



NEO related activites of Padova (University and Astronomical Observatory) team

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The contribution of Padova Team to NEO observations mainly focuses on astrometry, spectroscopy and photometry.

Padova Team

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Previous experience and obtained results

•SINEO project (Spectroscopic Investigation of Near Earth Objects): a large spectroscopic data base with about 200 spectra of NEOs in the visible and Near Infrared region (0.4-2.5 micron) partly published and not yet completely analyzed. 150 spectra in the visible and 90 in the NIR. Some examples:



•**Taxonomic classification:** needed for estimate the composition of the objects.

Obtained almost all the taxonomic classes found in the MB that confirms NEOs variegate origin. The use of the Principal Component Analysis confirms the taxonomic classification obtained.



PCA:performed using SMASS II data (Binzel 2002). Our data distribute in the same clusters defined by SMASS II data. Comparison of NEO spectra with those of about 900 meteorites taken from RELAB catalog. Most meterorites has not a clear origin. Found that 38% of NEOs have a meteoritic analogue; all C-types have a Carbonaceous Chondrite analogue and 24% of S-types have an Ordinary Chondrite analogue. A first conclusion is that NEOs are the principal parent bodies of meteorites that fall on the Earth.



Most part of the investigated S-types NEOs does not fit with any meteorite: their spectra are typically redder

Study of space weathering



Laboratory experiments made in collaboration with Catania observatory on OC meteorites indicate that ion bombardment of OC meteorites is able to mimic SW effects on S-type objects due to solar wind

The S-type NEOs that do not match with any meteorite are typically redder than the reddest OC meteorites and we conclude that this is due to space weathering effects



 Peculiar objects: dead/dormant comets, family asteroids, rare taxonomic types...



HUN: Hungarias; PHO: Phocaeas. 3:1 and v_{β} : a mean motion and a secular resonance, respectively.

We have found some peculiar objects: the spectra of four V-type objects very similar to Vesta.

Then the spectrum of a NEO probably belonging to the rare R-class.

The spectra of 2 objects of primitive composition that could be of cometary origin. In fact they also have a Tj typically cometary and a high probability to come from the JFC channel.





Tools adopted for SINEO

• Observations: low resolution spectra in the spectral range 0.40 - 2.50 micron

Telescope used: ESO-NTT La Silla-Cile and TNG-La Palma-Canarias

EMMI

Gr#1, D=5.9 Å/pix, Slit=5", seeing=1" V=20 in $T_{exp}=1h$ S/N=20

SOFI

GB, D=6.9 Å/pix, Slit=2", seeing=1" $J=16 (V \approx 17.5) \text{ in } T_{exp}=1.5h$ S/N=20 GR, D=10.2 Å/pix, Slit=2", seeing=1" $K=16 (V \approx 18) \text{ in } T_{exp}=2.5h$ S/N=20 DOLORES LR-R Grm3, D=2.9 Å/pix, Slit=5", seeing=1"

V=20.0 in T_{exp}=1.0h

S/N=23

NICS

Amici, D=30-100 Å/pix, Slit=2", seeing=1" $H=16.2 (V \approx 18.0)$ in $T_{exp}=1.0h$

S/N=30

Facilities easily available at Asiago Observatory for NEO observations

1.80 m Telescope

1.22m Telescope

Schmidt 67/92

The 182 cm telescope





Two instruments are available: a **low resolution spectrograph** and **imager (AFOSC)** and an high resolution spectrograph (Echelle).

The two instruments are complementary for spectral resolution and are therefore mounted in turn at the telescope following the moon cycle (AFOSC being usually available during grey and dark time).

Schmidt 67/92 Telescope





CCD TECHNICAL DATA

4049x2672 px

- CCD scale: 0.86 arcsec/px (unbinned);
- FOV: 58X38 arcmin
- Autoguider CCD: 657x495 pixel TC-237H
- Filters wheel with Johnson-Bessel BV and Cousins RI filters (2")

ADAS, Asiago-DLR Asteroid Survey

Past project in collabration with DLR for the search and follow up of comets and asteroids.

Performed with the Schmidt telescope equipped with a dedicated camera (station IAU codex 209)

- •Observing Statistics Objects observed: 3506
- •New Designations: 326
- •Total number of Positions measured and submitted to the MPC: 17215
- •Number of Positions published by the MPC: 14929
- •New orbits: 189
- •Special asteroids discovered:
 - 3 Trojans
 - 1 Hilda
 - 1 Hungaria
- •Marscrossers:
 - 2002 AN₇
 - 2002 CS
- •Numbered Objects: 108

Galileo telescope 1.22m equipped with a B&C spectrograph





4 gratings, dispersion from 42 Å/mm to 339 Å/mm CCD Andor iDus DU440 2048×512 pixels Spatial scale 1"/pixel

Some observations from Asiago for SSA

--Asteroid 2002 GT, 18 July 2013, target of NASA's Epoxi mission in January 2020. A very good and first example of European collaboration under the 'coordinating function' of ESA's Near-Earth Object Coordination Centre



Spectra and photometric data from Asiago Observatory which allowed determination of the asteroid type (Sq), in agreement with other observations. WT1190F observation campaign: The impact in the Indian Ocean on 13 November provided an excellent opportunity to simulate the observational sequence that needs to be triggered if an actual asteroidal impactor were

discovered.



Astrometric data and colour data of the object as well as an extended observational coverage to investigate the possibility of long rotational periods were obtained by the Asiago Schmidt telescope from very early after discovery to less than an hour before the impact.