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Dynamics of multipartite entanglement: from long-range to short-range interactions

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Quantum simulators realize the most controlled forms of quantum matter, in which one can hope to both design and probe many-body quantum coherence and entanglement. Pursuing this program away from equilibrium offers a much richer palette of entangled states than those possible in equilibrium systems; and the possibility to reach these states in a short time, a fundamental advantage for experiments.

In this talk I will present our recent results on the dynamics of U(1) symmetric Hamiltonians, corresponding to a large family of quantum simulators from AMO physics to superconducting platforms. A generic form of many-body entanglement generated in these systems away from equilibrium is spin squeezing, whose scaling is fundamentally controlled by the ability of the system to slowly relax a spin polarization imposed on it in the initial state.

Moreover further entangled states, in the form of Schrödinger's cat states and their generalization, are also observed in the dynamics, provided that the collective spin length remains sufficiently large during the dynamics.

I will discuss in particular the role of the interactions and of dimensionality, showing that entanglement dynamics known to exist for infinite-range interactions can survive when moving to strictly short-range (i.e. nearest-neighbor) interactions in planar geometries.

Orateur: ROSCILDE, Tommaso (ENS Lyon)