CRC 1227
Designed Quantum States of Matter

GUEST LECTURE

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Leibniz Universität Hannover
Welfengarten 1, 30167 Hannover
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Seminar room D326
at the Institute of Quantum Optics
28 June, 2018, 3:30 pm

"Superfluid dynamics of a trapped Bose gas"

Superfluidity is an intriguing property of some quantum fluids, which is characterized by specific manifestations in their dynamics: absence of viscosity, existence of a critical velocity for the appearance of excitations, vanishing moment of inertia, hydrodynamic behavior including irrotational flow, quantum vortices and collective oscillations. Widely studied in the context of liquid helium, it has been extended to three-dimensional quantum degenerate weakly interacting Bose gases which appear to present a superfluid character as Bose-Einstein condensation (BEC) is reached.

The case of two-dimensional quantum gases is very specific in this respect. In homogeneous gases, long range order (and thus BEC) is absent while a superfluid transition still occurs at low temperature when local phase fluctuations are reduced by vortex-antivortex pairing, as described by Berezinskii, Kosterlitz and Thouless (BKT) and recently acknowledged by the 2016 Nobel Prize. On the other hand, trapped two-dimensional gases present both BEC and BKT physics, as well as a scaling symmetry.

In this talk, I will present an overview of recent experimental results on the dynamics of superfluid Bose gases, confined in a quasi-two-dimensional geometry in an harmonic trap or in a ring trap. I will discuss in particular the collective modes of a harmonically trapped two-dimensional Bose gas, which give access either to its equation of state or to its superfluid character. The superfluid nature of the gas is also naturally evidenced in a ring trap, which can sustain persistent flows. I will present an alternative to stirring for the preparation of a persistent superfluid flow with phase imprinting.

All DQ-mat members and all interested are cordially invited to attend.