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The NEOSHIELD-2 project: results from the spectroscopic survey of small NEOs

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Abstract

The NEOShield-2 project was funded by European Commission (2015-2017) in the framework of the EU H2020 programme, and it is a follow-up of the first NEOShield (2012-2015) project. The main objectives of NEOShield-2 project are: i) to investigate the most promising mitigation techniques of an asteroid impact risk ; ii) to characterize the physical properties of NEOs of small sizes.
In this work we report the results of the spectroscopic survey on about 150 NEOs, most having sizes lower than 300 m, in order to constrain their surface composition.
The observations were carried out at the 3.6-meter NTT telescope of the European Southern Observatory under a Guaranteed Time Observations programme of 30 nights spanning two years (April 2015 to March 2017). The EFOSC2 spectrograph was used with the Grism #1 diffraction element. This configuration covers the spectral interval 0.40–0.92 μm with a resolution R$\sim$500. The objects with an absolute magnitude larger than 20 were selected, with a priority for the very small newly discovered ones.
The observed asteroids include 29 asteroids with diameters smaller than 100 meters, 71 with diameters between 100 m and 300 m, and 47 larger than 300 m. After standard reduction procedures and normalization of the spectra at 550 nm, we taxonomically classified 147 NEOs having good signal to noise ratio spectra by performing curve matching of their data with the visible part of the 25 template spectra defined by the Bus–DeMeo scheme [1], using the M4AST online tool [2].
We thus compare our results with those available in the literature from the European Asteroid Research Node (EARN) database of NEO physical properties.
Our main findings are the following [3, 4, 5]:
(1) The distribution we found from our observations is dominated by the S -complex at all sizes, in agreement with previous results for larger NEOs
(2) when comparing our sample with data reported in the literature, we observe an overabundance of A- and D-type for NEOs smaller than 300m compared to the bigger ones.
More specifically, A-type are 5.4% of the NEOs observed in our survey. Such olivine-rich bodies are very rare among larger NEOs and in the asteroid main belt, where objects of just a few hundred metres in size are not usually observable. Our results cast light on the missing olivine problem in the main belt, and they support the “battered to bits” scenario [6]: mantle fragments from disrupted differentiated parent bodies could have been shattered to dimensions below a few hundreds of metres, below the limit of detectability of previous spectroscopic surveys.
Nine new D-type asteroids were observed in our sample, with important exo-biological implication as these asteroids are considered the most primitive in the solar system and suppose to have a high abundance of organics and volatiles. D-type asteroids were considered to be very rare in the NEA population. Our results could conversely indicate that they are quite abundant among the small sized bodies, probably as a consequence of the high fragility of these carbonaceous asteroids, which favors the fragmentation of larger bodies. Six of them have also a ΔV lower than 6 km/s, and are good candidates for a sample-return mission to a D-type primitive asteroid.

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