A no-go result for implementing chiral symmetries by locality-preserving unitaries in a 3-dimensional Hamiltonian lattice model of fermions

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Abstract

We argue that the chiral U(1)A_ symmetry of a Weyl fermion cannot be implemented by a shallow depth quantum circuit operation in a fermionic lattice Hamiltonian model with finite dimensional onsite Hilbert spaces. We also extend this result to discrete Z_2N subgroups of U(1)_A, in which case we show that for N_f Weyl fermions of the same helicity, this group action cannot be implemented with shallow depth circuits when N_f is not an integer multiple of 2N.