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Quantum Monte Carlo for Gauge Fields and Matter without the Fermion Determinant

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Ab-initio Monte Carlo simulations of strongly-interacting fermionic systems are plagued by the fermion sign problem, making the non-perturbative study of many interesting regimes of dense quantum matter, or of theories of odd numbers of fermion flavors, challenging. Moreover, typical fermion algorithms require the computation (or sampling) of the fermion determinant. We focus instead on the meron cluster algorithm, which can solve the fermion sign problem in a class of models without involving the determinant. We develop and benchmark new meron algorithms to simulate fermions coupled to Z2 and U(1) gauge fields to uncover potential exotic properties of matter, particularly relevant for quantum simulator experiments. We demonstrate the emergence of the Gauss' Law at low temperatures for a U(1) model in (1+1)–d

Topical area

Algorithms and Artificial Intelligence

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