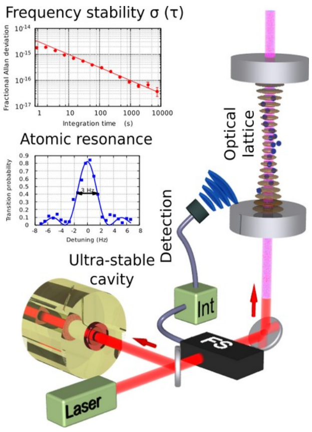
M2 Internship offer

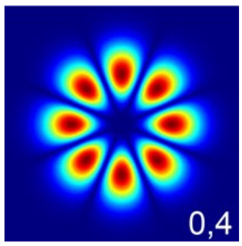
Optical lattice clocks :
multi-site trapping of ultra-cold atoms

LNE-SYRTE, the national time-frequency metrology laboratory located at Paris Observatory, develops some of the most accurate atomic clocks in the world. The caesium microwave fountains at LNE-SYRTE realise the second, the unit of time of the international system of units and contribute to the steering of TAI (Temps Atomique International), the basis of UTC. In parallel, LNE-SYRTE is developing a new-generation of atomic clocks, optical clocks, based on transitions of strontium or mercury atoms in the optical domain. These clocks use ultra-cold atoms trapped in an array of dipole traps, probed by a laser whose frequency is ultra-stable.



These clocks now reach an accuracy of the order of 10^{-17}, with prospects of a gain of several orders of magnitude in the coming years. In 2017, LNE-SYRTE's optical clocks demonstrated the first contribution of an optical clock to TAI. In this context of improving the accuracy and stability of clocks, the clocks of LNE-SYRTE take part to clock comparisons, both locally and internationally via satellite links and a fiber optic network linking European metrology institutes. These comparisons have many applications, both to demonstrate the reproducibility of clocks and to carry out fundamental physics tests. Finally, the demonstration of quantum entanglement effects between atoms can be used to improve the frequency stability of clocks.

The internship project aims at improving the accuracy of strontium optical clocks. In these clocks, ultra-cold atoms are trapped in the standing wave of a laser in a linear optical resonator. Several thousand sites of this array are populated, each by a few atoms. In order to reduce the number of atoms per site, and thus the density, we propose to demonstrate a new geometry for the trapping potential, using high order eigen-mode of the cavity (Laguerre-Gauss mode, as shown on the right). The objective of the internship will be to assemble an optical system using phase plates or a spatial light modulator to shape the trapping light according to the desired geometry, then to study the quantum characteristics of the trapped cold atoms (collision effects, light displacement,...).



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