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DISTRIBUTION OF SPIN-AXIS LONGITUDES FOR NEAs AND MBAs

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ABSTRACT

By analyzing brightness variation with ecliptic longitude and using the Lowell Observatory photometric database, we have previously estimated spin-axis longitudes for more than 350 000 asteroids (including around 1000 near-Earth asteroids (NEAs) and 100 000 main-belt asteroids (MBAs) having at least 25 photometric measurements and longitude uncertainty below 60°) [1]. Earlier spin axes had been known for fewer than 200 asteroids [2]. The new estimations allowed us for the first time to look on the extended number of objects and create more reliable spin-axis longitude distributions. We showed that the obtained spin-axis longitude distributions for near-Earth asteroids and main-belt asteroids are not random as previously considered.

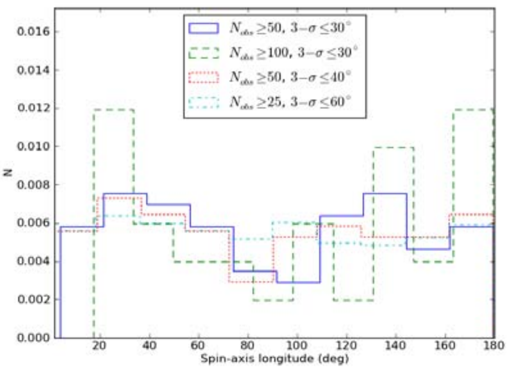

Illustration 1: Normalized spin-axis longitude distribution for near-Earth asteroids with different selection criteria, according to the minimum number of observations and spin-axis longitude uncertainty.

The spin-axis distribution for NEA shows two maxima: the first maximum between 0°-70° and second between 110°-180°(illustration 1) The spin-axis longitude distribution for MBA shows excess of longitudes from the interval 30°-110° and a paucity between 120°-180° (illustration 2).

Here we present the spin-axis longitude distributions for the two dynamical groups and discuss possible reasons causing the observed distributions. We consider two main hypothesis: 1) The observed distribution is caused by the influence of the YORP effect or other non-gravitational effects on small asteroids; 2) The observed distribution is due to observational and selection biases.

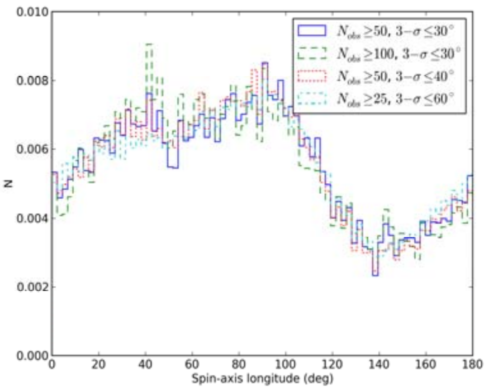

Illustration 2: Normalized spin-axis longitude distribution for main-belt asteroids with different selection criteria, according to the minimum number of observations and spin-axis longitude uncertainty.

In the first case if the observed distribution is of non-gravitational origin it should depend on asteroid size. For example the YORP effect affects mostly small (< 10 km in diameter) and moderate size (10-30 km) objects. The effect is very weak for large (> 30 km) objects. Any other non-gravitational effect will also depend on the size of the object. We find no dependency of the observed distribution on asteroid size, therefore we consider YORP or any other non-gravitational effects unlikely to produce the distribution.

The second possibility is the observational selection bias. In particular, we consider the line-of-sight specificity effect [3] [4]. Generally, only objects whose orbits place them in the line-of-sight of the telescope are detectable. Additionally most of the asteroids are observed in opposition. In this case asteroids are detected near the ecliptic plane at their ascending or descending node, favoring specific longitudes of ascending/descending nodes. Asteroids whose poles are directed towards the observer are the brightest. Therefore we observe an excess of asteroids having spin-axis longitudes 90° or 270° away from their nodes and the spin-axis longitude distribution relates well to the distribution of the longitude of ascending node.

In this effect the NEA population would be the least affected, the MBAs would be more affected and the TNOs should show the largest effect. We find that the effect is indeed strongest for the TNO population.

Therefore we consider the line-of-sight specificity effect a possible explanation of the observed longitude distributions.

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