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THE STRATOSPHERIC OPTICAL RUBIDIUM CLOCK EXPERIMENT

Abstract

The development of optical atomic clocks and optical frequency standards is foundational to the advancement of space-based missions in geodesy, deep-space satellite navigation, and fundamental physics. Examples of such fundamental physics investigations include the BOOST Symmetry Test (BOOST) satellite and the proposed Astrodynamical Space Test of Relativity using Optical Devices I (ASTROD I) mission, which both utilize ultra-stable clocks. Optical clocks fluctuate very rapidly ($\sim 10^{14}$ times per second), so the interval between "ticks" of an optical atomic clock is a few femtoseconds. Since the scale of time is divided into such small intervals, optical atomic clocks provide exceptional timing resolution and stability. However, most of these existing clocks are not compact enough to be suitable for space-based applications.

The Stratospheric Optical Rubidium Clock Experiment (SORCE) aims to demonstrate a compact optical atomic clock built from commercially available components on a stratospheric balloon platform, as a first step towards a functioning space-based system. This will be the first demonstration of a remotely operated, portable optical atomic clock. SORCE aims to perform a Lorentz violation test using two orthogonal clock systems utilizing the 778 nm $5S_{1/2}$ to $5D_{5/2}$ two-photon transition in rubidium, reaching a fractional stability of $5 \times 10^{-13}/\sqrt{\tau(s)}$ in a 35×35×25 cm package.

SORCE will fly on a high-altitude balloon as part of the 2019 STRATOS campaign (CSA/CNES) in late August from Timmins, Ontario, Canada. The results from the flight, including lessons learned and scientific outcomes, will be presented along with a complete characterization of SORCE.