NEOROCKS: INVESTIGATING THE PHYSICAL NATURE OF THE SMALL ASTEROID POPULATION

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NEOROCKS "NEO Rapid Observation, Characterization and Key Simulations project" is an EU project funded in the framework of the Horizon 2020 - Work Programme 2018-2020 Leadership in Enabling and Industrial Technologies – Space. It includes 14 partners from 7 countries.

The NEOROCKS project started in January 2020 and will end in June 2023. It has proposed a radically new approach to address the challenges posed by the NEO investigation for planetary defense: the dynamical and physical characterizations - two domains usually kept separate – are carried out in strict connection and the scientific/observational activity devoted to physical characterization is driven by the theoretical work on orbital dynamics.

SMALL-SIZE NEOs

A specific challenge for NEOROCKS is to keep the physical characterization up with the increasing NEO discoveries dominated by small-size objects.

The investigation of such small-sized NEOs is particularly important to constrain the asteroidal contribution to the delivery of prebiotic material (water and organics) to our planet (O'Brien et al. 2014, Icarus 239, 74). More in general, the proximity of NEOs allows us to study asteroids about two to three orders of magnitude smaller than those observable in the main belt (i.e., down to metre-sized objects), hence to open new frontiers in asteroid science. Indeed, investigating the physical properties of small asteroids allows us to shed light on planetary accretion mechanisms that took place in the primordial solar system under the same low-gravity environments (Chambers 2016, ApJ 825, 63). Small asteroids behave differently than the larger bodies in terms of regolith generation (Delbo et al. 2014, Nature 508, 233) and spectral properties (Perna et al. 2018, P&SS 157, 82, Devogèle et al. 2019, AJ 158, 196).

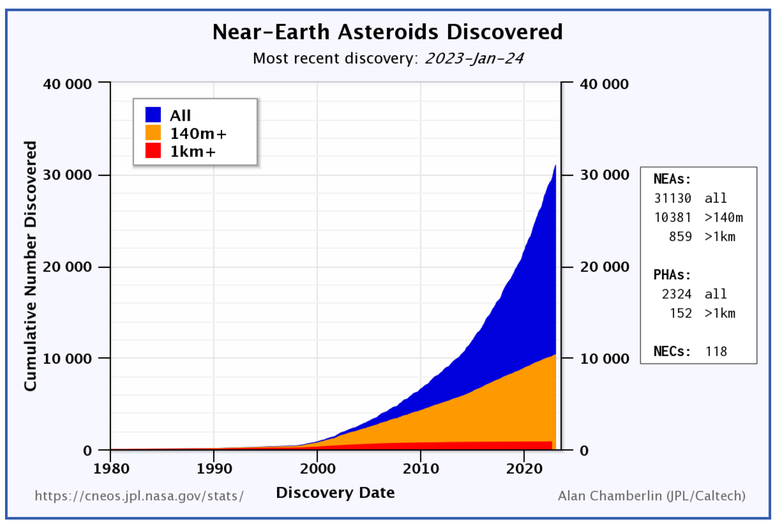


Fig 1. Number of NEAs discovered by date and size. Recent discoveries mostly concern NEAs smaller than 140m.

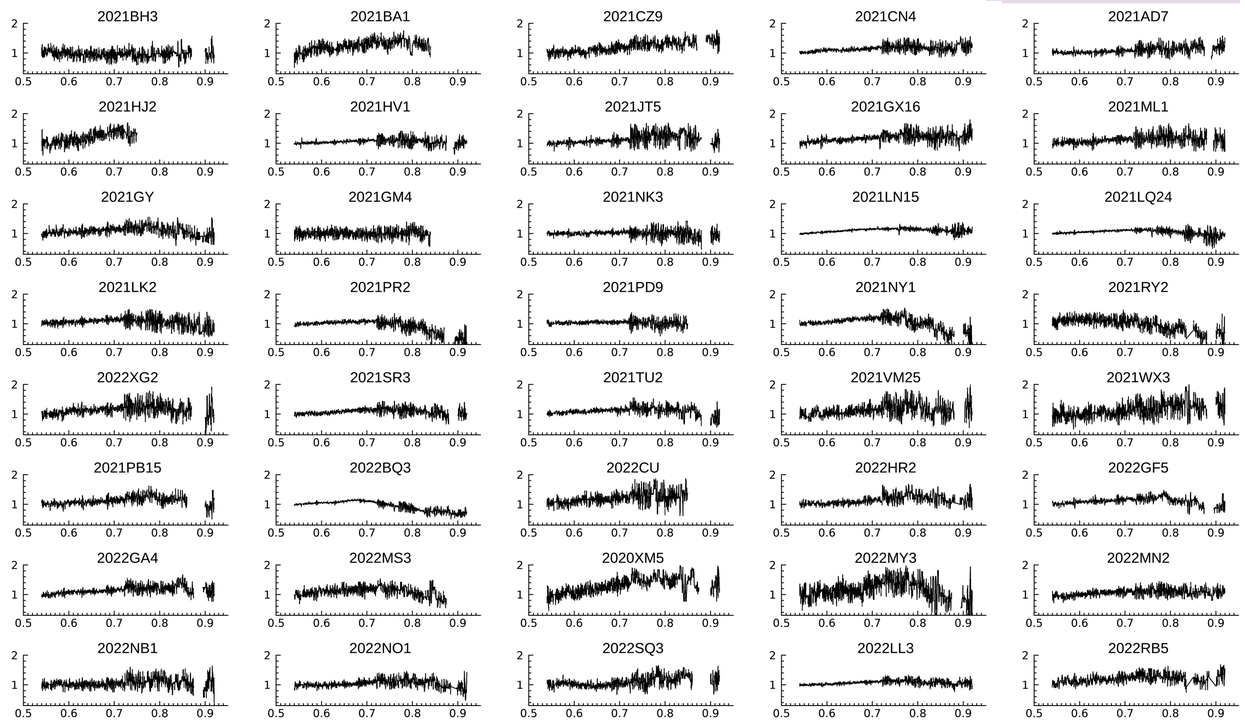
EARLY RESPONSE OBSERVATIONS

In the framework of NEOROCKS we executed **early-response** (within a month of discovery) spectroscopic observations of **newly-discovered** small – meteres to hectometeres– NEOs in order to investigate the physical nature of this population. Our sample is composed by **"high-priority" NEOs**, identified due to small size and/or planetary protection considerations, which could be lost if not characterized with early-response observations, usually becoming too faint for characterization within 2-8 weeks from discovery, whereupon becoming unobservable for years or even decades.

In terms of the current impact risk, the small objects deserve our particular attention, as they have the highest statistical likelihood of impact, and can still produce a catastrophe at a regional/national scale (Perna et al. 2015, P&SS 118, 311). Moreover, to confirm or reject collision scenarios to a high confidence level with small asteroids (smaller than ~300 m) it is crucial to reduce the uncertainty regarding their dynamical evolution on a timespan of decades/centuries. We can reduce this uncertainty by determining, with good confidence, physical properties such as surface composition and surface scattering properties, to constrain the object's response to the Yarkovsky effect due to radiative recoil of anisotropic thermal emission (Farnocchia et al. 2013, Icarus 224,1).

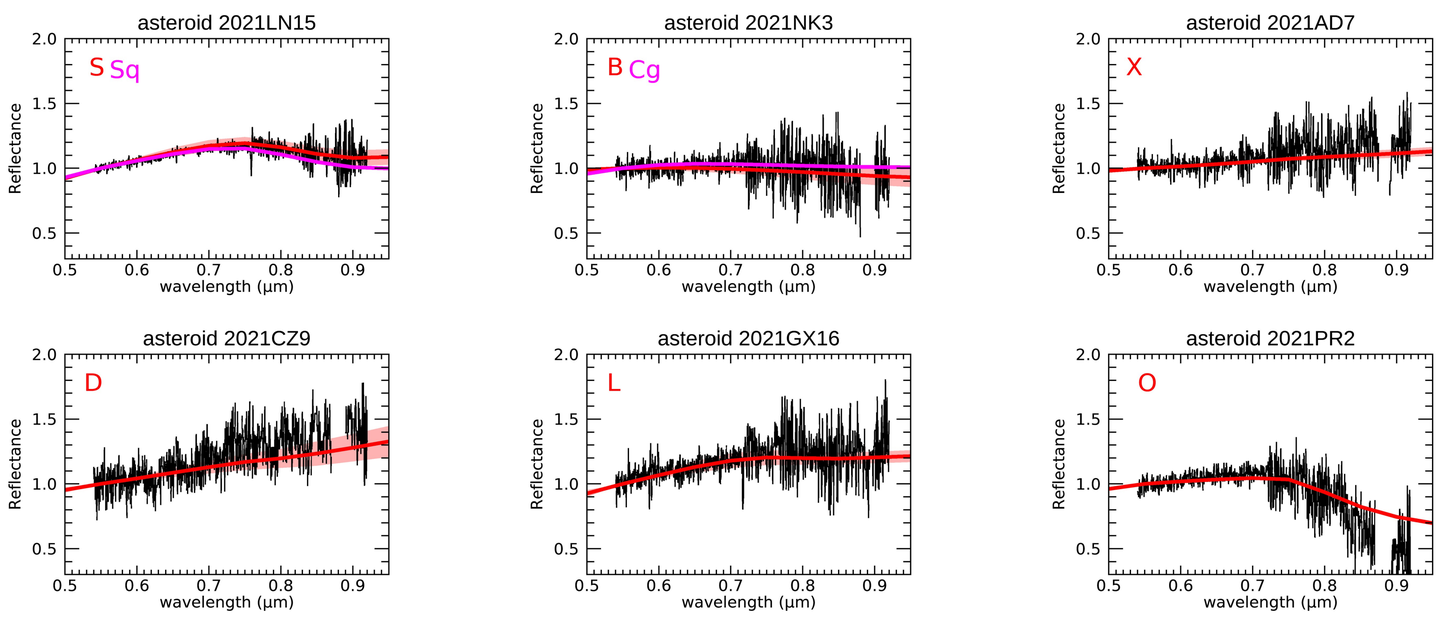
We acquired TNG-3.5m/ DOLORES low-resolution **visible spectra** of newly-discovered targets (with H = 19-25 mag) during three observing semesters, from spring 2021 to fall 2022. Our programme is currently ongoing at NOT-2.56m with ALFOSC and NOTCam programmed observations and at VST-2.6m with OMEGACAM spectrophotometry.

Fig 2. Reflectance spectroscopy of a sample of newly-discovered small (Hmag = 19-25) asteroids, obtained with TNG-3.5m/ DOLORES



PHYSICAL CHARACTERIZATION

Visible-range low-resolution asteroid spectra allow to properly identify a number of broad absorption features related to the presence of different types of anhydrous and/or hydrated minerals, hence carrying information on the asteroid composition (e.g., silicaceous, carbonaceous, metallic, etc.) and thermal history. Such highly diagnostic spectral signatures correspond to different well-determined taxonomic compositional classes



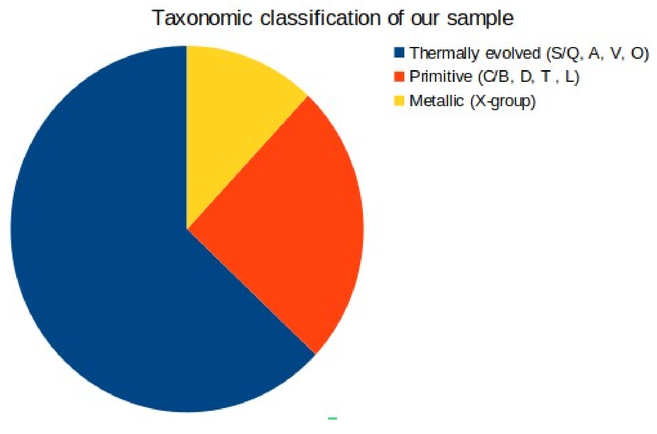


Fig 3. Examples of our classification according to Bus-DeMeo Taxonomy: our sample spans a variety of different taxonomic classes belonging to S- , C- and X-groups and several end-members.

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