Contribution ID: **118** Type: **Invited Oral**

Developments to improve the stability of optical lattice clocks

Tuesday 17 October 2023 09:30 (30 minutes)

We will present the progress of our Hg optical lattice clock. This work is motivated, in particular, by the low sensitivity of Hg to blackbody radiation and stray electric fields and by the possibility to use ratio between Hg and other optical transitions for fundamental physics and metrology. We re-port on our work done with the 199Hg fermionic isotope to improve uncertainty, stability and relia-bility [1][2], noting that managing the required deep UV wavelength remains a significant experi-mental challenge. We will also report on a series of frequency ratio measurements with 87Sr and other species, as allowed by the optical fiber network in Europe, including the REFIMEVE infra-structure in France [3]. The excited clock state 3P0 in 199Hg has a rather short spontaneous decay time compared to other species, which can become a limit to exploit the most recent ultra-stable lasers. Bosonic isotopes can circumvent this limit. We will describe our on-going work to develop a Hg clock based on bosonic isotopes and making use of the quenching method [4] and of hyper-Ramsey interrogation [5][6].

We are also developing a non-destructive detection scheme adapted to Sr optical lattice clocks. The scheme is based on a differential heterodyne measurement of the dispersive properties the atomic sample, enhanced by a high finesse cavity. A first implementation demonstrated how to implement the scheme in a technically robust manner and clarified the path to achieve the quantum non-destructive regime [7]. We will report on our new implementation, on its characterization it terms of quantum noise and destructivity, and on its practical potential to improve optical lattice clocks [8].

Finally, we will report on our investigation of laser stabilization using spectral hole burning in rare-earth doped crystals at ultra-low temperature. We have developed agile heterodyne dispersive prob-ing methods based digital signal generation, modulation and demodulation that gives low detection noise, slow fading of the spectral hole and immunity to perturbations present in the cryogenic envi-ronment [9]. We will report on our investigation of properties of spectral holes at 1.4 K [10] and at cryogenic dilution temperature of a few 100 mK, at which favorable conditions to realize laser sta-bilization at 10-17 or better.

These advances, individually or combined for example with spectral purity transfer with combs and composite clock approaches, shall bring significant progress in clock stability and accuracy.

Authors: FANG, Bess (LNE-SYRTE, Observatoire de Paris - PSL, CNRS, Sorbonne Université); LODEWYCK, Jérôme (LNE-SYRTE, Observatoire de Paris - PSL, CNRS, Sorbonne Université); POTTIE, Paul-Eric (LNE-SYRTE, Observatoire de Paris - PSL, CNRS, Sorbonne Université); LE TARGAT, Rodolphe (LNE-SYRTE, Observatoire de Paris - PSL, CNRS, Sorbonne Université); BIZE, Sébastien (LNE-SYRTE, Observatoire de Paris - PSL, CNRS, Sorbonne Université); LE COQ, Yann (LNE-SYRTE, Observatoire de Paris - PSL, CNRS, Sorbonne Université)

Presenter: BIZE, Sébastien (LNE-SYRTE, Observatoire de Paris - PSL, CNRS, Sorbonne Université)

Session Classification: Lattice Clocks

Track Classification: Molecular, Atomic, Ion and Nuclear Clocks