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Symmetry and Controllability for Quantum Spin Networks XIAOTING WANG, University of Massachusetts at Boston, SOPHIE SCHIRMER, Swansea University, DANIEL BURGARTH, Aberystwyth University, PETER PEMBERTON-ROSS, University of Basel, KURT JACOBS, University of Massachusetts at Boston — Symmetry is found to be an important tool to study the controllability problems in quantum control. Based on quantum spin networks subject to control of a single node by a local potential (Z-control), we have considered the relation of symmetriy and subspace controllability. Focusing on the single excitation subspace it is shown that for single-node Z-controls external symmetries are characterized by eigenstates of the system Hamiltonian that have zero overlap with the control node, and there are no internal symmetries. For uniformly coupled XXZ chains a characterization of all possible symmetries is derived from Bethe ansatz. Moreover, for uniform Heisenberg and XX chains, basic number theory can be used to prove that the lack of symmetry is equivalent to subspace controllability. On the other hand, symmetries in the Hamiltonian can be classified into two types: the internal and the external symmetries. Based on the external symmetries, we can rigorously prove the subspace controllability in each of the invariant subspaces for both XXZ and XYZ chains, but not for XX or Ising chains. All these results are useful to design the appropriate control strategy when implementing QIP in real physical systems.

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