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Symmetry defects and gauging for quantum states with matrix product unitary symmetries

Gauging global symmetries—promoting them to local symmetries—has been fundamental to advances in both particle physics and quantum many-body theory. In tensor network formalism, on-site unitary symmetries give rise to virtual symmetry defects within Matrix Product States (MPSs), represented by operator insertions along virtual bonds. We extend this framework to non-on-site symmetries implemented via Matrix Product Unitaries (MPUs) and use it to propose a formal gauging procedure based on a group-cohomological condition we call block-independence. When this condition is satisfied, the gauging preserves the bond dimension of the original MPS and yields commuting Gauss projectors built from fusion operators. For systems that violate block-independence, we introduce a state-level gauging scheme that also preserves bond dimension but relaxes the commutativity of projectors—potentially allowing for a broader class of gauge theories.Our results offer a systematic approach to gauging MPU symmetries and highlight new directions in the interplay between symmetry, topology, and tensor networks.

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