IAF SPACE EXPLORATION SYMPOSIUM (A3)
Solar System Exploration including Ocean Worlds (5)

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TESTING TORSION THEORIES OF GRAVITY WITH THE ESA/JAXA BEPICOLOMBO MISSION TO MERCURY

Abstract

BepiColombo is a joint ESA/JAXA mission for a comprehensive exploration of the planet Mercury. The mission has been launched in October 2018 and it is scheduled for orbit insertion at the end of 2025. The Mercury Orbiter Radio science Experiment (MORE) is one of the on-board experiments, devised to enable a better understanding of the geodesy and geophysics of Mercury, on one side, and of fundamental physics, on the other. Thanks to full on-board and on-ground instrumentation capable to perform very precise tracking from the Earth, MORE will have the chance to determine with very high accuracy the Mercury-centric orbit of the spacecraft and the heliocentric orbit of Mercury and the Earth.

Taking advantage from the fact that Mercury is the best-placed planet to investigate the gravitational effects of the Sun, MORE will allow an accurate test of relativistic theories of gravitation (relativity experiment). The test consists in constraining the value of a number of Post-Newtonian (PN) parameters together with some other parameters of general interest, as the gravitational mass and oblateness of the Sun. The challenging scientific goals of MORE can be fulfilled only by performing a very accurate orbit determination (OD) of the spacecraft, of Mercury and of the Earth. Starting from the radio observations (range, range-rate) between the on-board transponder and one or more on-ground antennas, we perform the OD together with the parameters estimation by means of an iterative procedure based on a classical non-linear least squares (LS) fit.

Here, we present the latest results of the global simulations of the MORE relativity experiment, performed with a dedicated OD software, ORBIT14, entirely developed by the Celestial Mechanics Group of the University of Pisa, under an Italian Space Agency (ASI) contract. The dynamical model adopted for our simulations accounts for a full relativistic framework in the standard parameterized PN approximation. In particular, we discuss the opportunity to add to the dynamical model the contribution due to a possible non-vanishing spacetime torsion, which is not allowed in General Relativity (GR). The results of our simulations show that possible modifications of GR due to torsion could be constrained by BepiColombo-MORE significantly below the percent level.

Study partly performed within the scope of the Addendum No. I/080/09/1 of the Contract No. I/080/09/0 with ASI.