Creation and transfer of non-classical states of motion using Rydberg dressing of atoms in a lattice

Fri, 2017-06-23 11:01 - David Petrosyan [1] **Date:** 2017-01-06
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Reference:
Phys. Rev. A 95, 013403 (2017)

URL:
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We theoretically investigate the manipulation of the motional states of trapped ground-state atoms using Rydberg dressing via nonresonant laser fields. The forces resulting from Rydberg state interaction between dressed neighboring atoms in an array of microtraps or an optical lattice can strongly couple their motion. We show that intensity modulation of the dressing field allows us to squeeze the relative motion of a pair of atoms and generate nonclassical mechanical states. Extending this pairwise scheme to one-dimensional chains provides flexible control over the mechanical degrees of freedom of the whole system. We illustrate our findings with protocols to manipulate all motional degrees of freedom of a pair of atoms and create entangled states. We also present a method to transfer nonclassical correlations along an atomic chain of nontrivial length. The long-lived nature of motional states, together with the high tunability of Rydberg dressing, makes our proposal feasible for current experimental setups.

- 04.10.+s Entanglement in spin models/oscillator chains [3]
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