Quantum dynamics of spin impurities and magnon bound states

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Résumé

In two recent experiments, we have explored the quantum dynamics of spin impurities in a one-dimensional Bose gas loaded in an optical lattice. In the first experiment, we have prepared a single spin impurity and probed its full spatial probability distribution at different times using single-site-resolved imaging. In the Mott-insulating regime, a post-selection of the data allowed to reduce the effect of temperature, giving access to a space- and time-resolved measurement of the quantum-coherent propagation of the magnetic excitation in the Heisenberg model. Extending the study to the bath's superfluid regime, we have determined quantitatively how the bath strongly affects the motion of the impurity. In the second experiment, we have prepared two neighbouring spin impurities in the Mott-insulating regime and subsequently observed the quantum walk of both free and bound magnon states through in-situ correlation measurements of the two spin impurities. The increased effective mass of the compound magnon state results in slower spin dynamics as compared to single excitations. In our measurements, we also determined the decay time of the bound magnons, which is most likely limited by scattering on thermal fluctuations in the system.

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