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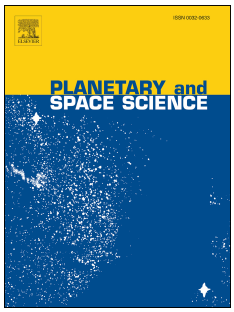

How long will asteroids on retrograde orbits survive?

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How long will asteroids on retrograde orbits survive?

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Abstract

Generally, a common scenario for the origin of minor planets with high orbital inclinations does not exist. This applies especially to objects whose orbital inclinations are much greater than 90 degrees (retrograde asteroids).

Since the discovery of Dioretsa in 1999, approximately 100 small bodies now are classified as retrograde asteroids. A small number of them were reclassified as comets, due to cometary activity. There are only 25 multi-opposition retrograde asteroids, with a relatively large number of observations and well-determined orbits.

We studied the orbital evolution of numbered and multi-opposition retrograde asteroids by numerical integration up to 1 Gy forward and backward in time. Additionally, we analyzed the propagation of orbital elements with the observational errors, determined dynamical lifetimes and studied their chaotic properties.

Conclusively, we received quantitative parameters describing the long-term stability of orbits relating to the past and the future. In turn, we were able to estimate their lifetimes and how long these objects will survive in the Solar System.

Keywords: methods: numerical celestial mechanics minor planets, asteroids: general.

1. Introduction

Discovery statistics. The 1999 discovery of the first asteroid in retrograde orbit was so unusual, such that the suggested name was the ananym of the word 'asteroid': Dioretsa. This unusual minor body has been observed for a long time (since its precovery in 1998) and is still classified as a Centaur. At the present time a great number of asteroids with $i > 90^\circ$ are known. For sake of brevity, we will use a short term for such objects: retrograde asteroids. When we started studying this asteroid group around 2008, we had only 22 discovered objects, of which a few were numbered. Furthermore, a few of the studied objects were later reclassified as comets. Despite this, the number of classified asteroids is constantly increasing (Fig. 1).

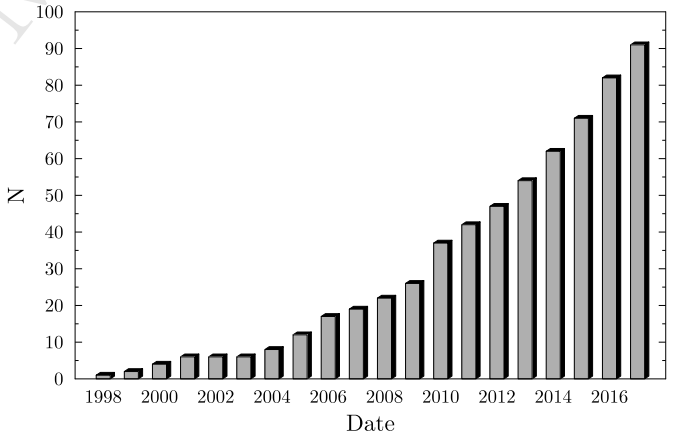

Figure 1: The discovery statistics of retrograde asteroids: the cumulative number of known small bodies in retrograde orbits, without objects re-classified as comets.

Hypotheses of origin. So far, there is no consistent hypothesis on the origin of retrograde asteroids. Since the number of these objects is relatively small, their lifetimes must be short, therefore the 'production' mechanism is probably not effective. According to some authors, particular resonances with giant planets can play an important role in this mechanism. It has been proven that some well known resonances, such as a 3:1 with Jupiter, can produce NEA orbits with extreme inclinations (Greenstreet et al., 2012). de la Fuente Marcos and de la Fuente Marcos (2014) also suggested that higher order resonances with giant planets correlate with the 'chaotic' production of retrograde orbits. There may exist a hypothetical reservoir of these objects located at a great distance from the Sun, acting as a source of eccentric and extremely inclined orbits. This could be the Oort Cloud.

Similarities to comets. Unusual values of inclinations raise the suspicion that most of the bodies in retrograde orbits are simply inactive comets. This hypothesis can be

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