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The NEOShield-2 EU project: the Italian contribution

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Abstract. The NEOShield-2 (2015-2017) project has been recently approved by the European Commission in the framework of the Horizon 2020 programme with the aim *i)* to study specific technologies and instruments to conduct close approach missions to NEOs or to undertake mitigation demonstration, and *ii)* to acquire in-depth information of physical properties of the population of small NEOs (50-300 m), in order to design mitigation missions and assess the consequences of an impact on Earth. The Italian scientific community is widely involved in this project.

Key words. Asteroids: photometry – NEOs

1. Introduction

The Near Earth Object (NEO) population comprises both asteroids and comet nuclei on orbits with perihelion distances q≤1.3 au, which periodically approach or intersect the Earth's orbit. NEOs are responsible of a continuous flux of impactors with our planet: most meteorite falls (like the Chelyabinsk event in 2013) as well as occasional major catastrophic impact events (like Tunguska in 1908),

The physical characterization of NEOs is essential to define successful mitigation strategies in case of possible impactors. In fact, whatever the scenario, it is clear that the technology needed to set up a realistic mitigation strategy depends upon the knowledge of the physical properties of the impacting object. Moreover, the knowledge of the physical and and chemical properties of the NEO population can give us crucial information about the early evolution of the Solar System and the the delivery of water and organics to the primitive Earth.

Unfortunately, about 95% of the 13000 known NEOs, is still missing a compositional characterization. In particular we have information of only about 1.5% of the known small objects population (D<300 m) and their increasing discovery rate (more than 1000 objects/year) makes the situation progressively worse.

At a European level, the European Commission promoted the study on NEOs by approving and financing the NEOShield project. The NEOShield-1 project (2012–2015) has been set-up to provide detailed test mission designs to develop an actual deflection demonstration mission. The NEOShield-2 (2015–2017) project has been recently approved and financed in the framework of the Horizon 2020 program with the aim *i)* to study detailed technologies and instruments to conduct close approach missions to NEOs or to undertake mitigation demonstration, and *ii)* to retrieve the physical properties of a wide number of NEOs, in order to design impact mitigation missions and assess the consequences of an impact on Earth.

2. Observational activies

One of the main goals of the NEOShield-2 project is to undertake an extensive observational campaign of a large number of NEOs in the 50–300 m size range. Photometric, spectroscopic and thermal infrared observations have to be carried out using guaranteed rapid access to worldwide telescopes owned by NEOShield-2 consortium members (12 telescopes in the 1–2 m size range, 2 in the 3–4 m, and 1 in the 8 m), as well as by competitive proposals to get access to medium/large telescopes and very large telescopes (see Table I).

A negotiation for purchase of observational time at ESO NTT 3.5 m telescope (La Silla, Chile) has been successfully carried out. An agreement has been signed by ESO and the Paris Observatory (1st March 2015) to use ESO/NTT and 30 nights have been allocated to this project. A *Guaranteed time* proposal has been accepted (program 095.C-0087, P.I. D. Perna): VIS/NIR spectroscopy (+photometry). 7 nights have been already allocated (April, June, July 2015).

In the framework of the EU project NEOShield-2, the Italian community is responsible of the *Task 10.2.1 – Colours and Phase function*, which has the aim to acquire photometric measurements in order to:

1. perform a preliminary taxonomic classification using computed color indexes and have the first constraints on the surface composition and albedo of the observed objects. It is important to note that by discriminating between C- and V- class (which have mean albedo of 0.13 and 0.43 respectively) we can reduce the uncertainty on diameter of about 300% and consequently reduce about 20 times the uncertainty on the impact energy;
2. study the phase function, and to derive the correct β and G parameters; these values will be used to better compute the absolute magnitude and hence to estimate albedo and diameter. The obtained phase functions will also give an independent confirmation of the taxonomic classification;
3. obtain information on the surface physical properties (e.g. regolith, thermal inertia, ...) through the combination of the results obtained in the visible bands with thermal infrared observations, already planned in the framework of the NEOShield-2 project;
4. contribute to the estimation of the response to non-gravitational forces (mainly to the Yarkovsky effect), through the estimate of the internal density, and therefore model the future dynamical evolution of the observed bodies.

An operational interface is maintained together with the ESA NEO Coordination Centre (NEOCC, http://neo.ssa.esa.int) in order to optimize observations devoted to physical characterization.

The Italian team is guaranteeing observations throughout rapid access to Italian telescopes and facilities (e.g. Campo Imperatore, Asiago), as well as by competitive proposals to get access to medium/large and very large telescopes (e.g. TNG, LBT, and VLT). 24 hours are already allocated at TNG in the September 2015 – February 2016 semester.

Table 1. Available Telescopes

Telescope, site	Diameter	Wavelength	Availability
Photometry (lightcurve, colors)			
T1M, Pic du midi (F)	1.06 m	VIS	Guaranteed (OBSPM), quick response
OHP, Haute Provence (F)	1.2 m	VIS	Easy access (by OBSPM proposals)
SCHMIDT, Campo Imperatore (I)	60/90 cm	VIS	Guaranteed (INAF), quick response
AZT24, Campo Imperatore (I)	1.10 m	JHK bands	Guaranteed (INAF), quick response
LBT, Mount Graham (Arizona, USA)	8.4 m	VIS/NIR (<2.5μm)	Guaranteed easy access (under discussion, INAF)
TNG, La Palma, Canary Islands (E)	3.58 m	VIS/NIR (<2.5μm)	Guaranteed easy access (INAF)
Pan-STARRS	2 x 1.8 m	VIS	Guaranteed survey data access (QUB)
LT, La Palma, Canary Islands (E)	2.0 m	VIS/NIR	Competitive proposal (QUB)
SQT, La Palma, Canary Islands (E)	1.0 m	VIS	Guaranteed easy access (QUB)
SCHMIDT, Asiago (I)	67/92 cm	VIS	Guaranteed (INAF), quick response
TGO, Les Makes, LaReunion (F)	60 cm	VIS	Guaranteed (OBSPM), quick response
1-meter, Calern (F)	1.0 m	VIS	Guaranteed (CNRS), quick respose
OASI, Itacuruba (BR)	1.0 m	VIS	Guaranteed (in collaboration with ON Brazil), quick respose
Lijang Station (Yunnan, CN)	2.4 m	VIS	Easy access (by proposals)
NTT, La Silla (RCH)	3.5 m	VIS/NIR (<2.5μm)	Time slots during spectroscopic observations
VIS/NIR Spectroscopy			
TNG, La Palma, Canary Islands (E)	3.58 m	VIS/NIR (<2.5μm)	Competitive proposals
NTT, La Silla (RCH)	3.5 m	VIS/NIR (<2.5μm)	Purchase of 30-35 nights
IRTF, Mauna Kea (Hawaii, USA)	3.0 m	NIR (0.8-2.4 μm, SpeX	Competitive proposals
SOAR, Cerro Pechon (RCH)	4.1 m	VIS/NIR (<2.5μm)	Competitive proposals collaboration with ON Brazil)
VLT, Paranal (RCH)	8.2 m	VIS/NIR (<5μm)	Competitive proposals
LBT, Mount Graham (Arizona, USA)	8.4 m	VIS/NIR (<2.5μm)	Competitive proposals
Galileo, Asiago (I)	1.22 m	VIS	Guaranteed (INAF), quick response
Thermal Infrared			
GTC, La Palma, Canary Islands (E)	10.4 m	7.5-25 μm	Competitive proposals
VLT, Paranal (RCH)	8.2 m	7.5-25 μm	Competitive proposals

3. Conclusion

In the course of the whole NEOShield-2 project, we estimate to obtain information on size, shape, rotation, composition, regolith properties and albedo of a great number of NEOs, throughout photometric, spectroscopic and thermal IR observations. This large sample of data acquired with the same instrumentation and analyzed by the same scientific team will minimize several bias effects present in the literature data, and will allow us for the first time ever to carry out an in-deep statistical study of the small NEA population.

The NEOShield-2 project will undertake – for the first time ever – a significant and comprehensive characterization of the small NEO population, to study their typical mitigation-relevant physical properties (size, albedo, mineralogy, shape, density, internal structure). Such information will establish a new benchmark of knowledge and understanding of the physical properties of NEOs and will also be of huge scientific relevance to model the NEO population for a better determination of the early evolutionary phases of our solar system.

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