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Precise orbitography of BepiColombo and the determination of Mercury's gravity field.

L. Iess (1), A. Milani (2), G. Tommei (2)

(1) Universita' La Sapienza, Rome, Italy, (2) Universita' di Pisa, Italy
(luciano.iess@uniroma1.it/+39-06-44585670)

Precise microwave tracking of interplanetary spacecraft has been a crucial tool in the determination of planetary gravity fields and in tests of general relativity and alternate theories of gravity. Today, thanks to the use of Ka-band and multifrequency radio links, significant improvements are at hand both in range and range rate measurements, with potential benefits to planetary science and navigation.

The experiment MORE of BepiColombo, the ESA mission to Mercury, addresses scientific goals in geodesy, geophysics and fundamental physics. The key instrument is a Ka/Ka (32-34 GHz) digital transponder enabling a high phase coherence between uplink and downlink carriers and supporting a wideband ranging signal. The radio system is expected to provide an end-to-end two-way accuracy of 20 cm and 3 micron/s (at 1000 s integration times), respectively in range and range rate measurements.

The dynamical model required to fit the high accuracy tracking observables generated by MORE will require the identification of the state vectors of four different bodies, namely the spacecraft, Mercury, the Earth and the tracking station, each one at its own time, with separate relativistic corrections. The orbit determination software currently under development will provide these vectors consulting separately four dynamics: the first gives the S/C orbit around Mercury, with gravitational and non gravitational perturbations, tides and relativistic corrections, using also the ISA accelerometer data; the second gives the orbit of Mercury and of the Earth, taking into account the current model of solar system dynamics, in a fully relativistic framework; the third gives the rotation of Mercury, including the spin-orbit resonance, obliquity, libration in longi-

tude and other deviations from Cassini's laws; the last gives the rotation of the Earth, according to the best available IERS model.

We present the overall architecture of the orbit determination software and results for the expected accuracies in the spacecraft state vector and Mercury's harmonics coefficients. In an effort to obtain realistic estimates, the orbital simulations made use of the current error models for tracking data and onboard measurements of non-gravitational accelerations, where both colored noise and systematic effects were taken into account.