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Exploring second-order gravitational effects and the possibility for dark matter detection with the next generation of space-borne atomic standards of frequency and time

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General relativity (GR) and quantum theory form the basis of the modern physical picture of the universe. However, attempts to unify them inevitably lead to violations of the Einstein Equivalence Principle (EEP) which is the basis of GR. A promising kind of experiments to test the domain of validity of EEP is based on measuring the gravitational redshift. Recent progress in the stability and accuracy of atomic clocks, including those qualified for operation in space, provides for significant improvements of the accuracy of these measurements in the next 10 years, and also enables new kinds of experiments.

To assess the accuracy of such experiments and process their data, the current models of frequency and time transfer between two spacecraft in the Solar system, or a spacecraft and a ground station, need to be refined. We present such an improved model, which includes terms to order c^{-4} and accounts for nonrelativistic Doppler compensation schemes, and use it to analyze the accuracy of EEP tests and PPN parameter measurements which can be performed in near-future space experiments in the Solar system. We also formulate the constraints on EEP violations predicted by fuzzy dark matter theories which can be achieved in such experiments.

Primary authors: Dr LITVINOV, Dmitry (Lebedev Physical Institute); Dr PILIPENKO, Sergey (Lebedev Physical Institute)

Co-authors: Dr ZAKHVATKIN, Mikhail (Keldysh Institute of Applied Mathemetics); Mr FILETKIN, Alexander (Sternberg Astronomical Institute)

Presenter: Dr LITVINOV, Dmitry (Lebedev Physical Institute)

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