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Investigating the composition of Potentially Hazardous Asteroids with the NEO-SURFACE survey

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Abstract

There is a high degree of diversity among the physical properties of the Potentially Hazardous asteroids (PHAs). For these objects, the physical characterization is essential to define a successful mitigation mission, therefore ground-based surveys like NEO-SURFACE could provide a fundamental contribution. Our analysis suggest a prevalence of silicate S-types in the PHA population, which could be due in principle to the high efficiency of the transport mechanisms in the inner main belt, or to an observational bias due to the fact that S-types are brighter.

1. Introduction

There is a great diversity among the physical characteristics of Potentially Hazardous Asteroids (PHAs), a class of Near-Earth Asteroids (NEAs) that deserve special attention due to the risk they pose to our planet. PHAs have compositions ranging from siliceous to carbonaceous, from basaltic to metallic, implying also completely different internal densities and strengths [1].

Physical characterization for these objects is essential to define successful mitigation strategies in case of possible impacts. In fact, whatever the scenario, it is clear that the technology needed to set up a realistic mitigation strategy strongly depends upon the knowledge of the physical properties of the impacting object. The analysis of its surface characteristics, which are connected with the internal structure, is an essential step towards developing means of deflection or destruction of the object. Unfortunately, our knowledge of the physical nature of PHAs is still rather limited, since almost 85% of the known PHAs do not have spectral types determined from observations. Several of them are large (D > 1 km) asteroids.

In order to increase the present knowledge of the physical properties of PHAs and NEAs easily accessible for a rendez-vous space mission we are carrying out a survey called NEO-SURFACE: Near Earth Objects - SURvey oF Asteroids Close to the Earth [2].

2. Observations and results

Data here presented have been collected in three different runs (December 2012, July and August 2014) at the Telescopio Nazionale Galileo (TNG) located at the Roque de los Muchachos Observatory in La Palma, Canary Islands, using the DOLORES detector (Device Optimised for the LOw RESolution) in photometric and spectroscopic mode.

We observed a global sample of 21 PHAs. We combined our visible spectra with infrared data, when available, from the MIT spectral catalogue [3] to constrain the taxonomic classification and identify a suitable meteorite analogue class for each observed PHA. Sixteen asteroids were classified as belonging to the S-complex, while only three PHAs were classified as belonging to the C-complex. Nineteen of these objects were taxonomically classified for the first time.

3. Conclusions

Considering the global sample of 255 PHAs with some physical characterization [5] (Fig. 1) there is a prevalence of silicate S-types over more porous carbonaceous C-types. This is probably due to dynamical effects, since S-types are more common in the inner main belt and they are closer to the 3:1 mean motion resonance with Jupiter, which pump their eccentricity and push hem into near-Earth orbits.

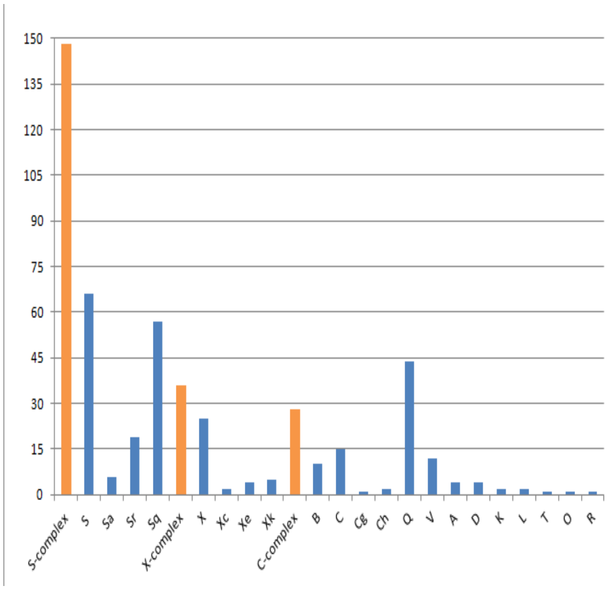

Figure 1 : The distribution of taxonomic classes among the sample of 255+19 PHAs with physical characterization.

However an observational bias, due to the fact that S-types are brighter, cannot be excluded [4]. Ground-based surveys, like NEO-SURFACE, can increase the number of PHAs with physical characterization, and likely provide a fundamental contribution to this purpose.

C-types are also the most interesting targets for a sample-return mission, since they contain pristine material and organic, prebiotic compounds. For this kind of mission ground-based surveys are crucial to guarantee the technical feasibility and the high scientific return, since the cost is extremely elevated and it depends on the orbit of the chosen object.

References

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