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Fachbereich Physik, Universität Stuttgart
Max-Planck-Institut für Festkörperforschung
Max-Planck-Institut für Intelligente Systeme

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Continuous Bose-Einstein condensation and superradiant clocks

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Abstract

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. I will present how we achieved continuous Bose-Einstein condensation, creating 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. 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. These clocks promise to become more rugged and/or more short-term stable than traditional optical clocks, thereby opening new application areas. I will present how we are developing two types of superradiant clocks within the European Quantum Flagship consortium iqClock, the first operating on a kHz-wide transition of Sr and the second on the mHz-narrow Sr clock transition.