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Stabilizers as a design tool for new forms of the Lechner-Hauke-Zoller annealer

In a recent paper, Lechner, Hauke, and Zoller (LHZ) described a means to translate a Hamiltonian of N spin-1/2 particles with "all-to-all" interactions into a larger physical lattice with only on-site energies and local parity constraints. LHZ used this mapping to propose a novel form of quantum annealing. We provide a stabilizer-based formulation within which we can describe both this prior approach and a wide variety of variants. Examples include a triangular array supporting all-to-all connectivity as well as arrangements requiring only 2N or N log N spins but providing interesting bespoke connectivities. Further examples show that arbitrarily high-order logical terms can be efficiently realized, even in a strictly two-dimensional layout. Our stabilizers can correspond to either even-parity constraints, as in the LHZ proposal, or odd-parity constraints. Considering the latter option applied to the original LHZ layout, we note that it may simplify the physical realization because the required ancillas are only spin-1/2 systems (that is, qubits rather than qutrits); moreover, the interactions are very simple. We make a preliminary assessment of the impact of these design choices by simulating small (few-qubit) systems; we find some indications that the new variant may maintain a larger minimum energy gap during the annealing process.