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Evidences of asymmetry in properties of L4 & L5 Jupiter Trojans

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Abstract. We search for possible differences in rotational frequencies, diameters, albedos, and orbital parameters between Trojans belonging to the L4 and L5 swarms using our own observations and literature data. With increasing number of observational data it becomes evident that the L4 and L5 populations have very similar distributions of most parameters with an exception of orbital inclination distribution.

Keywords. Trojans, asteroid families, orbital inclinations, asymmetry, proper elements

1. Introduction

In the second half of 2000's, after the emergence of new class of models of evolution of the early Solar system in the second half of 2000s (Nesvorny *et al.* 2013 and ref. therein) has increased interest to Jupiter Trojans. Mechanism of Trojans capture and the place of their origin (the population is either primordial or was captured from the outer part of Solar system during gas giants migration) were the significant component of these models. Therefore, investigation of this population is necessary to test these models. Below we investigate one of the most intriguing features of the Jupiter Trojans population related to the observed asymmetry between the L4 and L5 groups.

2. Search for asymmetries in dynamical and physical properties

From the beginning of the study of Jupiter Trojans, there is a well-known difference in number of objects between L4 and L5 groups. At present, according to MPC, there are more than 7000 Trojans in both swarms, moreover L4 population outnumbers the L5 in about 1.9 times. Except this well-known asymmetry between L4 and L5 swarm, in our previous work (Slyusarev & Belskaya 2014) we found a significant difference in orbit inclinations distribution. Here we search for possible differences in physical and dynamical properties using the increasing set of observational data. We examined such properties as albedo and diameters (Grav *et al.* 2011); inclinations, eccentricities, and absolute magnitudes (from MPCORB database); lightcurve amplitudes and periods (MPC Asteroid Lightcurve Database). We did not find statistically significant differences in the distributions of these parameters, except diameters (within fraction of asteroids smaller than 20 km) and inclinations. Distributions of inclinations show drastic differences in L4 and L5 (Fig. 1a). After peak at 8 degrees of inclination, the distribution of L4 Trojans decreases exponentially, while there is a wide plateau in L5 group. As it was firstly noted in (Di Sisto *et al.* 2014), the main contribution to this asymmetry is made by bodies smaller than 30 km in diameters. We validated this assumption for smaller diameters

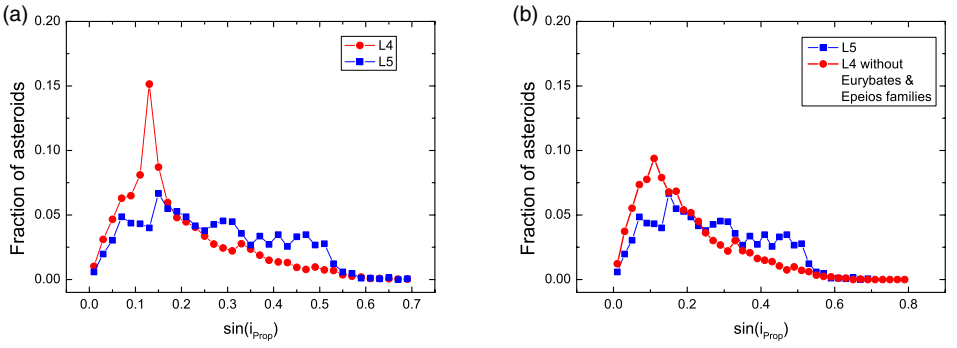

Figure 1. Distribution of sine of proper inclinations in L4 and L5 swarms; a) all asteroids, b) L4 after elimination Eurybates and Epeios families.

and found the same shape of asymmetry for asteroids smaller than 20 km. Since such small asteroids are a product of collisional history, we assume that families in Trojan swarms could be the key to understanding the reason of asymmetries because they are also formed due to collisions. That is why we also built distributions of sine of the proper inclinations and saw similar kind of asymmetry (Fig. 1). We have checked if the elimination of family members influences the asymmetry. Firstly, we extracted asteroids of Eurybates family, the only robust family among Trojans (Broz & Rozehnal 2011), and found that a strong peak in L4 significantly decreased (Fig. 1b). We also checked the contribution of Ennomos family in L5 and Epeios family in L4 (Broz & Rozehnal 2011 and Vinogradova 2015). Elimination of Ennomos family members didn't affect the distribution, while those of Epeios family did. We see that families cannot wholly explain the asymmetries between the swarms: differences still present in the sin(i) intervals of 0.07-0.16 and 0.25-0.55. (Fig. 1b).

3. Conclusions

We have compared the distributions of albedos, diameters, lightcurve amplitudes, rotational frequencies, eccentricity, and inclinations of Trojan asteroids of L4 and L5 swarms. All these parameters, except inclinations, showed no significant differences. We found that asteroids smaller than 20 km in diameter mainly contribute to asymmetry inclinations distribution. Taking into account that small asteroids are the product of collisions, we checked the contribution of the most reliable Jupiter Trojans families to this asymmetry and found significant influence of Eurybates and Epeios families. However, families solely cannot explain all the differing features of the distributions. This fact gives us the reason to assume that some asymmetries of L4 and L5 swarms could be primordial.

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