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Gravity Investigations with the MarcoPolo-R Radio Science Experiment RSE

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1. MarcoPolo-R

The ESA sample return mission MarcoPolo-R is one of the current candidate M3 missions. It will rendezvous with a primitive Near Earth Asteroid (NEA), scientifically characterize it at multiple scales, and return a unique sample to Earth [3]

The determination of the global physical properties of the mission target, the Near Earth Asteroid 2008 EV5, is among others one science objective of the MarcoPolo-R mission. In this context one key parameter is the gravity field, especially GM (gravitational constant times the mass) and the low order gravity coefficients C_{20} and C_{22} of the asteroid.

2. The NEA 2008 EV5

The Near Earth Asteroid 2008 EV5 has an oblate spheroidal shape with dimensions along the principal axis of (415 x 410 x 385) ± 50 m. Measurements of the optical albedo are consistent with a rocky or a stony/iron composition. The NEA shows an equatorial ridge and a large concavity interpreted as an impact crater [4, 8].

2. The Radio Science Experiment RSE

The Radio Science Experiment RSE on MarcoPolo-R will use the onboard resources of the Radio subsystem of the spacecraft to perform its measurements. The Radio Science technique enables the estimation of the gravity field of a planet, a moon or a small body like a comet or an asteroid by measuring the gravity induced Doppler shift of the radio carrier frequency [2, 7]. From Doppler shifts, we can even constrain variations in mass distribution within the body.

The mass and the bulk density of asteroids are key parameters for the derivation of their composition and internal structure. The bulk density of the asteroid can be derived from the estimation of GM and a volume estimate provided by an imaging instrument. The bulk density can be compared with the spectral type of the asteroid [2].

The gravity field coefficients characterize the deviation of the external gravity field of a body from that of a point mass. Thereby, the coefficients carry information about the internal structure of the body. Gravity field coefficients, together with other information (shape, moments of inertia) may help to disentangle the interior of an asteroid [1].

A dedicated Radio Science Phase during the mission will enable the RSE to determine the gravity field of the asteroid. The orbits necessary to estimate the gravity field shall be self-stabilizing to avoid perturbations caused by SC maneuver [5, 7].

The feasibility of the estimation of GM (gravitational constant times the mass) and the low order gravity coefficients C_{20} and C_{22} of the NEA 2008 EV5 and the accessibility of stable orbits around the asteroid are investigated.

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