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Collective non-equilibrium spin exchange in cold alkaline-earth atomic clocks[1] OSCAR LEONARDO ACEVEDO, ANA MARIA REY[2], JILA, NIST, Center for Theory of Quantum Matter, University of Colorado, Boulder —
Alkaline-earth atomic (AEA) clocks have recently been shown to be reliable simulators of two-orbital $SU(N)$ quantum magnetism. In this work, we study the non-equilibrium spin exchange dynamics during the clock interrogation of AEAs confined in a deep one-dimensional optical lattice and prepared in two nuclear levels. The two clock states act as an orbital degree of freedom. Every site in the lattice can be thought as populated by a frozen set of vibrational modes collectively interacting via predominantly p-wave collisions. Due to the exchange coupling, orbital state transfer between atoms with different nuclear states is expected to happen. At the mean field level, we observe that in addition to the expected suppression of population transfer in the presence of a large magnetic field, that makes the single particle levels off-resonance, there is also an interaction induced suppression for initial orbital population imbalance. This suppression resembles the macroscopic self-trapping mechanism seen in bosonic systems. However, by performing exact numerical solutions and also by using the so-called Truncated Wigner Approximation, we show that quantum correlations can significantly modify the mean field suppression. Our predictions should be testable in optical clock experiments.

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