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 1(2)-year postdoctoral researcher in atom optics for the superradiant laser project.

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Candidates should apply before 15th of May, and provide their CV and at least one recommendation letter. We are looking for candidates with a PhD and experience in optics and atomic physics. A prompt start of the contract is desirable and provides a unique opportunity for a young post-doc to take responsibilities on a very exciting and already funded project.

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.

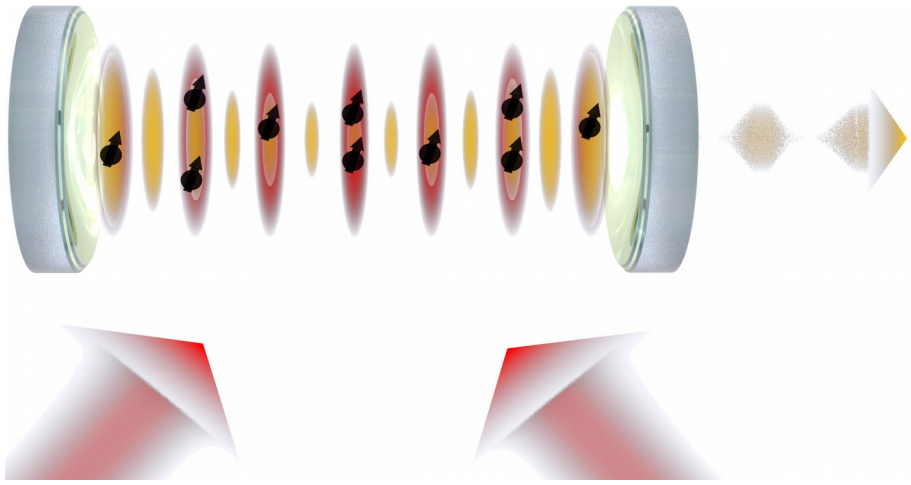

Figure 1: Sketch of superradiant laser setup emitting pulses. Atoms will be pumped into the excited state of the clock transition and emit superradiant pulses. In black: atoms, in yellow: optical cavity mode; in red: trapping lattice.

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The project: The goal of this new project is to exploit quantum coupling between atoms and cavity to observe superradiance with an ytterbium gas. Prior to an actual observation of superradiance, we will perform high-resolution spectroscopy of an ultra-cold ytterbium ensemble coupled to a single mode high finesse Fabry-Perot cavity to evaluate the influence of the cavity on the transition frequency. The next objectives will focus on the first observation of superradiance on the clock transition of ytterbium. A sketch of the experiment is indicated in Fig. 1. The metrological aspects, including frequency stability characterization and efforts towards a continuous superradiant laser will represent an important part of the project. However, fundamental aspects such as squeezing and other collective phenomena such as the effect of interactions can also be explored.

Current status: The vacuum system for the MOT is now pumping, and we have received the commercial MOT lasers. Depending on when the lab re-opens, we should obtain a MOT of ytterbium this summer. We have started to design the cavity and received funding to start the ultra-stable systems (cavity, clock laser) this fall.

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 EIPHI graduate school and Région Bourgogne Franche-Comté. It is currently guaranteed for one year, but extra funding has been requested to several sources to extend it to two or more years. Gross monthly salary will be between 2600€ and 3600€, based on experience.

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