Migration of trans-Neptunian bodies to Earth

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Due to the gravitational influence of planets and mutual close encounters, some bodies from the Edgeworth-Kuiper belt can migrate inside the solar system. Duncan et al. [1] obtained that the portion of Neptune-crossing objects, which reach the Jupiter's orbit during their lifetimes, is about 1/3. The results of our numerical investigations of orbital evolution of bodies under the gravitational influence of planets showed that the mean time interval, during which an object crosses the Jupiter's orbit during its lifetime, is about 0.2 Myr, the portion of Jupiter-crossers that reach the orbit of the Earth during their lifetimes is equal to 0.2, and the mean time, during which a Jupiter-crossing object crosses the orbit of the Earth, is about 5000 yr. It is considered that there are about 10^{10} bodies with diameter $d > 1$ km with semimajor axes between 30 and 50 AU and about 10–20% of them could leave the Edgeworth–Kuiper belt during last 4 Gyr. Basing on the above data, we obtained [2] that the number of the present Jupiter-crossers with diameter $d > 1$ km, which came from the belt, is equal to 30000 and there are about 170 former trans-Neptunian objects with $d > 1$ km, which cross both the orbits of Earth and Jupiter (i.e., about 20% of all Earth-crossers with $d > 1$ km). The portion of such objects colliding with the Earth is smaller than their portion among Earth-crossers, because the characteristic time elapsed up to a collision with the Earth for a Jupiter-crossing body is larger by a factor of several than that for an Apollo object (the latter is on average about 100 Myr). The number of former Jupiter-crossers that move inside the orbit of Jupiter in Encke-type orbits can be of the same order (or even more) than the number of objects that cross both the orbits of Jupiter and Earth. The number of trans-Neptunian objects with $d > 1$ km and semimajor axes between 30 and 50 AU can be larger than 10^{10} [3], and also some objects moving in highly eccentrical orbits with larger semimajor axes can migrate inside the solar system. So, the portion of former trans-Neptunian objects among near-Earth objects can be even larger than the above estimates. This work was supported by the Russian Federal Program "Astronomy".

[1]. Duncan M., Levison H.F., and Budd S.M., Astron. J., 1995, v. 110, 3073-3081.

[2]. Ipatov S.I., Celest. Mech. Dyn. Astron., 1999, v. 73, 107-116.

[3]. Jewitt D., Annu. Rev. Earth. Planet. Sci., 1999, v. 27, 287-312.