Abstract Submitted
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Quantum Monte Carlo Study of Superconductor-Insulator Transition and BCS-BEC crossover in a two-band system[1] TAMAGHNA HAZRA, Ohio State University, RICHARD SCALETTAR, University of California, Davis, NANDINI TRIVEDI, MOHIT RANDERIA, Ohio State University — A direct transition from an insulator to a superconductor (SC) forces us to re-examine our conventional understanding of superconductivity as a Fermi surface instability. We have recently introduced a simple, disorder-free, two-band fermionic model to address this issue. We found that [1] the route from fermionic insulator to SC proceeds through a crossover to a Bose insulator, with low energy charge $2e$ excitations, followed by a phase transition to a BEC of these bosons, and finally a crossover to a BCS SC with an underlying Fermi surface. Using sign-problem free Quantum Monte Carlo simulations, we establish that the insulator near the SC-insulator transition (SIT) is characterized by a two-particle gap which drops below the one-particle gap E_g and goes soft at the SIT while E_g remains finite. In the SC, characterized by finite superfluid stiffness and compressibility, this naturally leads to a pairing pseudogap above T_c. We study how this BEC SC crosses over to a two-band BCS SC at half-filling, which is relevant for compensated semi-metals. Our work unequivocally establishes that the SIT is from a Bose insulator to a BEC, and provides insights into the BCS-BEC crossover in multi-band systems away from weak coupling. [1] Y. L. Loh et al, Phys. Rev. X 6, 021029(2016)

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