Continuous Bose-Einstein condensation and superradiant clocks

Prof. Dr. Florian Schreck

University of Amsterdam

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]. I will present how we achieve continuous Bose-Einstein condensation and create condensates (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]. Our experiment is the matter wave analog of a cw optical laser with fully reflective cavity mirrors. The only step missing to create a continuous-wave atom laser beam 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 achieve the continuous source of thermal atoms are also nicely suited to tackle another challenge: the creation of a continuously operating superradiant clock [3,4,5,6]. 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 [4,5,6].

References

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