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Generation of high-fidelity spin entanglement by controlling Wannier orbitals of ultracold atoms in an optical lattice YUUKI TOKUNAGA, NTT Secure Platform Labs., KENSUKE INABA, KIYOSHI TAMAKI, KAZUHIRO IGETA, MAKOTO YAMASHITA, NTT Basic Research Labs., JST, CREST TEAM
— We propose a method for generating high-fidelity multipartite spin entanglement of ultracold atoms in an optical lattice within short operation time, which is suitable for measurement-based quantum computation. To produce the desired spin entanglement, we propose to actively utilize the extra degrees of freedom (DOFs) included in the Hubbard Hamiltonian of atoms, such as, (pseudo)charge and orbital DOFs, which are usually neglected in the perturbative spin interaction. Our active control of the Wannier orbital DOF allows us to overcome the fundamental difficulty of simultaneous achievement of high fidelity, short operation time, and scalability due to the fact that enhancing interaction for short operation time breaks the perturbative condition and intrinsically induces unwanted correlations among spin and the extra DOFs.

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