Near-Earth asteroids spectroscopic survey at the Isaac Newton telescope

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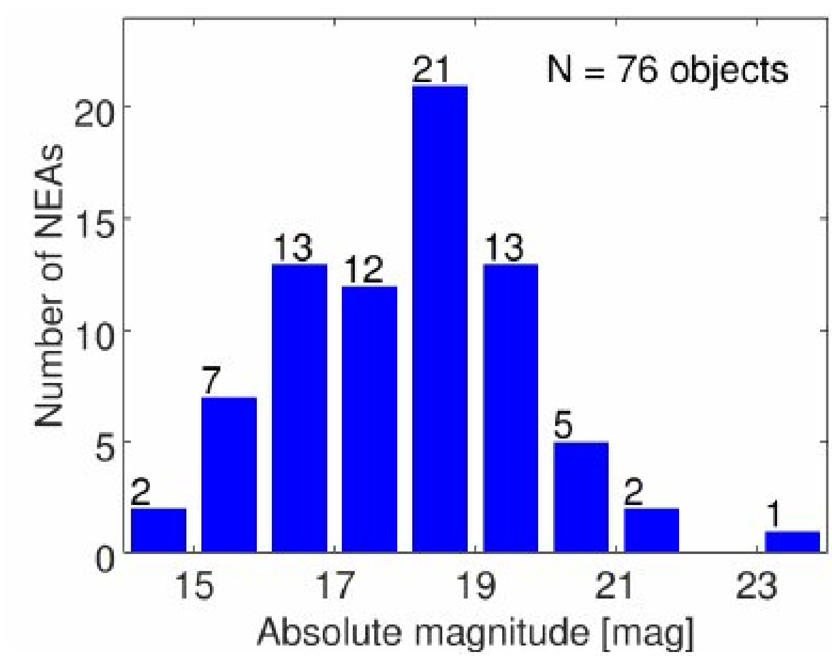

The absolute magnitude distribution of the observed NEAs with INT/IDS. Credit: Marcel Popescu (IAC/AIRA)

The study of near-Earth asteroids (NEAs) is driven by both scientific and practical reasons. Because of their proximity to our planet, they can provide key information regarding the delivery of water and organic-rich material to the early Earth, and the subsequent emergence of life. On the other hand, these small bodies of the Solar System have non-negligible long-term probabilities of colliding with the Earth, and can be targets of future space exploration.

In the framework of the EURONEAR collaboration, a group of astronomers performed a spectroscopic survey of NEAs using the Isaac Newton Telescope (INT) equipped with the Intermediate Dispersion Spectrograph (IDS). The ING studentship programme, aimed at providing hands-on training of 4-6 students per year, was at the core of this research. The students were invited to take part in the EURONEAR survey by carrying out the observations, and they were assisted remotely from the Astronomical Institute in Bucharest (Romania) by one of the principal investigators of the programme.

The goal of this collaborative work was to characterise spectroscopically a significant sample of NEAs with sizes in the range of 0.25-5.5 km (categorised as large). The sizes of the asteroids are determined by their absolute magnitudes (the distribution of absolute magnitudes of the observed objects is shown in Figure 1) and by their surface properties (albedos), which can be inferred from spectroscopy.

The team of astronomers found that the population of NEAs shows a large variety of objects in terms of physical and dynamical properties. Broadly, it matches the composition patterns of the Inner Main Asteroid Belt (located at heliocentric distance between 2.2 and 2.5 astronomical units), which is the likely source region of these bodies. However, they show spectral differences because NEAs are subject to planetary approaches, energetic micrometeorite bombardment, strong solar wind and radiation effects.

Firstly, the asteroids with a carbonaceous-like composition, denoted as C-complex (an example is shown in Figure 2), have a higher value of perihelion heliocentric distance (in the order of one astronomical unit) compared with the median perihelion of bodies dominated by olivine and pyroxenes minerals. These C-complex asteroids break up more easily as a result of thermal effects and the small ones are more likely to be destroyed farther from the Sun. And secondly, this work outlines evidence that thermal fatigue fragmentation is one of the main processes for rejuvenation of NEA surfaces.

One extreme case corresponds to (267223) 2001 DQ8 which has a surface temperature at perihelion (at a heliocentric distance of 0.18 astronomical units) of about 625 K, but when it reaches aphelion at 3.5 astronomical units from the Sun, the temperature drops to 150 K. This large temperature variation leads to thermal fatigue followed by thermal fragmentation.

Motivated by reasons of space exploration, this team of astronomers observed 31 possible targets for space missions. They included the asteroids (459872) 2014 EK24, (436724) 2011 UW158, and (67367) 2000 LY27, which are suitable for sample return exploration.

In particular, the most interesting of these is the A-type asteroid (67367) 2000 LY27. It has an olivine rich composition which may have formed in the mantle of a large body. Thus, it may represent a good opportunity for studying fragments coming from planetesimals that differentiated (a process defined as the separation of distinct layers forming an iron nucleus, a silicate mantle and a basaltic crust) in the early history of the Solar System.

Finally, 27 asteroids which are potentially hazardous (these celestial bodies show a long-term risk of colliding with our planet) were characterised. The mitigation strategy depends very much on their physical properties, so spectral data were obtained to determine their compositions.

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