Contribution ID: **120** Type: **Poster**

Rotation sensor in a cavity-BEC system, and critical dynamics in 2d condensates

Monday, 11 September 2023 22:40 (20 minutes)

On this poster, I present two recent studies on cold-atom dynamics.
Firstly, I will present our proposal to utilize cavity-BEC systems as a rotational sensor, see Ref. [1]. The atoms are set up in an array of Bose-Einstein condensates, and coupled to a single light mode of an optical cavity. The photon emission from the cavity indicates changes in the rotation frequency in real time, which is crucial for inertial navigation. We derive an analytical expression for the phase boundaries and use a semi-classical method to map out the phase diagram numerically, which provides the dependence of the photon emission on the rotation. We further suggest to operate the sensor with a bias rotation, and to enlarge the enclosed area, to enhance the sensitivity of the sensor. With these ingredients, the dependence of the superradiant phase transition on the rotation frequency supports a highly sensitive and fast rotation sensor.
Secondly, I will discuss our recent demonstration of a dynamical Berezinskii-Kosterlitz-Thouless transition in 2D Bose gases, and the understanding of this transition via a real-time renormalization approach, see Ref. [2]. Experimentally, the dynamics is triggered by a quench from the superfluid to the normal phase, by splitting the 2D gas in two, and probing the subsequent relaxation dynamics. The local phase fluctuations are measured via matter-wave interferometry, to determine the phase correlation function and vortex density. We show that their time evolution obeys universal scaling laws, supported by classical-field simulations, and interpreted using real-time renormalization group theory.

[1] Jim Skulte, Jayson G. Cosme, Ludwig Mathey, arXiv:2303.13468.
[2] Shinichi Sunami, Vijay P. Singh, David Garrick, Abel Beregi, Adam J. Barker, Kathrin Luksch, Elliot Bentine, Ludwig Mathey, Christopher J. Foot, arXiv:2209.13587.

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Session Classification: Poster Session II

Track Classification: Hybrid Quantum Systems