

Controlling spin dynamics in a one-dimensional quantum gas

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Abstract

Reducing the dimensionality of a system has dramatic consequences and leads to remarkable new physics. In this regard, quantum gases offer unique opportunities to address important open questions in quantum many-body physics, by allowing full control over all relevant parameters.

We create coherent superpositions of both spin and motional degrees of freedom and probe spin dynamics of a one-dimensional (1D) Bose gas of ^{87}Rb on an atom chip. We observe interaction-driven dynamics of one spin component by mean field interaction with another component, directly related to the effective 1D interaction strength. We demonstrate experimental control over the 1D interaction strengths through state-selective radio-frequency dressing [1]. The dynamics are altered by tuning the trapping potential in a state-dependent way as a means to modify the inter-and intra state interactions. This enables, for instance, access to the point of spin-independent interactions where exact quantum many-body solutions are available [2, 3] and to the point where spin dynamics are frozen.

Keywords: many-body, spin, interactions, one-dimension, Bose-gas, dynamics, dressed potentials

References

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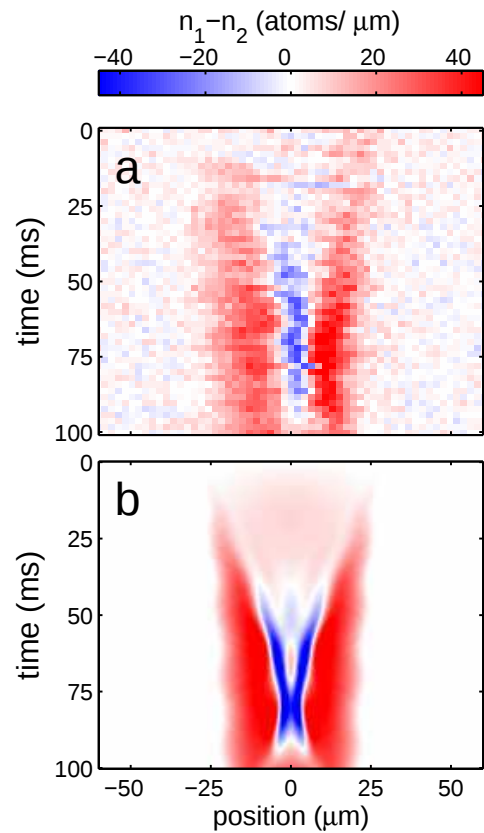


Figure 1: (a) Observed evolution of spin polarization in one dimension. (b) Corresponding numerical Gross-Pitaevskii simulation. Clearly, the spin polarization shows rich dynamics, well captured by the simulation. The total density (not shown) does not evolve in time.