EPSC Abstracts
Vol. 13, EPSC-DPS2019-1335-2, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Spectral and spectro-photometric characterization of NEOs at the Canary Islands Observatories

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Abstract

We present results of an ongoing observational program dedicated to near-Earth objects (NEOs) characterization. This program is performed using telescopes of the Canary Islands Observatories (El Roque de los Muchachos and Teide Observatory). We report the spectra of 91 NEOs observed with the 2.5m Isaac Newton Telescope (INT), the colors and partial lightcurves for 44 NEOs obtained using the 1.5m Telescopio Carlos Sánchez (TCS). Additionally, spectral data of three Near-Earth Object Human Spaceflight Accessible Targets (NHATS) were obtained with the 10.4m Gran Telescopio Canarias (GTC).

This observational data is analyzed using taxonomic classification and by comparison with laboratory spectra of meteorites. The results are interpreted in the context of orbital parameters and of other data (near-infrared spectra, albedo, and light-curves), whenever available. In general terms, the taxonomic distribution of our sample is similar to the previous studies and matches the broad groups of the inner main belt asteroids. Nevertheless, we identified correlations between the spectral types, the orbital parameters and the sizes.

1. Introduction

The population of near-Earth objects (NEOs) shows a large variety of physical and dynamical properties. They are subject to planetary encounters and to strong solar wind and radiation effects. Their study is relevant for the science of planetary systems and for practical reasons regarding space exploration and long-term probability of impact with the Earth [1].

In this context we started an observational program using several telescopes of the Canary Islands Observatories. We aim to obtain spectro-photometric data and light-curves with the MuSCAT2 instrument available on the TCS and optical spectra with IDS spectrograph mounted on the INT. For the characterization of faint targets listed by NASA NHATS [2] we use the OSIRIS spectrograph and camera instrument on the GTC.

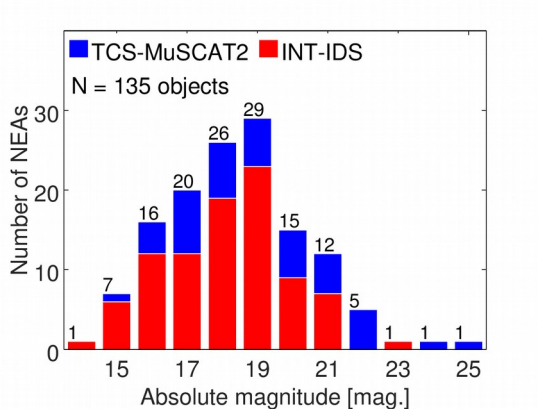

Figure 1: Absolute magnitude distribution of NEAs observed with INT-IDS and with TCS-MuSCAT2 instrument.

2. Observations and results

The INT-IDS spectrograph (which covers the 0.4 – 0.92 μm wavelengths) allows observations of targets with an apparent magnitude up to mag_V~18.5. The TCS - MuSCAT2 can obtain accurate spectro-photmetric data (i.e. SNR ~ 20) for celestial objects up to the apparent magnitude ~ 19. Thus, the most accessible NEOs for our program were in the size

range of 0.20 - 5.5 km. Three of our targets have an equivalent diameter bellow 100 m.

The GTC-OSIRIS instrument allows to obtain optical spectral (in the range of 0.5 – 0.95 μm) for targets with an apparent limit magnitude of 23. This telescope was used to observe 2013 RV9, 2017 PV25 and (65803) Didymos.

2.1 Spectra obtained with INT-IDS

A total of 91 NEOs were observed with the INT-IDS spectrograph using the low-resolution mode (R~500). These observations were performed in the framework of EURONEAR collaboration - *www.euronear.org*. They were split in two programs over five semesters.

The first program [3] includes a number of 15 NEOs with T_J ≤ 3. The T_J is the Tisserand parameter with respect to Jupiter and it is a rough limit between the cometary-like orbits (T_J ≤ 3) and the majority of asteroid orbits (T J > 3). Their taxonomic distribution includes two B/C-complex objects, six Q/S-complex, and seven T/X-complex ones.

The second program [4] has a total of 76 near-Earth asteroids with T_J > 3. We spectrally classified 44 (58%) of them as Q/S-complex, 16 (21%) as B/C-complex, eight (10%) as V-types, and another eight (10%) belong to the remaining taxonomic classes denoted as miscellaneous. This sample contains 27 asteroids categorized as potentially hazardous and 31 possible targets accessible to space missions.The spectral data corresponding to (276049) 2002 CE26 and (385186) 1994 AW1 show the 0.7μm feature that indicates the presence of hydrated minerals on their surface.

2.2 Colors and light-curves observed with TCS - MuSCAT2

The MuSCAT2 instrument mounted at TCS allows us to obtain simultaneous imaging in the *g* (400–550 nm), *r* (550–700 nm), *i* (700–820 nm), and *zs* (820–920 nm) bands. It is equipped with four CCD cameras of 1024 x 1024 pixels, with a field of view of 7.4 x 7.4 arcminutes [5].

During a preliminary observing program we obtained data for 44 NEOs. The target selection prioritized the objects suitable for a space mission and the small NEAs. The observing strategy consists in continuous image acquisition during one hour. Depending on the apparent magnitude the individual exposures were between 5 to 30 seconds long. The data reduction used the PHOTOMETRYPIPELINE developed by Michael Mommert [6]. This was optimized for our survey strategy. For a preliminary taxonomic classification (Fig. 2) we follow the same approach as the on used for the Sloan Sky Survey data [7]. This allows us to distinguish the main classes of asteroids, the C-complex, the S-complex, and the V-types.

Acknowledgements

Acknowledgements. We thank to the ING students for helping us with the observations. MP, JL, and JLR acknowledges support from the AYA2015-67772-R (MINECO, Spain). MP and JL acknowledge support from the project ProID20170112 (ACIISI/Gobierno de Canarias/EU/FEDER). JdL acknowledges support from the Severo Ochoa Program SEV-2015-0548 and the project AYA2017-89090-P (MINECO). The work of ILB was supported by the project PN-III-P1-1.2-PCCDI-2017-0371. NPA acknowledges support from the NEOO-ROSES of the Solar System Observations program by NASA, 2018. The spectroscopic observation program is running since April 2019 in the framework of the ESA P3-NEO-I "Observational support from collaborating observatories programme.

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