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BOOST: A TEST OF SPECIAL RELATIVITY

Abstract

BOOST is a mission that aims at testing the foundations of Special Relativity. The centre piece of BOOST are two frequency references mounted on a satellite. It is dedicated to test the validity of Lorentz invariance by comparing a length reference (i.e. a highly stable optical resonator) with a molecular frequency reference. Similar experiments have been performed on Earth. The current best Earth-bound test has been performed by Tobar et al. [1] in 2010, being able to determine the Kennedy-Thorndike coefficient with an accuracy of 4 10ˆ8. By operating a state-of-the-art experimental setup in space for a duration of two years that accuracy could theoretically be improvement to 1 10ˆ10. With the restrictions induced by the choice of orbit and the achievable stability of the in-build clocks an improvement of the accuracy in the order of two orders of magnitude is targeted.
In addition, BOOST could be employed to observe Lorentz violations and CPT violations. These violations are described by the standard model extension by introducing new terms to the according Lagrangian[2]. The accuracy of the associated standard model extension coefficients could be improved by a two orders of magnitude in the fermion sector by executing BOOST.

Finally, BOOST yields the possibility to access the fine structure of the iodine in the frequency standard. The dependency of the transition in the iodine frequency standard leads to an improvement in the determination of the fine structure constant. Compared to similar ground based experiment [3], an improvement of two orders of magnitude could be expected.
In addition to the expected scientific outcome, BOOST offers substantial technological progress with impact on other space-based missions, such as LISA, NGGM, STE-QUEST, and future GNSS namely:

- Operating optical clocks with unprecedented frequency stability in orbit
- High performance thermal stabilization of the optical resonator
- Space-qualification for state of the art diode laser technologies
- Efficient, space qualified Electronics

BOOST is a phase 0 study funded by DLR that is planned to be constructed in a combined effort by participants from the University of Bremen, DLR, the University of Hannover, the Humboldt University Berlin, and Airbus Defence and Space.

1. M.E. Tobar, et al., Physical Review D, 81 (2010) 022003
2. D. Colladay, et al., Physical Review D, 58 (1998) 116002
3. M.E. Tobar, et al., Phys. Rev. D, 87 (2013) 122004