



Postdoc position: Superradiance on ytterbium clock transition for frequency metrology

The time and frequency metrology group at FEMTO-ST in Besançon is looking for a 2-year postdoctoral researcher in AMO physics for the superradiant laser project.

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Candidates should provide their CV and the name of at least one person who could provide a recommendation letter. We are looking for candidates with a PhD and experience in cold atoms.

Context: With the advent of optical atomic clocks, precision measurements have entered a new era. Fractional frequency accuracies have reached the 18th decimal, and are now providing key insights into faint fundamental phenomena. Yet, the current limitations of traditional, “passive”, optical clocks are now challenging to overcome, and new optical frequency keepers are emerging. Among them, one exciting perspective is to realize superradiant lasers. They are based on cold atoms with a narrow-linewidth optical transition coupled to a high-finesse Fabry-Perot cavity. Superradiance emerges as the constructive quantum interference between the various decay paths from a many-body fully excited state to the ground state. A superradiant laser uses directly the enhanced atomic emission inside the cavity as the ultra-stable signal.

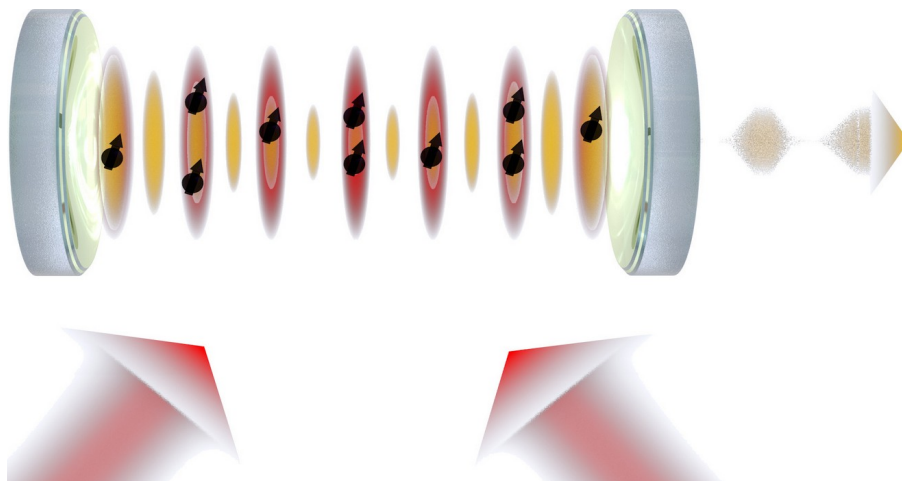


Figure 1: Sketch of a superradiant laser setup emitting pulses. Atoms will be pumped into the excited state of the clock transition and emit superradiant pulses. In black: atoms, in yellow: optical cavity mode; in red: trapping lattice.

The project: The goal of this project is to exploit quantum coupling between atoms and cavity to observe superradiance with an ytterbium gas. A sketch of the experiment is indicated in Fig. 1. The next



experimental objective is to transport ytterbium atoms to the cavity via an optical conveyor belt. In the cavity, we will perform high-resolution spectroscopy of an ultra-cold ytterbium ensemble coupled to a single mode high finesse Fabry-Perot cavity to estimate the atom-cavity coupling. The next objectives will focus on the first observation of superradiance on the clock transition of ytterbium. Then, we will transport a second atomic ensemble inside the cavity and study the emergence of quantum correlations between the two ensembles.

Current status: The ytterbium MOT is operational and reliable, and the cavity has been fully characterized. We are setting up an initial optical transport using a Ti:saph laser and are ordering another set of lasers for a more efficient transport.

The lab: FEMTO-ST is a research institute focusing on various topics, ranging from energy storage to optics and time and frequency. Our group is part of the very active OHMs team of the time and frequency department (<https://teams.femto-st.fr/equipe-ohms>). It has a long tradition of excellence, and is particularly renowned for its ultra-stable oscillators. The superradiant laser project is in line with this tradition, as it is targeting the future of ultra-stable oscillators.

Besançon: Besançon is a UNESCO world heritage city, located in the heart of Franche-Comté, at the foot of Jura, and is a heaven for nature enthusiasts. It is a university metropolis, with more than 20,000 students and a very active cultural life. Local information can be found on EIPHI-BFC graduate school website (<http://gradschool.eiphi.univ-bfc.fr/>).



Grant: The postdoctoral fellowship is provided by the QuantERA project EQUINOCS for one year. Extra funding will be available on the ANR project CRYSTAL for up to 18 months in order to explore the repumping mechanisms that could lead to a quasi-continuous superradiant emission. Gross monthly salary will be between 2600€ and 3600€, based on experience.