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HIGH PERFORMANCE SOLAR RADIATION PRESSURE MODELING FOR A TEST OF THE GRAVITATIONAL REDSHIFT USING THE GALILEO NAVIGATION SATELLITES

Abstract

On 22 August 2014, the GALILEO satellites Galileo-FOC FM1 and Galileo-FOC FM2 were injected into an incorrect orbit which has an eccentricity of about 0.16. Despite this launch failure, this incident turned out to offer the unique opportunity to carry out a test on Einsteins theory of general relativity, since both satellites are equipped with high precision atomic clocks which are potentially capable of resolving relativistic time phenomena as the gravitational redshift. Depending on whether the satellites are in closer proximity to earth or more distant, while they orbit around earth on their unique trajectory, the atomic clocks are thus expected to run more slowly or speed up in a periodic manner according to the nature of their orbit geometry. The recovery of the signature of this relativistic effect from the atomic clock signature requires to resolve all systematic effects that are known to have an impact on the clock's data. We show, how precise orbit modeling can improve the quality of the data. In this respect, we address the accurate modeling of non gravitational disturbances and in particular solar radiation pressure perturbations. In this context, we propose an a-priori finite element model of the GALILEO-FOC satellite, which represents technical details such as precise geometrical information and specific optical material properties assigned to the FE model's surface elements. Furthermore, a performance validation is presented, which contrasts the major differences with respect to conventional SRP models. Finally, we discuss the benefit of our modeling method on the improvement of the relativistic redshift verification.