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Quantum spin dynamics and entanglement in systems with long-range interactions[1]

ANA M REY, JILA, NIST and University of Colorado at Boulder

One of the fundamental goals of modern quantum sciences is to learn how to control and manipulate non-equilibrium many-body systems and use them to make powerful and improved quantum devices, materials and technologies. However, out-of-equilibrium systems are complex, typically strongly correlated and entangled, and thus to model them we are in an urgent need of new methodologies. In this talk I will discuss new theoretical methods that we have developed to investigate emergent non-equilibrium phenomena in driven-dissipative spin systems interacting via long-range interactions. I will show we can capture the dynamics of correlations and entanglement in close systems and the interplay between dissipation and entanglement in open quantum systems including spin-boson models. As a specific application I will discuss the use of our methods to model the spin dynamics exhibited by arrays of trapped ions with controllable long-range interactions. I will show that our predictions are consistent with recent experimental measurements. I will also discuss new protocols to diagnostic and characterize entanglement based on well-established NMR protocols

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