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Physical characterization of Kuiper belt objects from stellar occultations and thermal measurements

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Abstract

The knowledge of the physical and thermal properties (i.e. size, shape, density, albedo, thermal inertia, surface roughness) of the Kuiper belt objects (KBOs) is improving in the last times thanks to the record of stellar occultations produced by these objects [5] and by more sensitive observations and modeling of their thermal emissions [7,15]. Each of these techniques can take advantage of the other in order to improve the physical characterization of these icy bodies.

1. Introduction

Stellar occultations and thermal measurements of KBOs are complementary techniques to gain information on the physical and thermophysical properties of these objects. Both techniques are briefly described, and the state of the art of each one regarding the KBOs is presented.

2. Stellar occultations

Occultations by KBOs is a very direct and elegant technique to obtain sizes (with a few kilometers uncertainties), shapes and albedos of these bodies from the timing of a star disappearing and reappearing behind the object's limb [13]. In the last decade has been possible to predict and to observe stellar occultations by KBOs thanks to the best knowledge of their orbital elements and thanks to the improvement on the star positions from the available stellar catalogues. Around a dozen of KBOs have been characterized by stellar occultations up to date, including some of the largest (e.g. Eris [14], Makemake [8], Quaoar [2], 2007 UK_{126} [1], 2003 VS_2 [10], 2003 AZ_{84} [4], etc), and the ringed centaur Chariklo [3]. It is expected a significant increase in the number of stellar occultations by KBOs detected thanks to the use of the GAIA star catalogue to predict these events. This refinement will allow us the detection of stellar occultations by smaller KBOs than the detected up to date. GAIA DR1 catalogue is now available and improvements in predictions of stellar occultations are starting to be obvious, future GAIA realeases will improve the situation even more.

3. Thermal data

Radiometric technique provides diameters and albedos of KBOs from measures of their thermal emission. A thermal or thermophysical model applied to the thermal measurements, together with the knowledge of the absolute magnitude, allow us to obtain diameters and albedos, but with larger uncertainties (~10% in diameters and ~20% in albedos) than those obtained from stellar occultations. Thermal properties, like thermal inertia or surface roughness, can also be derived from thermophysical modeling. The maximum of the thermal emission for the KBOs is in the 70-160 μm range, these wavelengths are only reachable from space-based telescopes like Spitzer or Herschel. Spitzer has detected the thermal emission of a few dozens of KBOs [15] and Herschel Space observatory, within its key program "TNOs are Cool", has increased the number to ~140 objects (see [6,7,9] and references therein). For all these objects equivalent diameters, albedos and thermal properties have been derived.

4. Summary and Conclusions

Stellar occultations by KBOs provide very precise diameters and albedos while the radiometric technique is less accurate but allows accessing to a larger number of objects. There is a clear synergy between both techniques and it is possible to put both together in order to obtain a better physical and thermal characterization of these bodies [11,12]. It is also possible to improve the physical knowledge adding results obtained by other techniques like rotational light curves, photometry, spectra, etc, deriving a very complete physical portrait for selected objects: this is the main goal of the European Union's funded project known as "Small Bodies Near and Far" (SBNAF). A sample of small bodies, including some of the most relevant KBOs, is being characterized within this project using a multi-technique approach.

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