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A Consistent Radiative Transfer Model for Infrared Spectra of Trojans

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Abstract

The published thermal infrared (TIR) emission spectra of three Trojan asteroids obtained with the Spitzer space telescope consistently exhibit a 10-μm emissivity plateau that closely resemble the emission feature of active comets (Emery et al., 2006). Emery et al. suggested that the Trojan surfaces may consist of fine-grained silicates suspended in a transparent matrix. To explore Emery's hypothesis, we developed a new radiative transfer model with the goal of determining whether both the NIR and thermal IR spectra could be explained by the same model. We find that the Trojan spectra in both wavelength regions can be explained by $\sim$1wt% silicates and 2-10 wt% highly absorbing material (such as carbon and iron) suspended in a transparent matrix if the particles are $\sim$1 μm in size or smaller. Fine-grained silicates, carbon and iron (the latter found in abundance in Stardust samples from Wild 2) may have originated from cometary or asteroidal collisions. Debris from such collisions could have been transported outwards from the inner solar system by radiation pressure, contaminating the surfaces of the Trojans..

1. Introduction

The Jovian Trojan asteroids inhabit two large co-orbital swarms at the L4 and L5 Lagrangian points of the Sun-Jupiter system. Their nature is of high interest owing to their intermediate position between the inner solar system asteroids and the Kuiper belt population beyond Neptune. The origin of this population is currently unknown; they may have formed in Jupiter's vicinity, or elsewhere in the outer solar system and were captured subsequently by Jupiter. The compositions of these objects hold clues both to the nature of their origin, and the early evolution of the solar system. Recent thermal infrared (TIR, 6-30 microns) observations of the three largest Trojans using the Spitzer space telescope provide a powerful new constraint on the surface composition of the Trojans (Emery et al., 2006). Despite the lack of any reported comet-like activity such as the presence of a coma on Trojan asteroids, Emery et al. noted that the spectra of the measured Trojans most closely resembled the comae of comets–diffuse dust clouds of silicates and other components suspended in space that have scattering and spectral properties unlike planetary regoliths.

2. Figures

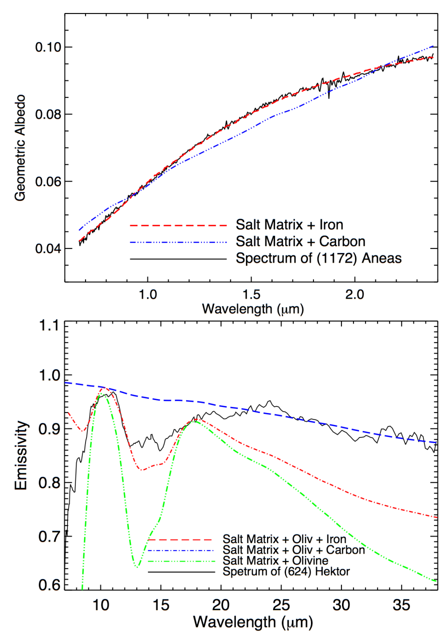

Figure 1: The solid lines are the observed spectra of two Trojan asteroids in the NIR and TIR respectively. The red dashed lines are the modeled spectra using 5 wt.% of iron and 1 wt.% of olivine suspended in a salt matrix. The blue dashed lines are the modeled spectra using 10 wt.% of carbon and 1 wt.% of olivine suspended in a salt matrix. The model that uses only olivine in a salt matrix is shown in green.

3. Summary and Conclusions

Previous spectral models of the Trojans (Cruikshank et al., 2001; Emery & Brown, 2003) used relatively large grain sizes (>10 microns) and several components to attempt to match the measurements. We explore the effects of extremely fine-grained components and use models with a total of only three materials, of a palette of four: a transparent matrix, assuming a refractive index of 1.54 representing many salts; two strong absorbers– amorphous carbon and native iron– of micron size or less; and the silicate olivine. The results of modeling the NIR and TIR spectra are shown in Figure 1. In the NIR, extremely small-sized olivine is a very weak absorber and principally acts as a scattering center, with an effect nearly identical to reducing the particle size of the transparent host grains. So the NIR models place only a weak constraint on olivine abundance. Using the same model, we calculated the TIR spectra of the best-fit assemblages found in the NIR analysis. Interestingly, at longer wavelengths the silicate dominates the spectrum. The models differ from measurements in detail, especially slope and average emissivity, but are generally consistent in the position and intensity of the silicate feature. The mismatch in slope and emissivity is consistent with uncertainties in the physical state and composition of the Trojans. We find that the iron-bearing mixtures are able to produce better fits to the shapes of the Trojan spectra both in the NIR and TIR.

Our model suggest that the large Trojan may have salt-encrusted surfaces with fine grained silicates and absorbing particles (such as iron and carbon) are loosely suspended in the salt matrixes. Fine-grained silicates, carbon and iron may have originated from cometary or asteroidal collisions in the inner solar system or in the vicinity of Jupiter.

Acknowledgements

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References

Cruikshank, D. P., Dalle Ore, C. M., Roush, T. L., Geballe, T. R., Owen, T. C., de Bergh, C., Cash, M. D., & Hartmann, W. K. 2001, Icarus, 153, 348

Emery, J. P., & Brown, R. H. 2003, Icarus, 164, 104

Emery, J. P., Cruikshank, D. P., & van Cleve, J. 2006, Icarus, 182, 496