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Development of a Sr optical lattice clock for systematic effects characterization below 10^{-18} uncertainty level

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Strontium optical lattice clocks (OLC) are a promising instrument for applications ranging from the redefinition of the second in the international system to geodesy and fundamental physics, for instance, dark matter detection, variation of fundamental constants, or general relativity tests. LNE-SYRTE, Observatoire de Paris operates two Sr OLCs with a systematic uncertainty on the order of 10^{-17}, mostly limited by the inhomogeneous thermal distribution of the vacuum chamber inducing black body radiation (BBR) shift, but also by cold collisions between the atoms trapped in each site of the optical lattice.

Aiming to improve the characterization of systematic effects in optical lattice clocks below 10^{-18}, the thermal design of the new setup comprises an Ultra High Vacuum (UHV) chamber made in copper that is also placed in a primary vacuum environment. This will limit conductive and radiative exchanges between the experimental system and the laboratory, which contributes to BBR control.

In adition, we propose the implementation of Laguerre-Gaussian modes (LG_{pl}) to shape a multi-site trap in the 1D optical lattice. Hence reducing the density of atoms, while preserving the advantages of 1D lattices such as amplified power and spatial purity of the modes, unlike 3D optical lattices or tweezers.

In this seminar, we present the progress in the assembling of the new SrC clock setup, as well as the generation of $LG_{0\ell}$ modes with angular index ℓ up to 4. Trapping depths up to $39E_r$ for an LG_{04} lattice were obtained, a priori making it possible to implement LG lattices within the clock sequence.

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