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Low delta-V Near Earth Objects: a survey of suitable targets for space missions

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Abstract

Near-Earth asteroids (NEAs) are attracting nowadays more and more attention from the scientific community, because of their constant threat to human civilization, their increasing feasibility for future space missions and the opportunity to investigate pristine material. Unfortunately only 10% of discovered NEAs have been physically characterized. So, to help design future rendez-vous space missions we perform spectroscopic observations of 13 NEAs without a taxonomic classification and high accessibility from Earth, based upon their minimal change in the spacecraft's speed to shuttle to the asteroid's orbit. The obtained data are also important to settle the ground truth for all those asteroids who will never be visited by a spacecraft.

1. Introduction

Near-Earth Asteroids, as the remnants of primitive leftover building blocks of the Solar System formation process, offer important clues to the chemical mixture of the protonebula from which the planets formed some 4.6 billion years ago. Current exobiological scenarios for the origins of life invoke an exogenous delivery of water and organic matter to the early Earth [1].

NEAs are also interesting for human exploration because, in the long term, they contain the most accessible resources in space, for propellant, life support and construction materials. Missions to asteroids and comets are becoming increasingly feasible both from a technical and a financial point of view. In particular, those directed towards the Near-Earth Asteroids have proven suitable for a low-cost approach, thus attracting the major space agencies as well as private companies.

It is possible to show that NEAs can be more accessible than the Moon or as difficult to reach as Jupiter [2]. The accessibility from Earth of a potential target of a space mission is studied by classical orbital transfer algorithms (i.e. the Hohmann transfer formulation [3,4), which gives the minimum energy transfer trajectory between two orbits in space. This algorithm has been applied to estimate the delta-V, the velocity change applied to an already free-flying spacecraft needed to realize a rendez-vous mission to NEAs [5,6].

A high degree of diversity in terms of composition and spectral properties is present among the NEA population. The physical properties of more than 90% of the 9800 NEAs that have been discovered so far are still unknown [7]. The analysis of their surface via spectroscopic observations, which is generally connected with the internal structure, could help to better characterize asteroids for a future rendez-vous mission.

2. Observations and discussions

We used different telescopes all around the world to perform spectroscopy in the visible and near-infrared range for a list of Near-Earth asteroids with delta-V <12.3 km/s (the escape velocity from Solar System). They were obtained with the New Technology Telescope (ESO-NTT) at La Silla Observatory, the NASA Infrared Telescope Facility (NASA-IRTF), located at the Mauna Kea observatory in Hawaii, and the Telescopio Nazionale Galileo (TNG), located at the Roque de los Muchachos Observatory in La Palma, Canary islands.

The visible data presented in this work were obtained during three observational campaigns (June 2005, October 2005 and November 2006) at the NTT telescope, with the EMMI instrument and the grism #1 and in December 2012 at the TNG with the

DOLORES instrument and the LR-B grism. The near-infrared spectra were obtained in August, September and October 2004 at IRTF, equipped with the SpeX spectrograph and the low-res grism, and in August 2006 and July 2007 at the TNG, with the NICS+Amici instrument. We obtained seven spectra in the visible and seven in the NIR.

The taxonomic classification of the observed NEAs has been obtained by performing a best fit between our data and the mean spectra of each spectral class proposed by Bus & DeMeo [8]. We also compared our observational data with laboratory spectra, searching for a possible meteorite analogue: linking a NEA spectrum with a known laboratory meteorite sample could be in principle used as a proxy to investigate NEA's surface composition. Finally we investigate mineralogy by sampling the prominent bands in the NIR, typical of pyroxene and olivine assemblages [9,10,11]. All of the data have been reduced and are currently under analysis. The results will be presented at the Europlanet meeting.

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