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PRIDE and MarcoPolo-R: VLBI applications for Near-Earth Asteroids science

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Abstract

The core of the Planetary Radio Interferometry and Doppler Experiment (PRIDE) is the accurate estimation of the state-vector of a spacecraft using Very Long Baseline Interferometry (VLBI) tracking. In this contribution, we will describe the technique and the technical requirements as well as the multidisciplinary scientific outcome of PRIDE as a part of the ESA mission MarcoPolo-R towards the Near-Earth Asteroids.

PRIDE and MarcoPolo-R

The MarcoPolo-R is a sample return mission to a primitive Near Earth Asteroid (see [1] and [2]). Its science goals focus on understanding the processes occurring in the early solar system, and studying the physical properties of the building blocks of terrestrial planets.

The PRIDE experiment for the ESA MarcoPolo-R mission (PRIDE-MP) will estimate the state-vector of the spacecraft with high accuracy by performing VLBI observations of the spacecraft and natural celestial reference radio sources.

Due to the ability to provide precise measurements of spacecraft lateral coordinates, radial velocity and its derivatives ([3]), PRIDE will contribute into estimates of the mass and gravity field of MarcoPolo-R study objects. Furthermore tracking the orbiter in the gravity field of binary Near-Earth Asteroid will allow us not only to determine the spacecraft trajectory but also to improve the ephemerides of the Near-Earth Asteroids.

PRIDE-MP offers a high degree of synergy with MarcoPolo-R on-board instrumentation and does not include components requiring mission-critical technology developments. The required on-board instrumentation (transmitters, ultrastable oscillators, antennas) will be developed and used for MarcoPolo-R mission operations regardless of PRIDE-MP.

PRIDE-MP will address the following scientific areas:

- Ultra-precise celestial mechanics of a binary Near-Earth Asteroid system;
- Geodynamics, internal structure and composition of primordial asteroids;
- Shape and gravimetry of the asteroids.

These are key points for studying the physical properties and the evolution of the potential building blocks of terrestrial planets.

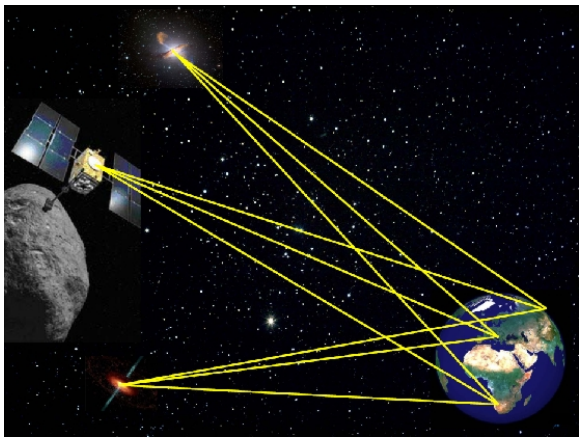

Figure 1: Artistic impression of the PRIDE setup for the ESA MarcoPolo-R mission.

VLBI tracking of the orbiters in combination with routine observations of radio sources of the celestial reference frame will allow us to firmly tie the binary asteroid system into the reference frame. This would represent a major contribution to Near-Earth planetary geodesy and the definition of the Solar System reference system.

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