universität innsbruck

Department of Theoretical Physics

Seminar Talk

Prof. Ephraim Shahmoon, Weizmann Institute of Science

"Quantum entanglement at the origin of classical collective radiation"

Abstract

We consider the relation between the state of a macroscopic spin, such as an ensemble of atoms, and the radiation it emits. We introduce a new family of collective spin states, defined as the asymptotic eigenstates of the SU(2) lowering operator. While these states are quantum entangled, they are surprisingly responsible for the emergence of classical response to light of a macroscopic spin. We call these states coherently radiating spin states (CRSS), and study properties and realization. In particular, we show that CRSS emerge naturally in superradiance and underlie the dissipative Dicke phase transition, hence predicting the optimal scaling of spin squeezing in superradiance and its classical-like radiation. In a realistic system, where individual decay competes with collective radiation, we find that the system exhibits a quantum bistability, where it dynamically jumps between CRSS and a non-entangled state. More generally, we find that CRSS emerge as ground states of a collective spin Hamiltonian. CRSS thus provide a promising concept for studying many-body spin systems in various platforms, with applications ranging from quantum metrology to phase transitions.

[1] O. Somech and E. Shahmoon, "Quantum entangled states of a classically radiating macroscopic spin", PRX Quantum 5, 010349 (2024).

[2] N. Leppenen and E. Shahmoon, "Quantum bistability at the interplay between collective and individual decay", preprint: arXiv: 2404.02134

Monday | 07.10.2024 | 10:30 am

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