ON A DYNAMICAL CLASSIFICATION OF THE GROUPS OF NEAS

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Abstract: The near Earth asteroids (NEAs) are dynamically classified according to their orbital characteristics into four groups: Atens, Apollo, Amor and Atira. The Atens have a semi-major axis of less than 1 au and aphelion distance greater than the Earth's perihelion distance (0.983 au). The Amors have perihelion distance greater than the Earth's aphelion distance (1.017 au) and aphelion smaller than 1.3 au. The Apollos have semi-major axis of more than 1 au and perihelion distances smaller than the Earth's aphelion distance. The Atiras, or IEO (Interior to the Earth Orbit) have aphelion distance smaller than Earth's perihelion distance. The mean lifetime of NEAs is of the order of 10 Myrs. The dynamic of the NEAs are dominated by the gravitational interaction with the terrestrial planets. A single close encounter with one of these planets can move the asteroid from one group to another. The goal of this work was to study the temporal orbital evolution of the NEAs paying special attention to their mobility as a function of their initial location in the semi-major axis versus eccentricity plane (a x e), and consequently in their transition between the groups. Our method was based on numerical integrations of the gravitational N-body problem of a system composed by the Sun, the planets Venus, Earth, Jupiter, Saturn, Uranus and Neptune and a sample of 1500 NEAs – 500 Atens, 500 Apollo and 500 Amor, for a time span of 10 Myrs – the mean lifetime of NEAs. After the integration, we analyzed the evolution of the orbit of each NEA. They were classified as Atens, Apollo, Amor, IEO, or a MBA (Mean-Belt Asteroid) for each output step of the integration. Our simulations showed cases where a single asteroid experienced four change of group. In other cases some NEAs spend their whole life oscillating between only two groups, and we also found some NEAs that do not experience a change in the initial group that they belonged to. We then characterized the transition of these asteroids among the groups along their lifetime within the population of NEAs, and we analyzed how this is related to the initial orbit of the asteroid in terms of their initial semi-major axis, eccentricity and inclination. The results of this analysis suggest that in fact the usual classification of NEAs between groups in a statical approach is acctually a “snapshot” of the population. The dynamical classification that we propose give a better representation of these groups.

keywords: asteroids, NEAs.