Dynamics in one-dimensional chains of bosons

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Abstract

Ultracold atoms are an ideal setting to study non-equilibrium quantum many-body dynamics in a very controlled way. I will present a series of experiments in the context of strongly correlated atomic bosons in one-dimensional geometry. Specifically, we study the dynamics of one-dimensional chains after a sudden quench of the systems Hamiltonian, for which we independently control J, the (coherent) tunneling rate, U, the strength of the interaction, and E, a tilt along the longitudinal direction of the chains. For a quench to $U \approx E$ we couple to nearest neighbors collectively and observe characteristic oscillations in the number of double occupancies that we analyze in the many-body context [1]. For $U/2 \approx E$, $U/3 \approx E$ etc. we observe collective long-range quantum tunneling to next-nearest neighbors and beyond. In particular, for $U/3 \approx E$ we observe dynamics due to the higher-order super-exchange interaction scaling as J^3/U^2 [2]. For $J \approx U \ll E$ we observe interaction-induced quantum phase revivals, and for $J \approx U \approx E$ we find evidence for the transition to the quantum chaotic regime [3]. If time allows, I will give an outlook on our endeavor to realize ultracold bosonic molecular systems with "real" long-range interactions [4]

Keywords: Quantum quenches, one-dimensional bosons, quantum tunneling

References

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