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Superconductor-Insulator Transition and Fermi-Bose Crossovers[1]
NANDINI TRIVEDI, The Ohio State University, YEN LEE LOH, University of North Dakota, MOHIT RANDERIA, The Ohio State University, CHIA-CHEN CHANG, RICHARD SCALETTAR, University of California, Davis — The direct transition from an insulator to a superconductor (SC) in Fermi systems is a problem of long-standing interest, which necessarily goes beyond the standard BCS paradigm of superconductivity as a Fermi surface instability. We introduce here a simple, translationally-invariant lattice fermion model that undergoes a SC-insulator transition (SIT) and elucidate its properties using analytical methods and quantum Monte Carlo simulations. We show that there is a fermionic band insulator to bosonic insulator crossover in the insulating phase and a BCS-to-BEC crossover in the SC. The SIT is always found to be from a bosonic insulator to a BEC-like SC, with an energy gap for fermions that remains finite across the SIT. The energy scales that go critical at the SIT are the gap to pair excitations in the insulator and the superfluid stiffness in the SC. In addition to giving insights into important questions about the SIT in solid state systems, our model should be experimentally realizable using ultracold fermions in optical lattices. Ref: arXiv:1507.05641

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