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MarcoPolo-R: Sample return from NEA (341843) 2008 EV5

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Abstract

MarcoPolo-R is a European-led Near-Earth Asteroid (NEA) sample return mission [1], selected in February 2011 for the Assessment Study Phase of the M3 mission in ESA's Cosmic Vision programme. MarcoPolo-R will rendezvous with the primitive NEA (341843) 2008 EV5, scientifically characterize it at multiple scales and return a unique pristine sample to Earth unaltered by the atmospheric entry process or terrestrial weathering.

We will present an overview of the science objectives, the new target NEA, the planned mission profile, and recent developments in the mission profile, spacecraft design and the recently selected instrument suite.

1. Scientific objectives

The mission will address the fundamental Cosmic Vision questions "How does the Solar System work?" and "What are the conditions for life and planetary formation?".

Small bodies of our Solar System can retain evidence of the primordial solar nebula and provide a record of early solar system processes that shaped their evolution. 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. 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.

Small bodies are thought to have been the principal contributors of water and organic material essential to create life on Earth. They offer us a unique window to investigate both the formation of planets and the origin of life. Moreover, in the current epoch, these small bodies also represent both a potentially rich resource for future space exploration and a threat to the very existence of humankind.

It is no surprise therefore that sample return missions are considered a priority by a number of the leading space agencies.

2. Baseline target

New observational data has led the ESA Science Study Team, supported by their relevant scientific communities and associated working groups, to change the baseline target from the binary Near-Earth Asteroid (175706) 1996 FG3 (now the backup target) to (341843) 2008 EV5. It has a diameter of about 400 m [2] and a moderate albedo (0.10-0.12) compared with other primitive objects to be visited by a sample return mission (NASA OSIRIS-REx, JAXA Habayusa 2). The spectrum is typical of primitive C-type asteroids and shows a feature at 0.48 micron, which is a signature of the presence of alteration minerals with similarity to the CI meteorite Orgueil [3]. Therefore it is likely that this body is particularly primitive in nature (CI carbonaceous chondrites have the closest match to solar atmosphere elemental abundances), has accreted in a volatile-rich region, and may represent a transitional object between comets and asteroids.

3. Mission profile and payload

2008 EV5 offers an efficient operational and technical mission profile, with a complete mission scenario (round-trip) of 4.5 years with optimal launch windows in 2022-24. Mission analyses performed by ESA and by industries profiles with relatively constant heliocentric distance and small geocentric distance throughout the mission, resulting in a cost reduction compared with a mission to other potential targets. The reduced mission duration will bring the time of the sample analysis closer to the expected return epoch of other sample return missions, allowing Europe to contribute in a timely manner to the international sample return activities.

The baseline mission for MarcoPolo-R to 2008 EV5 involves a single primary spacecraft, with solar-electric propulsion, carrying the Earth re-entry capsule and sample acquisition and transfer system, launched from Kourou using a Soyuz-Fregat.

The in-situ scientific payload has now been selected. It constitutes a narrow angle camera, close-up camera, visible/near-IR spectrometer, Mid-IR imaging spectrometer and radio science experiment. It will provide global and local (of up to five potential landing sites) characterization of the asteroid to aid in navigation, landing site selection and sample context measurements.

Sampling will be performed by the main spacecraft using the ‘touch and go’ method. Up to three sampling attempts will be possible before the sample canister is sealed in the Earth Return Capsule (ERC). After return to the Earth the ERC will be released into the atmosphere, where it will decelerate by aerobraking before a hard landing (crushable material will reduce the impact shock to the sample).

4. Conclusion

MarcoPolo-R promises a legacy for future generations of scientists with the potential for application of new analysis techniques and instrumentation to address as yet unexplored aspects of planetary science through its unique sample. It addresses a wide range of science questions of interest to astronomers (interstellar grains and primordial nucleosynthesis, the interstellar medium) and astrobiologists as well as planetary scientists and the large community of sample analysts.

In addition to addressing the exciting science goals, the MarcoPolo-R mission also involves innovative European technologies for which ESA technical development programs are well under way that can be used as pathfinders for other future missions for science, human exploration and mitigation. It provides exciting and accessible science of interest to the public and new generations of potential scientists alike.

References

[1] Barucci, M.A., Cheng, A.F., Michel, P., Benner, L.A.M., Binzel, R.P., Bland, P.A., Böhnhardt, H., Brucato, J.R.., Campo Bagatin, A., Cerroni, P., Dotto, E., Fitzsimmons, A., Franchi, I.A., Green, S.F., Lara, L.-M.., Licandro, J., Marty, B., Muinonen, K., Nathues, A., Oberst, J., Rivkin, A.S., Robert, F., Saladino, R., Trigo-Rodriguez, J.M., Ulamec, S. and Zolensky, M.: MarcoPolo-R. Near Earth Asteroid Sample Return Mission, Experimental Astronomy, Vol. 33, pp. 645-684, 2012.

[2] Busch, M.W., Ostro, S.J., Benner, L.A.M., Brozovic, M., Giorgini, J.D. Jao, J.S., Scheeres, D.J., Magri, C., Nolan, M.C., Howell, E.S., Taylor, P..A., Margot, J.-L., Brisken, W.: Radar observations and the shape of near-Earth asteroid 2008 EV5, Icarus Vol. 212, pp. 649-660, 2011.

[3] Reddy, V., Le Corre, L., Hicks, M, Lawrence, K., Buratti, B.J., Abell, P.A., Gaffey, M.J. and Hardersen, P.S.: Composition of near-Earth Asteroid 2008 EV5: Potential target for robotic and human exploration, Icarus Vol. 221, pp. 678-681, 2012.