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Proposals for quantum simulating simple lattice gauge theory models using optical lattices[1] JIN ZHANG, University of California, Riverside, JUDAH UNMUTH-YOCKEY, Univerisity of Iowa, ALEXEI BAZAVOV, University of California, Riverside, YANNICK MEURICE, Univerisity of Iowa, SHAN-WEN TSAI, University of California, Riverside — We derive an effective spin Hamiltonian for the (1+1)-dimensional Abelian Higgs model in the strongly coupled region by integrating out the link variables. With finite spin truncations, the Hamiltonian can be matched with a 1-dimensional two-species Bose Hubbard model in the strong-coupling limit that can be implemented with cold atoms on an optical lattice. We study the phase diagram of the original Abelian Higgs model with Monte Carlo simulation and Tensor Renormalization Group methods. The results show a crossover line which terminates near the Kosterlitz-Thouless transition point. The effective quantum Hamiltonian is also studied with the DMRG method, and we find that they have a similar behavior. We discuss practical experimental implementations for our quantum simulator. Species-dependent optical lattices and ladder systems with double-well potentials are considered. We show how to obtain each of the interaction parameters required in the Bose-Hubbard model that we obtained, and confirm the possibility of tuning these interactions to the region in which our mapping is valid. We emphasize that this proposal for quantum simulating a gauge theory uses a manifestly gauge-invariant formulation and Gauss's Law is therefore automatically satisfied.

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