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The roles of antiferromagnetic and nematic fluctuations in cuprate superconductors: a sign-free quantum Monte-Carlo study ZIXIANG LI, HONG YAO, Institute for Advanced Study, Tsinghua University, FA WANG, International Center for Quantum Materials, School of Physics, Peking University, DUNG-HAI LEE, Department of Physics, University of California at Berkeley — Superconductivity is an emergent phenomena in the sense that the energy scale at which Cooper pairs form is generically much lower than the bare energy scale, namely the electron kinetic energy bandwidth. Addressing the mechanism of Cooper pairing amounts to finding out the effective interaction (or the renormalized interaction) that operates at the low energies. Finding such interaction from the bare microscopic Hamiltonian has not been possible for strong correlated superconductors such as the copper-oxide high temperature superconductor. In fact even one is given the effective interaction, determining its implied electronic instabilities without making any approximation has been a formidable task. Here, we perform sign-free quantum Monte-Carlo simulations to study the antiferromagnetic, superconducting, and the charge density wave instabilities which are ubiquitous in both electron and hole doped cuprates. Our result suggests only after including both the nematic and antiferromagnetic fluctuation, are the observed properties associated with these instabilities reproduced by the theory.

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