

# Trojans distribution in the Solar system

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**Abstract.** Orbits of potential Trojans of different planets in the solar system were selected from the MPC catalog on February, 2017. The evolution of those orbits was calculated. The bodies on librating orbits around the points L4 and L5 were determined. The quantities of real Trojans in the MPC catalog are as follows: Mars - 5, Jupiter - over 4500, Saturn - none, Uranus - 2, Neptune - 15. A reasoned explanation of such distribution of Trojans in the solar system is proposed.

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## 1. Introduction

A decade ago a specific non-gravitational effect (NGE) in the asteroid belt was revealed (Kazantsev, 2007). More detail description of the NGE is presented in (Kazantsev & Kazantseva, 2017). This NGE causes an increase in the semimajor axes of orbits of low-albedo asteroids relative to the semimajor axes of orbits of high-albedo bodies. The NGE existence is confirmed by the distributions of albedo values in separate asteroid families. The physical mechanism behind this NGE should be close in nature to the NGE seen in comets. It is possible to propose a reasoned explanation for the origin of Trojans in the Solar system using the NGE.

## 2. Origin of Planet Trojans under the NGE action

Planetary perturbations can move a small body from the inner or outer zone to become Trojans. But the initial orbit eccentricity of the body should be pretty high. Therefore such body cant remain in the 1:1 commensurability with the planet for a long time. We carried out numerical calculations of asteroid orbital evolution taking into account not only planet perturbations but also a model NGE. The model NGE in every step of integration gives the asteroid an additional impulse either in the direction of its orbital velocity, or in the opposite direction. In the first case the NGE causes an increase in the semimajor axis, in the latter case decrease in the semimajor axis. During the evolution under the NGE influence, the semimajor axis increases or decreases in response to small changes of the eccentricity. Therefore such orbit can remains in the commensurability 1:1 with the planet for a long time. If the NGE is several times more powerful than for Jupiter family comets (JFC), an asteroid from the outer edge of the asteroid belt can move into the 1:1 resonance with Jupiter. The bodies that do not fall into 1:1 resonance with Jupiter, behind its orbit pass into orbits typical for Centaurs. They will never be able to become stable Trojans of other planets. Neptune Trojans can pass from the inner edge of Kuiper belt under the NGE action. In that case the NGE power may be less than for JFC. The semimajor axes of orbits that do not fall into 1:1 resonance with Neptune continue to decrease smoothly at small eccentricities. Some bodies on such orbits can become Uranus Trojans. It is clear the quantity of such bodies should be much less than

Neptune Trojans. And sizes of Uranus Trojans should be noticeable smaller than sizes of Neptune Trojans. It is difficult to say if some bodies from Kuiper belt can become Saturn Trojans. In any case, such bodies should be very small (if the bodies exist generally). This conclusion corresponds to the available data as well. Origin of Mars Trojans can be explained by transition of bodies from the inner edge of MBA under the NGE action. But Mars cant hold at its Lagrange points these bodies, which undergo the NGE action like for JFC. If the NGE is three orders of magnitude lesser than for JFC, the bodies have a possibility to become Mars Trojans.

### 3. Conclusions

The origin of the planetary Trojans in the Solar system can be explained by the NGE action. There exists a simple method to verify the presented explanation: 1) Jupiter Trojans should mainly have prograde rotation; 2) Mars Trojans should mostly have retrograde rotation.

### References

- Kazantsev, A. 2007, *Kinem. Phys. Celest. Bodies*, 23, 258  
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