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Hektor : a space mission towards Jupiter Trojans

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Abstract

We present Hektor, a space mission towards the Jupiter Trojans. The detailed in-situ investigation of these objects, beside their unprecedented characterization, is likely to bring key indices for our understanding of the Solar system. The mission concept is a flyby of 5-10 Trojans with a relative velocity <3 km/s. The total duration of the mission is 8 years, with 3 years for scientific investigations in the Trojans clouds. The Hektor spacecraft includes a 50 kg scientific payload.

1. Introduction

The Jovian Trojans are asteroids confined to two swarms at the L4 and L5 Lagrangian points of the Sun–Jupiter system. It is a very intriguing population which has not attracted much attention in the past. Their very existence and their dynamical and physical evolutions represent major challenges, putting very strong constrains on any theory of the formation and evolution of the solar system. A detailed in-situ investigation of these objects, beside their unprecedented characterization, is likely to bring key indices for our understanding of the Solar system.

2. Scientific objectives

The main scientific objectives of the Hektor mission are the following:

- Determination of the physical parameters (size, volume, shape, pole orientation, rotation period). Combining with gravimetric measurements, this will allow deriving the density and the internal mass distribution, both information connected to the formation of Trojans.
- Determination of the thermal parameters (surface temperature, thermal inertia). These physical quantities will allow deriving the global thermophysical properties of the Trojan (heat conductivity, roughness) that connect to its origin and evolution, and quantifying the Yarkovsky effect for dynamical evolution.
- Determination of surface morphology (crater size distribution, presence of features such as ridges, grooves, faults, boulders, evidence of regolith). This connects to the age of the body, and to its past and recent evolution through collisions, irradiation or other surface processes (e.g., flows).
- Determination of mineralogical composition and photometric properties (albedo, heterogeneity of the surface, identification of local chemical zones, superficial texture). This connects to the origin of Trojans, to know where they were formed in the Solar System, and if they are made of one or several blocks, homogeneous or heterogeneous in term of composition.
- Search for possible gravitationally bound companions (detection of binary/multiple systems). This connects to dynamical studies and capture scenarii, and will allow determining the mass and density of the visited Trojans.

3. Mission scenario

Owing to the diversity of the properties possibly pointing to several families of different origins, we strongly favor a mission scenario where the spacecraft will investigate a substantial number of objects, and in addition, if possible, the two clouds L4 and L5.

The proposed mission is composed of one or two identical spacecrafts going to the L4 and/or L5 Lagrangian points of the Sun-Jupiter system. Each spacecraft will characterize about 5-10 Trojans (CONTOUR type mission). The orbital feasibility of such a mission is of course a key question.

A possible solution is illustrated by Fig. 1. It is based on:

- A Soyouz launch from the Kourou Space Center (French Guyana);
- Gravity assists from Venus and Earth;
- A cruise of $\sim$5 years, with the possibility to investigate a couple of main-belt asteroids on the way;
- A slow aphelion trajectory leading to two crossings of the Trojans cloud with a relative velocity $<$3 km/s, and a total residence time of $\sim$3 years allowing to flyby several Trojans;
- A possible extension of the mission to investigate additional main-belt asteroids or members of the Hildas family.

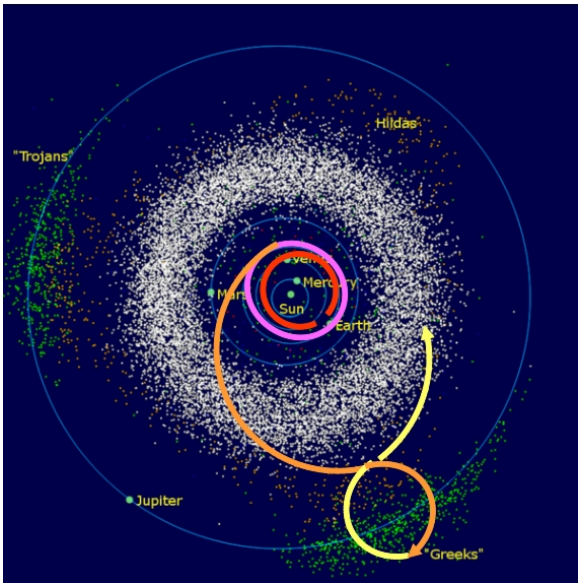

Figure 1: Proposed scenario for the Hektor mission. The trajectory is illustrated in the Sun-Jupiter rotating reference frame.

4. Scientific payload

The scientific payload mass is estimated to 50 kg, and a typical payload is given in Table 1.

5. Conclusions

There is a strong european community involved in the study of small bodies in the Solar system as evidenced by the past Giotto mission, the on-going Rosetta mission and the proposed Marco Polo mission. The Hektor mission could be a new, low-cost and realistic opportunity for an ESA led mission to small bodies, in the framework of the Cosmic Vision II program. We note that there also is a very strong interest in the US community for such a mission as mentioned in the last NASA decadal survey and confirmed by possible proposals for the current NASA Discovery program. A joint mission between ESA and NASA could therefore be an excellent solution to carry out the first in-situ reconnaissance of the Trojan asteroids.

Table 1: Proposed payload of the Hektor spacecraft

Instrument	Mass (kg)	Vol. (mm^3)
Core payload		
Narrow Angle Cam. (f=500 mm)	10	800x150x150
Wide Angle Cam. (f=75 mm)	5	200x150x150
Thermal mapper (f=75 mm)	5	200x200x200
Thermal spectro. (8-18 μm	10	200x200x200
Near-IR spectro. (1-5 μm	10	500x200x200
Total	40	
Total (with margin)	50	
Optional payload		
UV spectro.	5	200x200x200