University of Crete
Department of Physics

Physics Colloquium

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Fundamental studies and quantum technologies with driven Bose gases

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ABSTRACT

Ultracold gases constitute an established platform for the deeper understanding of quantum matter and for realizing new, quantum-enhanced technologies. In this framework, I will present our latest results on two different experiments with driven Bose gases, one in the group of Z.Hadzibabic at the University of Cambridge and one in the group of T.Esslinger at ETH Zurich.

For the former experiment, our newly built homogeneous two-dimensional (2D) system of 39K atoms serves to observe the hydrodynamic first and second sound, and to study the onset of turbulence. Second sound constitutes one of the most characteristic signatures of superfluidity, but its observation had remained elusive in any 2D superfluid, whose unconventional origin (compared to their 3D counterparts) is described by the Berezinskii-Kosterlitz-Thouless theory. With a stronger driving of the gas, a turbulent cascade emerges: energy injected into the system at a large lengthscale flows without loss through momentum space until it is dissipated at some small lengthscale.

In the second experiment, using a 87Rb spinor Bose-Einstein condensate inside a high-finesse optical cavity, we engineer correlated atom pairs in both their internal (spin) and external (momentum) degree of freedom. This mechanism has intrinsically many similarities with the parametric downconversion process in optical systems, but at the same time it provides new opportunities. The produced paired state is well placed to constitute the basis for a number of studies, ranging from proof-of-principle investigations of the mechanism of entanglement to fast quantum-enhanced interferometry to generating many-body models relevant to Quantum Information theory.