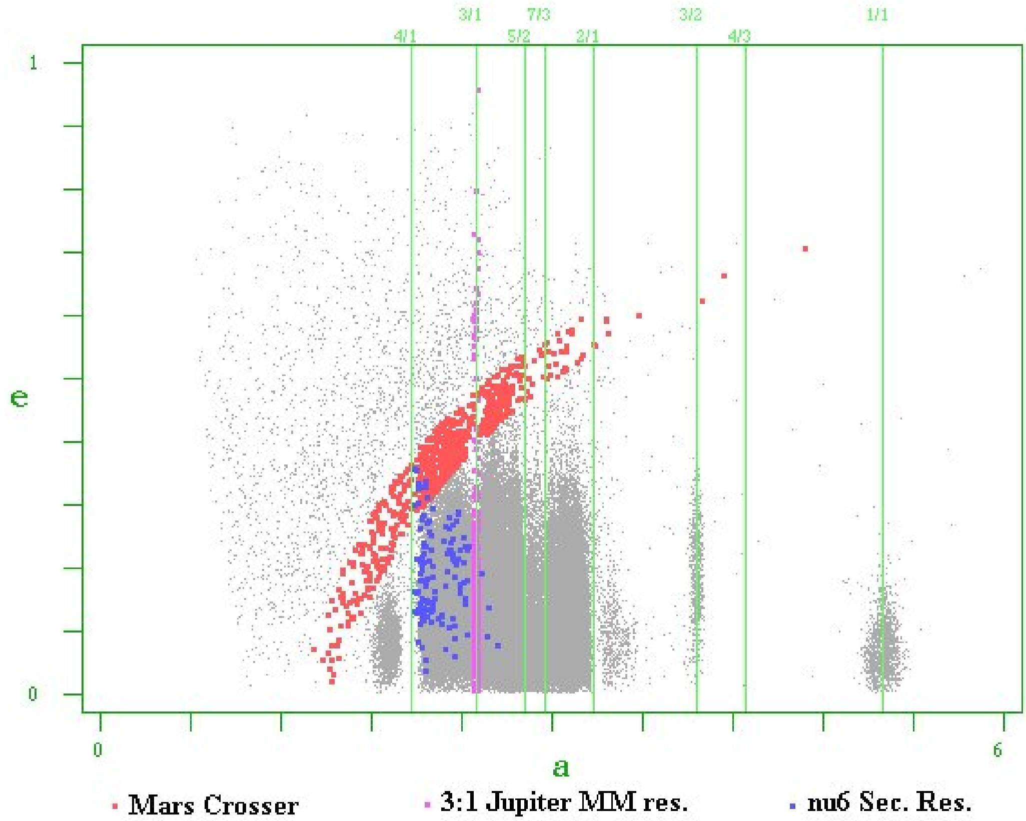

Figure 7: semi-major axis (a) versus eccentricity (e)

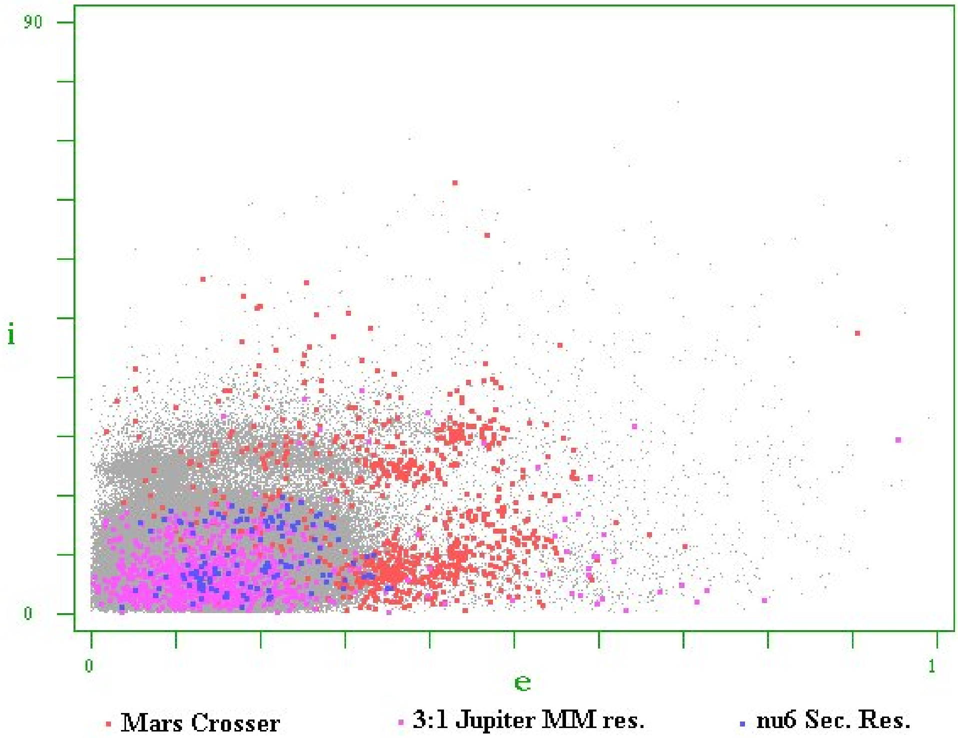

Figure 8: eccentricity (e) versus inclination (i)

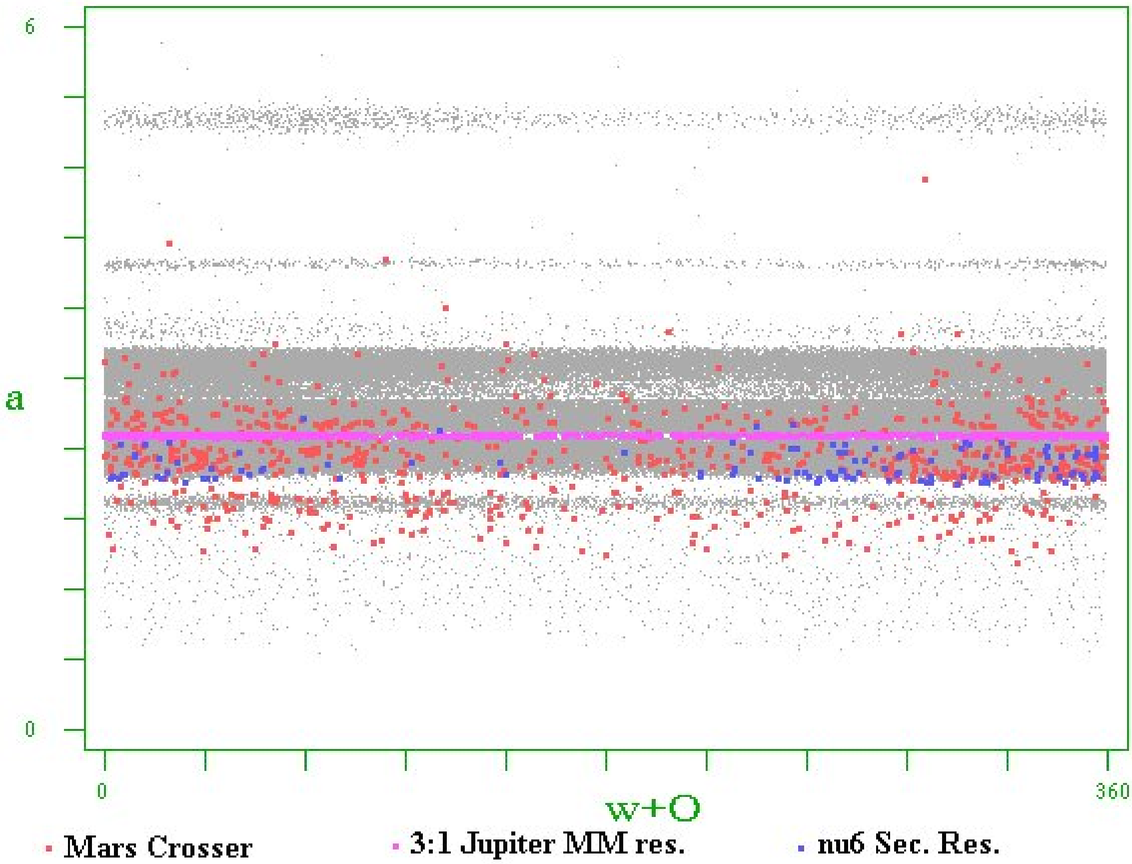

Figure 9: longitude of perihelium (w+O) versus semi-major axis (a).

JR	717
MC	726
MC + JR	5
MC + NU	10
NU	116
Total	1574

Table 1: numerosity of NEOSAP asteroids

Bibliography

[1] Morbidelli et. al. (2003)
Understanding the distribution on Near Earth Objects
http://www.obs-nice.fr/morby/ESA/esa.html

[2] MPC Orbit Database
ftp://ftp-cfa.harvard.edu/pub/MPCORB/
2003 sep. 17, Minor Planet Center

[3] Proper Elements of Minor Planets
http://hamilton.dm.unipi.it/astdys/
2003 sep. 17, Asteroid Dynamic Site