Highlights of Astronomy, Volume 16
XXVIIIth IAU General Assembly, August 2012
T. Montmerle, ed.

doi:10.1017/S1743921314005183

MarcoPolo-R: Near Earth Asteroid Sample Return Mission candidate as ESA-M3 class mission

Patrick Michel[1], Luisa-M. Lara[2], Bernard Marty[3], Detlef Koschny[4], Maria Antonietta Barucci[5], Andy Cheng,[6] Hermann Bohnhardt[7], John R. Brucato[8], Elisabetta Dotto[9], Pascale Ehrenfreund[10], Ian A. Franchi[11] and Simon F. Green[11]

[1]Univ. Nice/CNRS/Côte d'Azur Observatory, F
email: michelp@oca.eu

[2]IAA/CSIC, S, [3]CRPG, F, [4]ESA/ESTEC, NL, [5]LESIA/Obs. Paris, F,[6]APL/JHU, USA, [7]MPS, D, [8]INAF/Obs. of Arcetri, I, [9]INAF/Obs. of Roma, I,[10]Univ. of Leiden, NL, [11]The Open University, UK

Abstract. *MarcoPolo-R* is a sample return mission to a primitive Near-Earth Asteroid (NEA) selected in February 2011 for the Assessment Study Phase at ESA in the framework of ESAfs Cosmic Vision 2 program. *MarcoPolo-R* is a European-led mission with a proposed NASA contribution. *MarcoPolo-R* takes advantage of three industrial studies completed as part of the previous Marco Polo mission (see ESA/SRE (2009)3). The aim of the new Assessment Study is to reduce the cost of the mission while maintaining its high science level, on the basis of advanced studies and technologies, as well as optimization of the mission. *MarcoPolo-R* will rendezvous with a unique kind of target, a primitive binary NEA, scientifically characterize it at multiple scales, and return a unique pristine sample to Earth unaltered by the atmospheric entry process or terrestrial weathering. The baseline target of *MarcoPolo-R* is the primitive binary NEA (175706) 1996 FG3, which offers a very efficient operational and technical mission profile. A binary target also provides enhanced science return: the choice of this target will allow new investigations to be performed more easily compared to a single object, and also enables investigations of the fascinating geology and geophysics of asteroids that are impossible to obtain from a single object. Precise measurements of the mutual orbit and rotation state of both components can be used to probe higher-level harmonics of the gravitational potential, and therefore the internal structure. A unique opportunity is offered to study the dynamical evolution driven by the YORP/ Yarkovsky thermal effects. Possible migration of regolith on the primary from poles to equator allows the increasing maturity of asteroidal regolith with time to be expressed as a latitude-dependent trend, with the most-weathered material at the equator matching what is seen in the secondary. *MarcoPolo-R* will allow us to study the most primitive materials available to investigate early solar system formation processes. Moreover, *MarcoPolo-R* will provide a sample from a known target with known geological context. Direct investigation of both the regolith and fresh interior fragments is also impossible by any means other than sample return. The main goal of the *MarcoPolo-R* mission is to return unaltered NEA material for detailed analysis in ground-based laboratories. The limited sampling provided by meteorites does not offer the most primitive material available in near-Earth space. More primitive material, having experienced less alteration on the asteroid, will be more friable and would not survive atmospheric entry in any discernible amount. Only in the laboratory can instruments with the necessary precision and sensitivity be applied to individual components of the complex mixture of materials that forms an asteroid regolith, to determine their precise chemical and isotopic composition. Such measurements are vital for revealing the evidence of stellar, interstellar medium, pre-solar nebula and parent body processes that are retained in primitive asteroidal material, unaltered by atmospheric entry or terrestrial contamination. It is no surprise therefore that sample return missions are considered a priority by a number of the leading space agencies.