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Distribution of Jupiter-family asteroids and comets in near-Earth space

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Abstract

We analyze the orbital distribution of objects captured to near-Earth space from the flux of comets coming from the outer Solar system. For this purpose, we use the model of the cometary cloud developed earlier. This model is consistent with the broad dynamical characteristics of observed near-parabolic comets, short-period comets, Centaurs and high-eccentricity trans-Neptunian objects. We show that the observed distribution of near-Earth objects moving in cometary orbits is different from the modelled distribution formed dynamically by the action of planetary perturbations. In particular, while the distributions of arguments of perihelion for observed Jupiter-family comets and modelled cometary objects follow a sinusoidal law with pronounced maxima around 0 and 180 degrees, it is not the case for the distribution of observed cometary asteroids. We discuss those factors which could lead to this inconsistency in the distribution of active Jupiter-family comets and asteroids in cometary orbits.

1. Introduction

Models of the dynamical evolution of comets from both the Oort cloud and the trans-Neptunian region into short-period orbits predict many times more near-Earth comets than are observed [3[, [9], [4], [5]. This assumes that comets disintegrate during perihelion passages in the inner planetary region. In particular, it is shown that the mean physical lifetime of active Jupiter-family comets in orbits with perihelion distances q<1.5 AU is less than ~ 200 revolutions [4], [5], [1]. An important issue is to determine the fate of inactive comets. Here, we try to investigate this problem by comparing model results to observations of Jupiter-family comets and near-Earth objects.

2. Model

In the present study, we extend the calculations of the dynamical evolution of comets from the outer Solar system (the Oort cloud and the trans-Neptunian region) [4], [5], considering a much larger number of small bodies in order to obtain data for short-period near-Earh objects with greater statistical significance. This model of the cometary cloud is consistent with the broad dynamical characteristics of observed near-parabolic comets, short-period comets, Centaurs and high-eccentricity trans-Neptunian objects [6].

Figure 1 shows the region of Tisserand parameters T and perihelion distances q occupied by objects captured from the outer Solar system to short-period orbits with 0.05<q<1.3 AU and T>2 (no restriction on the physical lifetime).

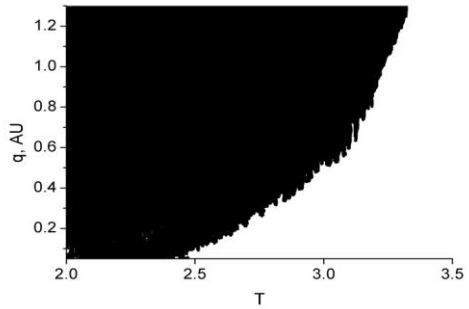

Figure 1: The distribution of T and q for near-Earth Jupiter-family objects captured from the cometary cloud.

3. Comparison with near-Earth asteroids in cometary orbits

The modelled distribution is consistent with the observed orbital distribution and the number of Jupiter-family comets if we assume a limit of about 150 revolutions for the physical lifetime of comets in

the region q<1.5 AU [6]. On the other hand, the observed distribution of cometary asteroids is substantially different from the model and observations of Jupiter-family comets. For example, Figure 2 shows the distribution of arguments of perihelion ω for objects from Figure 1. This distribution is very similar to that for the observed Jupiter-family comets [2], [7].

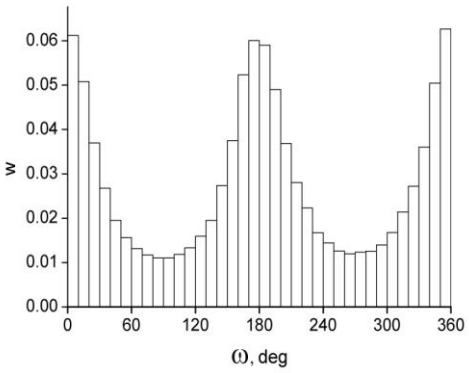

Figure 2: The distribution of ω for objects from Figure1.

But this distribution is very different from the distribution of cometary asteroids. Figure 3 shows the distribution of near-Earth asteroids with absolute magnitudes H<18, aphelion distances Q<4.5 AU, and Tisserand parameters located in the black region of Figure 1. These objects are usually regarded as candidates for inactive (dormant) comets [8].

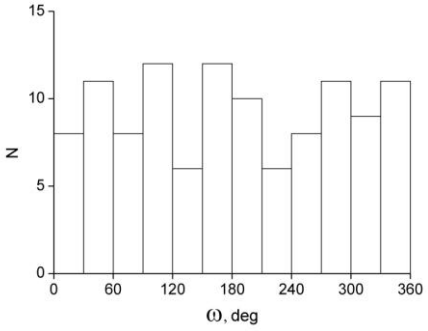

Figure 3: The distribution of ω for near-Earth cometary asteroids.

We will discuss those factors which could lead to this inconsistency in the distributions of active Jupiter-family comets and asteroids in cometary orbits.

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