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A fermionic quantum Monte-Carlo algorithm without the sign problem CONGJUN WU, SHOU-CHENG ZHANG, Department of Physics, Stanford University — Quantum Monte-Carlo (QMC) simulations involving fermions have the notorious sign problem. The only known case without this problem involves a fermion determinant which can be factorized into two real parts with the same sign. Recently, a new fermion QMC algorithm has been discovered in which the fermion determinant may not necessarily factorizable, but can instead be expressed as a product of complex conjugate pairs of eigenvalues, thus eliminating the sign problem for a much wider class of models. In this paper, we present general conditions for the applicability of this new algorithm and show that it is deeply related to the time reversal symmetry of the fermion matrix. We apply this algorithm to many models of strongly correlated systems, including models with purely repulsive interactions, and study their novel phases, for all doping levels and lattice geometries.

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