Strontium atomic fountain for metrology

Nikhil Dev Kummali Kongath,[1,*] Parviz Saedi,[1] and Andrea Bertoldi[1]

[1] *LP2N, IOGS, Université Bordeaux, F-33400 Talence, France*

Developing ultra-stable frequency references is a central goal in quantum metrology, with profound applications for precision timekeeping and fundamental physics. This research focuses on constructing a strontium atomic fountain designed to generate continuous superradiant emission on the optical clock transition. The setup involves a novel ultra-high-vacuum system, designed as an improvement over our group's earlier atomic source to enhance atom flux, temperature control, and cavity coupling [1]. Within this system, strontium atoms are laser cooled and vertically launched into an optical cavity operating in the bad-cavity regime. Inside the cavity, atoms will be cooled to microkelvin temperatures and coherently manipulated to enhance their collective emission. A central aspect of the project is the implementation of a mechanism to spatially separate ground- and excited-state atoms, based on the scheme proposed by Bychek and Ritsch [2], enabling a sustained population inversion and thereby allowing for continuous-wave superradiant light generation. This system is intended to function as an active optical frequency standard with exceptional long-term stability and low phase noise, opening new possibilities for next-generation optical clocks and high-precision measurements.

---

[1] C.-H. Feng *et al.*, *Quantum Sci. Technol.* **9**, 025017 (2024).
[2] A. Bychek and H. Ritsch, *New J. Phys.* **25**, 11301 (2023).

* first.last@institution.com; http://institute.country/