Out-of-Equilibrium Microscopes for Quantum Many-Body States

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We argue that forcing an interacting quantum many-body system to reside after a quench far from its equilibrium state, is an important tool to reveal information on the correlations in the initial ground state.

[1] We investigate the collapse and revival of first-order coherence in deep optical lattices when long-range interactions are turned on and find that the first few revival peaks are strongly attenuated already for moderate values of the nearest-neighbor interaction coupling. It is shown that the conventionally employed Gutzwiller wavefunction, with only on-site number dependence of the variational amplitudes, leads to incorrect predictions for the collapse and revival oscillations within the extended Bose-Hubbard model. We provide a modified variant of the Gutzwiller ansatz, reproducing the analytically calculated time dependence of first-order coherence in the limit of zero tunneling.

[2] We consider the rapid quench of a one-dimensional strongly correlated supersolid to a localized density wave (checkerboard) phase, and calculate the first-order coherence signal following the quench. It is shown that unique coherence oscillations between the even and odd sublattice sites of the checkerboard are created by the quench, which are absent when the initial state is described by a Gutzwiller product state. This is a striking manifestation of the versatility of the far-from-equilbrium and nonperturbative collapse and revival phenomenon as a microscope for quantum correlations in complex many-body states. For the present example, this opens up the possibility to discriminate experimentally between mean-field and many-body origins of supersolidity.

References

[1] Phys. Rev. A 84, 063635 (2011)
[2] http://arxiv.org/abs/1111.5787, to appear in EPL