Qutrit entanglement dynamics of cold spin-1 bosons trapped in optical triple-well potential

A. Barasiński[1,*] and W. Leoński[1]

[1]*Quantum Optics and Engineering Division, Institute of Physics, University of Zielona Góra, Z. Szafrana 4a, 65-516 Zielona Góra, Poland*

We consider a system comprising spin-1 ultracold bosonic particles, such as 23-sodium or 87-rubidium alkali atoms, confined in a three-wall superlattice potential. The triple-well potential required for such a system may be realized in a strongly trimerized Kagome lattice [1, 2]. Assuming that the tunneling amplitudes between trimers are much smaller than the tunnelings inside the trimers, we study entanglement dynamics for our system. Our model can be described by three-site Bose-Hubbard Hamiltonian that takes spin effects into account. In the limit of strong Hubbard repulsions, the Bose-Hubbard model can be simplified to the quadratic–biquadratic Heisenberg model [3, 4]. Applying such simplified spin model, with three spin-1 bosons trapped in optical triple-well potential, we derive analytical formulas describing time-evolution of the probability amplitudes corresponding to the states involved in our system's dynamics. With use of the concurrence and negativity as a measures of entanglement, we analyze the processes of entanglement generation. In particular, we show that genuine tripartite entangled states and W-type states can be produced from various initial product states. We find that W-type states can be achieved for the both: homogeneous and inhomogeneous spin-1 systems. By tracing out one of discussed subsystems (bosons), we also identify maximally entangled bipartite states.

* A.Barasinski@if.uz.zgora.pl

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