Towards an active optical clock based on strontium.

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Optical atomic clocks are the most accurate devices in the world, which makes them the best frequnecy standards. They offer one of the lowest instability, making them powerful tools in fundamental physics [1]. All state of the art of optical clocks are passive devices which limit their performance. One promising approach towards next generation optical clocks is the realization of an active optical clock based on superradiance phenomena [2][3].

We report on early-stage progress towards an active optical clock with strontium atoms in two dimensional optical lattice [4]. In particular, we present the current status of the experiment, including the construction of a strontium oven, installation of magnetic coils in a vacuum chamber, and implementation of laser systems for cooling and trapping atoms. The ultimate goal of this project is to achieve continuous superradiance on ultra narrow clock transition in both ^{88}Sr and ^{87}Sr.

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[1] P. Wcisło *et al.*, "Experimental Constraint on Dark Matter Detection with Optical Atomic Clocks", *Nature Astronomy* (2016).

[2] M. Norcia *et al.*, "Superradiance on the Millihertz Linewidth Strontium Clock Transition." *Science Advances* 2, no. 10 (2016)

[3] A. Gogyan *et al.*, "Theoretical Investigation of Superradiant Lasing in 2- or 3- Level Atoms in an Optical Lattice", (EFTF/IFCS), Gainesville, FL, USA, (2021), pp. 1-4.

[4] M. Bober *et al.*, "Towards a Continuous Active Optical Atomic Clock With Cold Strontium Atoms", (EFTF/IFCS), Gainesville, FL, USA, (2021), pp. 1-3.

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