Simultaneous observations in four optical bands for near-Earth asteroids using TCS/MuSCAT2 instrument

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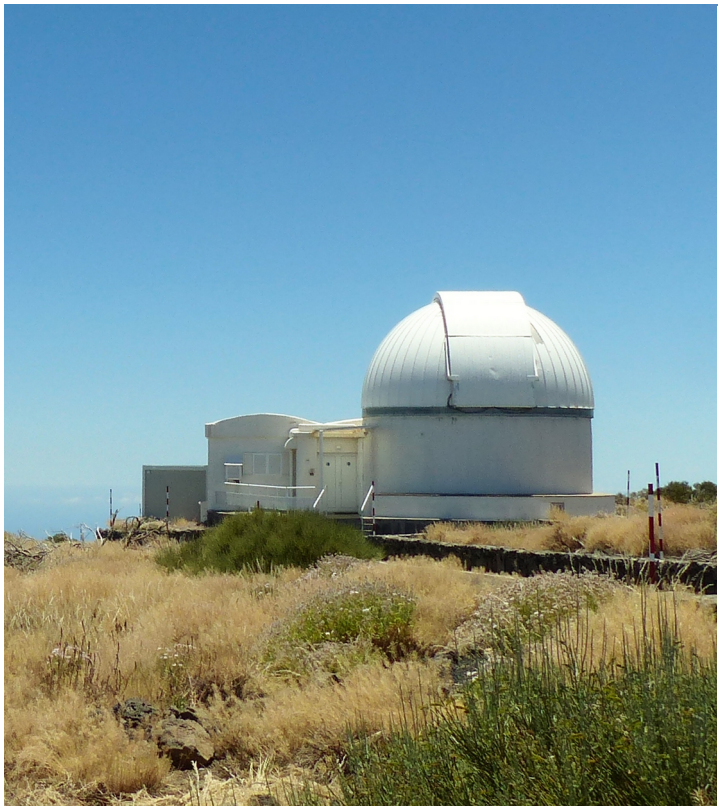
The program

Aim: Characterize a large sample of near-Earth asteroids (NEAS) based on spectro-photometric data.

- 1) obtain the taxonomic classification;
- 2) search for heterogeneous asteroids;
- 3) search for cometary activity inside the NEA's population;
- 4) quantify the phase angle effects;
- 5) determine the rotational periods and discuss them in the context of compositional types;
- 6) select the most interesting targets for a spectroscopic follow-up
- 7) complement the data with the information provided by other surveys;

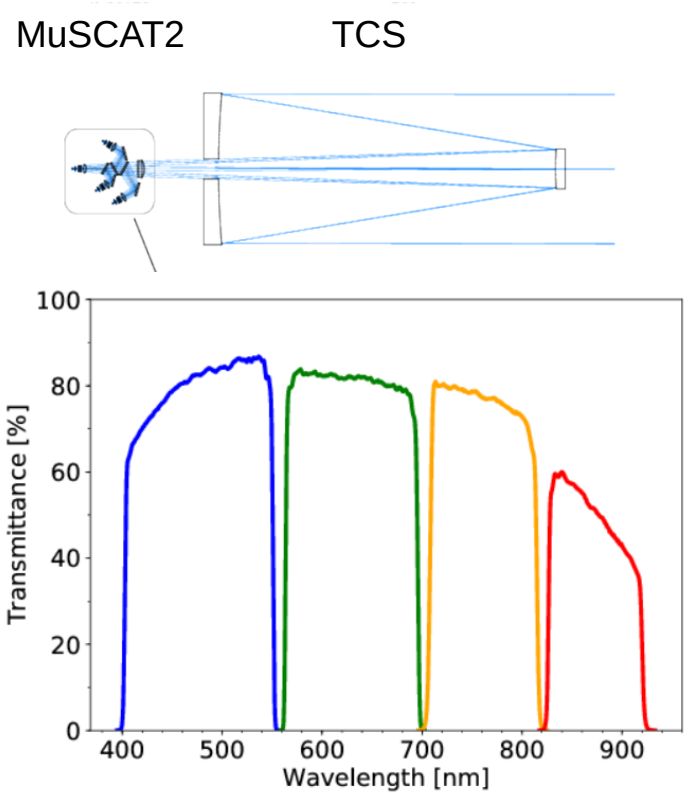
Strategy: Observe during two nights on every month to obtain data for 10 – 18 NEAs on each session.

The instrument



Telescopio Carlos Sánchez (TCS) is a 1.52 m telescope located on Teide Observatory, Izaña (Tenerife, Canary Islands, Spain) at 2390 m altitude.

MuSCAT2 instrument mounted on TCS. The four cameras provide images obtained simultaneously with four different filters.



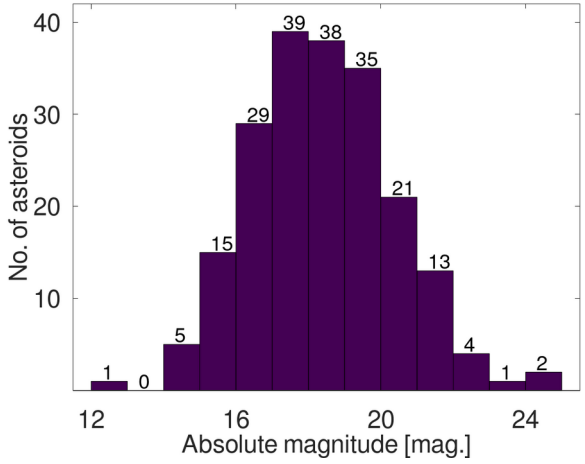
Total transmittance of the MuSCAT2 instrument in g (400–550nm), r (550–700 nm), i(700–820 nm), and zs (820–920nm) bands (Narita et al. 2019).

The observed sample: 283 observations for 203 NEAs

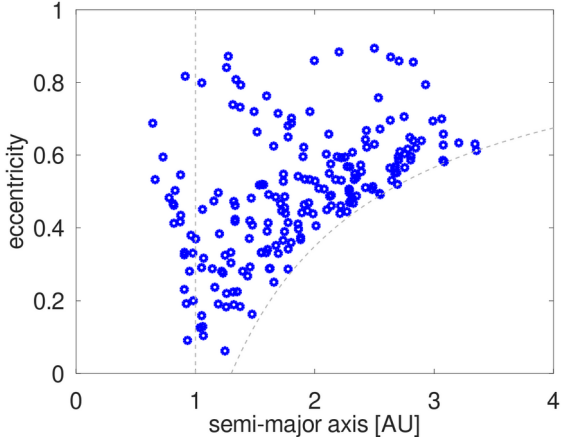
Sample statistics

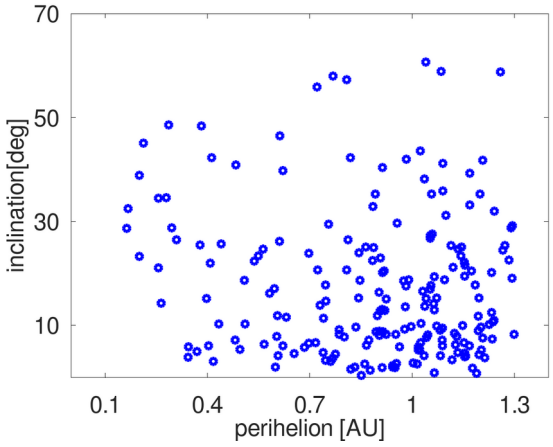
Types of orbit	No. of objects	Fraction[%]
AM	88	43.3
AT	94	46.3
AP	21	10.3
PHA	68	33.5

AM - Amor like orbits; AP - Apollo like orbits; AT - Aten like orbits. The Amor, Apollo, and Aten are the NEAs which are the representatives for their orbital class. PHA - potentially hazardous asteroid.

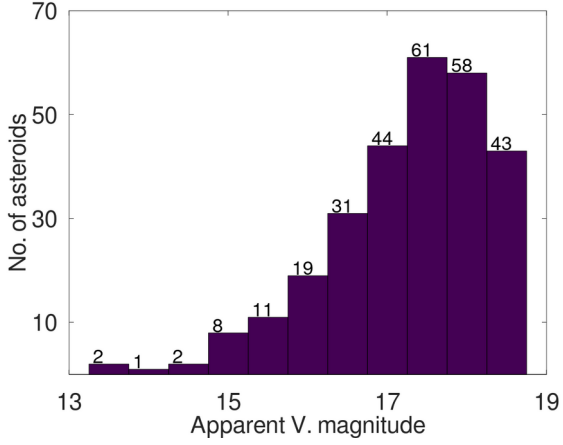


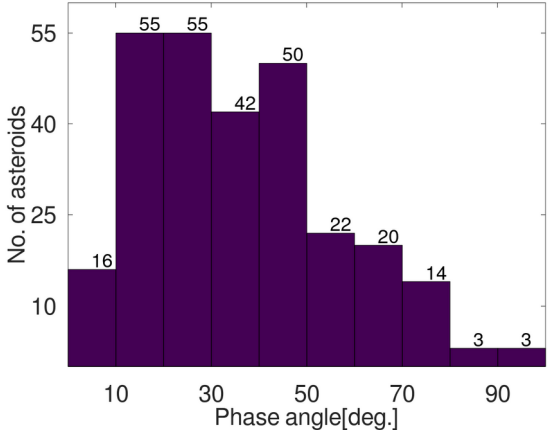
Orbital elements





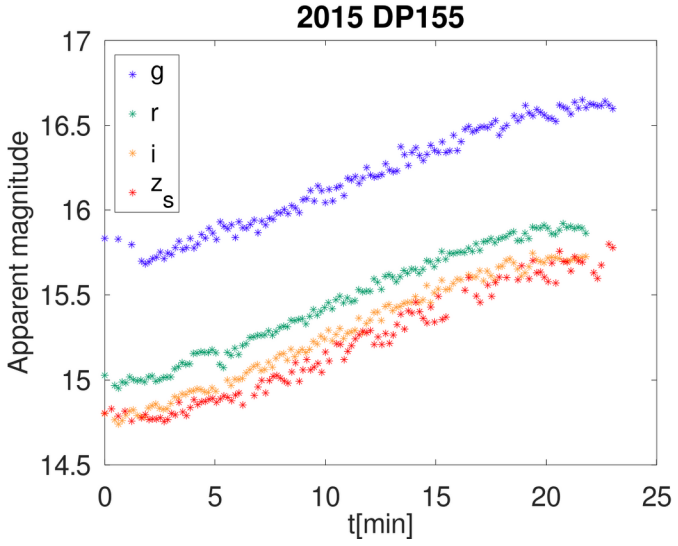
Observational circumstances



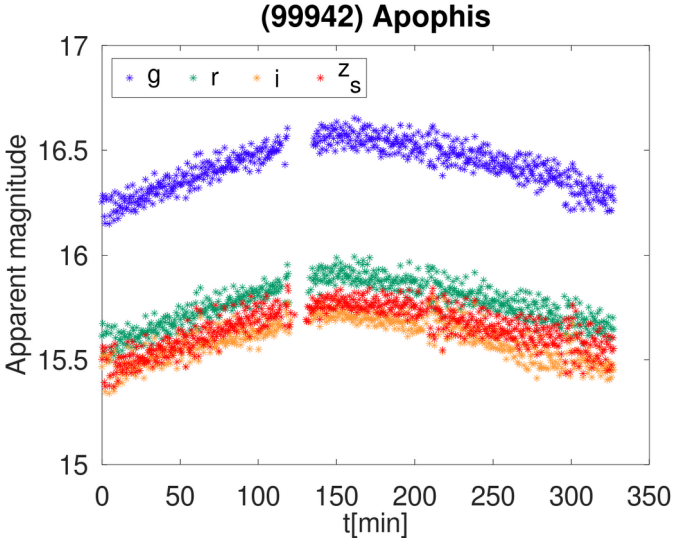


Key targets

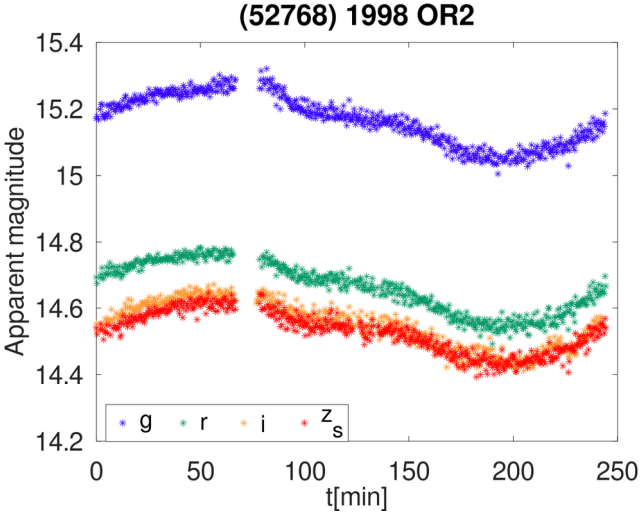
- Our targets included the ***newly discovered objects*** such as 2018 KE3 …, 2019 HC… 2020 AZ2, ..., 2020 DP4, and the ***space-mission candidates*** such as 65717 (1993 BX3), 2015 DP155, 2015 OH…., ***NEAs with low Tisserand parameter (T_J)*** – about 10% of the observed sample.



2015 DP155, an example of NHATS target (Near-Earth Object Human Space Flight Accessible Targets Study - CNEOS website https://cneos.jpl.nasa.gov/)



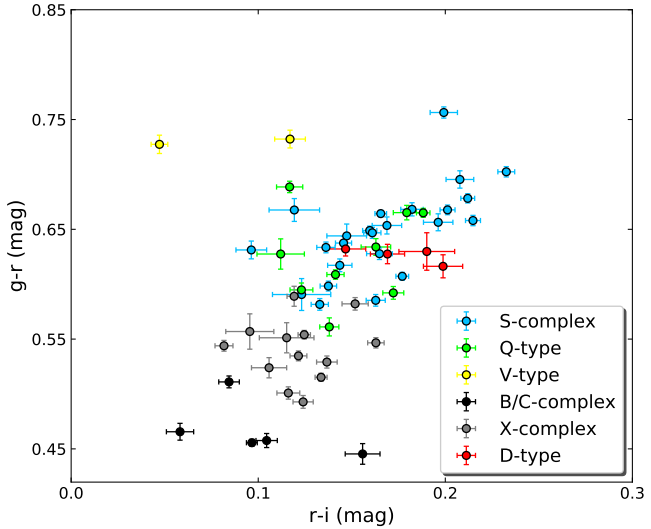
The PHA (99942) Apophis - see Licandro et al. presentation.

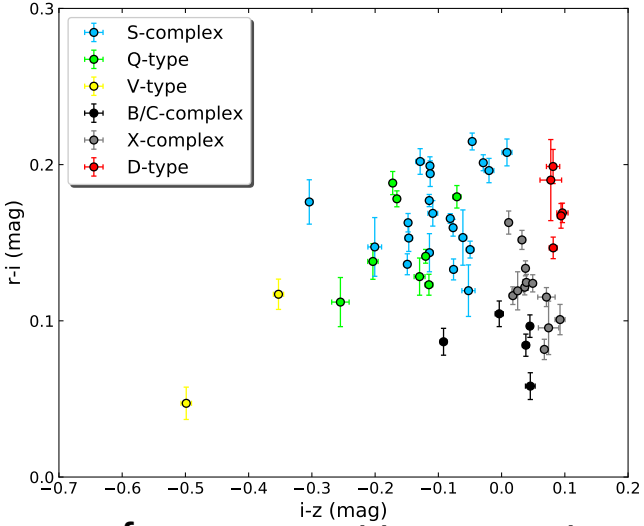


The PHA (52768) 1998 OR2, a target observed also by Arecibo radar. See Medeiros et al. presentation.

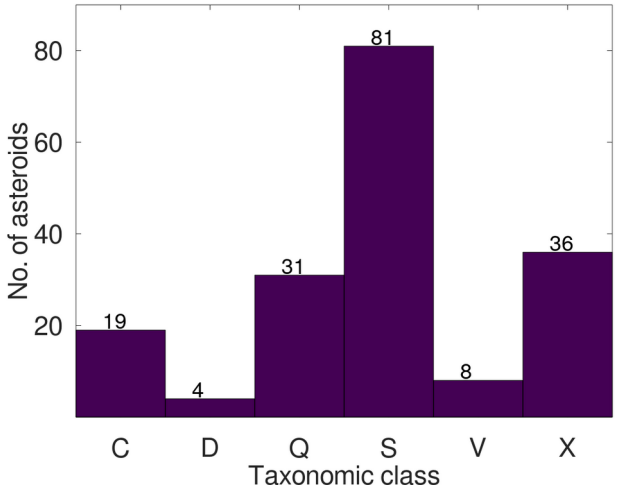
Taxonomic classification

- Each taxonomic group (C-complex, D, Q, S-complex, V, X) occupies a specific region in the color-color space, as a consequence of their different physical properties.
- The KNN (k-nearest neighbors) algorithm attributes a class for a given object, based on the values (taxonomies) of its first “K” neighbors from the reference set.
- **Classification results:** a number of 180 asteroids (120 of them were for the first time classified) were classified following this schema.





Reference set: color-color diagrams of 58 NEAs with spectra in the visible or near-infrared region which were classified based on their spectral data.



Result: The distribution of taxonomic groups for the observed sample

Conclusions

- We presented the first results of a spectro-photometric survey dedicated to near-Earth asteroids.
- The survey is performed with TCS/MuSCAT2 instrument which allows to acquire images in four bands simultaneosly.
- A total number of 203 NEAs were observed with the g (400–550nm), r (550–700 nm), i(700–820 nm), and z_s (820–920nm).
- The taxonomic classification has been made for the observed targets.
- This is an ongoing survey, with observing time allocated on every month since 2018.

References

[1] Narita, Norio et al.; Journal of Astronomical Telescopes, Instruments, and Systems, 2019.

[2] Mommert, M; Astronomy and Computing, 01/2017

Acknowledgments

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NEO ROCKS

Near Earth Object Rapid Observation, Characterization and Key Simulations