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Quantum superfluids as analog models of gravity: a fruitful synergy of gravity and quantum optics

Wednesday, 2 October 2024 11:10 (30 minutes)

In this talk, I will present the state of the art and the new perspectives in the theoretical and experimental study of analog models of quantum field theories in flat, curved, or time-dependent backgrounds using condensed matter and optical systems.

I will start with a brief presentation of the general concept of analog mode and a review of milestone theoretical and experimental works on Hawkingemission of phonons from acoustic horizons in trans-sonic flows of ultracold atoms.

I will proceed by reviewing the on-going investigations in the direction of observing back-reaction effects of the quantum field onto the background, both in single-mode circuit-QED configurations simulating Dynamical Casimir Effect and in multi-mode cold-atom platforms simulating the so-called preheating state of the early Universe at the end of inflation. New decoherence processes will be highlighted, also in connection with the outstanding problem of black hole evaporation.

I will conclude with an outline of a joint theoretical-experimental effort that is on-going at the BECCenter on false vacuum decay processes: I will present experimental evidence of the decay of an extended metastable state via the nucleation of spatially localized bubbles in a two-component atomic superfluid and I will review a numerical MonteCarlo wavefunction study of the role of coupling to the environment in speeding up the false vacuum decay in monitored quantum systems.

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