FEMTO-ST Colloquium

an opportunity to meet prestigious researchers

FLORIAN SCHRECK

University of Amsterdam

Thursday, June 29th, 2023
11.30

Amphi Émilie du Châtelet
SUPMICROTECH-ENSMM, Besançon

Florian Schreck uses ultracold quantum gases to explore quantum physics. After his PhD 2002 at E.N.S. Paris with Christophe Salomon and a postdoc in Austin, TX with Mark Raizen, he joined the group of Rudolf Grimm at IQOQI, Innsbruck in 2004.

He founded his own research group in 2008, soon afterwards creating the first quantum gas of strontium. In 2014 he moved his group to Amsterdam, where he extended his research using an ERC consolidator grant and an NWO Vici grant. Recently his group created the first quantum gas in steady-state, a great starting point for future continuous atom lasers. He is the coordinator of the iqClock consortium and the Quantum Sensing program of the Dutch National Agenda for Quantum Technology.

CONTINUOUS BOSE-EINSTEIN CONDENSATION AND SUPER-RADIANT CLOCKS

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 continuously operating clocks, in particular superradiant clocks and compact deadtime free clocks [3,4,5,6]. Such clocks promise better short-term stability and shorter averaging time than traditional clocks. In the second part of my talk I will present our progress in constructing such clocks.

References

[1] N. P. Robins, P. A. Altin, J. E. Debs, and J. D. Close, Atom lasers: Production, properties and prospects for precision inertial measurement, Physics Reports 529, 265 (2013).

[2] C.-C. Chen, R. González Escudero, J. Minář, B. Pasquiou, S. Bennetts, and F. Schreck, Continuous Bose-Einstein condensation, Nature 606, 683 (2022).

[3] M. A. Norcia, New tools for precision measurement and quantum science with narrow linewidth optical transitions, PhD thesis, JILA, University of Colorado, Boulder, USA (2018).

[4] J. Chen, Active Optical Clock, Chinese Science Bulletin 54, 348 (2009).

[5] D. Meiser, J. Ye, D. R. Carlson, M. J. Holland, Prospects for a Millihertz-Linewidth Laser, PRL 102, 163601 (2009).

[6] H. Liu, S. B. Jäger, X. Yu, S. Touzard, A. Shankar, M. J. Holland, and T. L. Nicholson, Rugged mHz-Linewidth Superradiant Laser Driven by a Hot Atomic Beam, PRL 125, 253602 (2020).

femto-st SCIENCES & TECHNOLOGIES

cnrs UBFC UNIVERSITÉ BOURGOGNE FRANCHE-COMTÉ

UNIVERSITÉ FRANCHE-COMTÉ SUP MICRO TECH utbm