THE MARCOPOLO-R SAMPLE RETURN MISSION : TRACING THE ORIGINS

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Outine: MarcoPolo-R is a sample return mission to a primitive Near-Earth Asteroid (NEA) selected for a second Assessment Study Phase in the framework of ESA's Cosmic Vision (CV) programme. The new assessment study, started at ESA on May 2011, will continue until the end of 2013, when ESA will finally select the M3 class mission at the beginning of 2014. MarcoPolo-R is a European-led mission with a possible contribution from other agencies. MarcoPolo-R will rendez-vous with a primitive NEA, scientifically characterize it at multiple scales, and return a unique sample to Earth unaltered by the atmospheric entry process or terrestrial weathering.

The key science goals that will be addressed by MarcoPolo-R are: *What was the astrophysical setting of the birth of the Solar System? What is the origin of material in the early Solar System and how did it evolve? What are the physical properties and evolution of the building blocks of terrestrial planets? How do organics in primitive NEAs relate to the origin of life on Earth?*

Asteroids also represent both a potentially rich resource for future space exploration and a threat to the very existence of humankind on Earth. MarcoPolo-R will allow characterization of a member of the population of Potentially Hazardous Asteroids (PHAs), which is of high interest for mitigation studies. It will return bulk samples from an organic-rich primitive asteroid to Earth for laboratory analyses, allowing us to explore the origin of planetary materials and initial stages of habitable planet formation.

Target: 2008 EV5, with a diameter of about 400 m (Busch et al. 2011, Icarus 212, 649), has a moderate albedo (0.10-0.12) compared with the low values for other primitive objects to be visited by sample return missions (NASA OSIRIS-REx, JAXA Hayabusa 2). The spectrum is typical of primitive C-type asteroids and shows a spectral feature at 0.48 micron, which is a signature of the presence of alteration minerals with similarity to the CI meteorite Orgueil (Reddy et al. 2012, Icarus 221, 678). Therefore it is likely that this body is particularly primitive in nature, has accreted in a volatile-rich region, and may represent a transitional object between comets and asteroids.

Mission scenario: The complete mission (round-trip) will last 4.5 years with optimal launch windows in 2022-24. A single primary spacecraft, carrying the Earth re-entry capsule and sample acquisition and transfer system, will be launched by a Soyuz-Fregat rocket from Kourou. The spacecraft will proceed to the in-situ characterization to investigate the internal structure of a NEA, which is of high relevance for mitigation studies. Samples returned in 2027-9 will be handled by a Europe-led consortium that will include leading international scientists and facilities.