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Circuitizing product formulas for (1+1)D SU(2) lattice gauge theories: Lessons from alternative formulations

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We develop digital quantum algorithms for simulating a 1+1 dimensional SU(2) lattice gauge theory in the Schwinger boson and loop-string-hadron (LSH) formulations. These algorithms complement and improve on the algorithm by Kan & Nam (arXiv:2107.12769) based on the angular momentum basis, which generalized an earlier algorithm for a U(1) gauge theory (the Schwinger model) [Quantum 4, 306 (2020)]. We share the lessons learned regarding the application of product formulas to time evolution in various formulations of this lattice gauge theory, especially the identification of individually-circuitizable Hamiltonian terms, how to circuitize the SU(2) interactions, and what factors make a given formulation more or less costly. Within this framework, the LSH formulation leads to the least resource-intensive algorithm to date for the model considered.

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