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Meron-Cluster Algorithms for Quantum Link Models

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State-of-the-art algorithms for simulating fermions coupled to gauge fields often rely on integrating fermion degrees of freedom. While successful in simulating QCD at zero chemical potential, at finite density these approaches are hindered by the sign problem, for example, leading to extensive research on alternative formulations suitable, inter alia, for simulations of gauge theories on quantum devices.

In this talk, we will discuss the simulation of lattice gauge theories in the Hamiltonian formalism and present an efficient generalized meron-cluster algorithm for the simulation of the Schwinger Model. A key feature of this algorithm is the ability to satisfy Gauss' law exactly during cluster flips, allowing for non-local updates while remaining within the physical subspace. Not only this enables the study of models directly relevant to current quantum simulators, but it also presents a promising first step toward constructing new efficient algorithms for more complicated gauge theories.

Topical area

Algorithms and Artificial Intelligence

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