Quantum correlations in cold atoms: static and dynamic aspects

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Résumé

Detecting and characterizing genuine quantum correlations in quantum many-body systems is a fundamental challenge of quantum simulation. The concept of quantum correlation generalizes that of entanglement, and, as we shall show, in equilibrium conditions it can be fully framed within a statistical mechanics description, namely it admits the definition of a (measurable) quantum correlation function, and a related quantum fluctuation function (or quantum variance) for each observable. These latter objects are naturally accessible with state-of-the-art experiments based on quantum-gas microscopes. In an out-of-equilibrium setting, on the other hand, the onset of correlations following a quantum quench which starts from a separable state is a distinct quantum phenomenon, unveiling the microscopic processes behind quantum information spreading in many-body systems. We shall discuss the onset of correlations in long-range interacting systems, such as dipolar magnetic atoms. There the long-range nature of interactions leads to a huge spread (from zero to infinity) in the group velocity of elementary excitations carrying the correlations: specific correlation functions, accessible in the experiments, are found to reveal directly the peculiar nature of excitations, generalizing the concept of "light-cone" spreading of correlations to that of multiple, wavevector-dependent light cones.

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