Continuous-Wave BECs and Superradiant Clocks

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Ultracold quantum gases are excellent platforms for quantum simulation and sensing. So far, these gases have been produced using time-sequential cooling stages, and after creation, they, unfortunately, decay through unavoidable loss processes. This limits what can be done with them. For example, it becomes impossible to extract a continuous-wave atom laser, which has promising applications for precision measurement through atom interferometry [1]. In the first part of this talk, I will present how we create continuous-wave BECs, BECs that persist in a steady-state for as long as we desire. Atom loss is compensated by feeding fresh atoms from a continuously replenished thermal source into the BEC by Bose-stimulated gain [2]. The only step missing to create the long-sought continuous-wave atom laser is the addition of a coherent atom outcoupling mechanism. In addition, this BEC may give us access to interesting driven-dissipative quantum phenomena over unprecedented timescales. The techniques we developed to create the continuous source of thermal atoms are also nicely suited to tackle another challenge: the creation of a continuously operating superradiant clock [3-6]. These clocks promise to become more rugged and/or more short-term stable than traditional optical clocks, thereby opening new application areas. In the second part of my talk, I will present how we are developing two types of superradiant clocks within the European Quantum Flagship consortium iqClock. The first operates on a kHz-wide transition of Sr [7] and the other on the mHz-narrow Sr clock transition.

References

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