1.14 An SLR campaign on Galileo satellites 5 and 6 for a test of the gravitational redshift

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Einstein's General Relativity (GR) predicts that time flows differently for two clocks that have a relative speed and are placed in different gravitational potentials. It is therefore possible to test GR by comparing two clock frequencies. The most precise test of the gravitational redshift to date has been realized with the Vessot-Levine rocket experiment in 1976, also named the Gravity Probe A (GP-A) experiment. The gravitational redshift was verified to 1.4 x 10^(-4) accuracy.
We propose to use the on-board atomic clocks of the Galileo satellites 5 and 6 to look for violations of GR [1]. The Galileo 5 and 6 satellites, with their large eccentricity and on-board H-maser clocks, are good candidates to perform this test. These two satellites were launched on August, 30th 2014 and, after a technical problem, the launcher brought them on an elliptic orbit. An elliptic orbit induces a periodic modulation of the gravitational redshift while the good stability of recent GNSS clocks allows to test this periodic modulation to a very good level of accuracy. Contrary to the GP-A experiment, it is possible to integrate the signal on a long duration, therefore improving the statistics.
The proposed approach to reach an improved test of the gravitational redshift requires an accurate knowledge of the frequency of the satellite clock as it orbits the Earth. These data are made available by several Analysis Centers (ACs) of the International GNSS Service (IGS) in the framework of the Multi-GNSS-EXperiment (MGEX) [2]. However, a good control of systematic effects will be essential in order to calculate robust limits on the parameters of the GR violation. This control can be accessible thanks to Satellite Laser Ranging (SLR).
Therefore we want to discuss the possibility for the ILRS community to join us in a concerted campaign of Satellite Laser Ranging on Galileo 5 and 6 satellites. If several SLR stations in the two hemispheres could participate in the tracking, the resulting SLR coverage would be the best solution. The SLR data will be analyzed by the GRGS ILRS AC, considering the orbital element time series adjusted on GNSS data and provided by IGS ACs participating to the MGEX experiment (among them GRGS) as an input for the ILRS. It will be a good opportunity to improve the calibration of (i) the IGS orbits, and (ii) SLR data in that framework.

[1] Delva, P., A. Hees, S. Bertone, E. Richard, et P. Wolf. Test of the gravitational redshift with stable clocks in eccentric orbits: application to Galileo satellites 5 and 6. arXiv:1508.06159, 2015. in press.
[2] Montenbruck O., Steigenberger P., Khachikyan R., Weber G., Langley R.B., Mervart L., Hugentobler U., "IGS-MGEX: Preparing the Ground for Multi-Constellation GNSS Science", InsideGNSS 9(1):42-49 (2014).