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Survival of water ice in Jupiter Trojans

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Abstract

Jupiter Trojans are asteroids trapped into the L4 and L5 Lagrangian clouds of the Jupiter-Sun system. Their origin is still a matter of debate, and their study could bring a critical test between different models of the solar system dynamical evolution. Trojans could have formed where they are, in which case they could bring crucial clues on the formation of Jupiter itself [1, 2]. It is not clear however, how this primordial population of Trojans could have survived the great shaking suggested in the Grand Tack model [3]. The Nice model indicates that Trojans might have been supplied from the outer parts of the solar system [4], in which case they could highlight the properties of their far less accessible parents, the Kuiper Belt Objects.

Understanding the composition of Trojans could thus put strong constraints on the conditions (temperature, pressure and chemical composition) prevailing at the time and place of their formation. In particular, models of the solar system dynamical evolution suggest that Trojans had a cometary part. As of today, a large observational effort has provided spectra, which are very similar to spectra of cometary dust [4, 5, 6, 7, 8, 9, 10, 11, 12]. Their low albedos and surface colors are also consistent to those of comets [13]. Their rotation period distribution indicates a possible past outgassing [14].

Although Trojans can be regarded as dead or dormant comets, no water ice has ever been reported, nor any coma ever detected. In this work, we investigate the possibility for Jupiter Trojans to maintain water ice in subsurface layers, using a 3D thermal evolution model. The influence of several parameters, like the albedo, the obliquity, the rotation period, or the thermal inertia, are studied. The survival of water ice is tested against sublimation, and bulk heating due to the decay of radioactive nuclides.

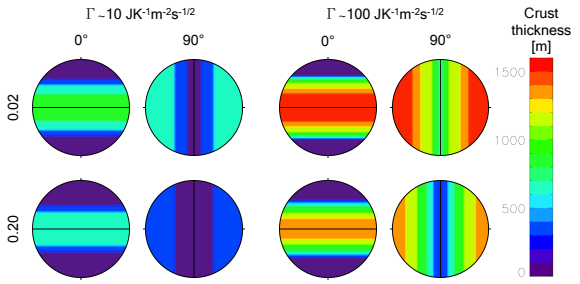

Figure 1: Thickness of a dust crust under which water ice can survive in Jupiter Trojans, for a 2% and 20% albedos, two thermal inertias, and two obliquities.

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