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Superfluid-insulator transition in a fermionic optical superlattice
RUBEM MONDAINI, The Pennsylvania State University, PREDRAG NIKOLIC, George Mason University, MARCOS RIGOL, The Pennsylvania State University —
Despite some of the high-temperature superconductivity properties can be exposed in clean and simple cold-atom systems, attempts to simulate the d-wave pairing of cuprates with cold atoms is difficult because the required temperatures are much lower than what is experimentally feasible today. However, the "pseudogap" physics of s-wave pairing is far more accessible. In this paper we consider a simple Mott insulator of tightly bound Cooper pairs as an s-wave analogue of a pseudogap state. The XY transition to a superfluid and the crossover to a band-insulator (conventional unpaired state) in the phase diagram are the phenomena that give this Mott insulator a similar role to the pseudogap of cuprates. We numerically investigate this transition of locally attractive fermions at half-filling and $T = 0$ in the presence of a checkerboard potential in two dimensions, using quantum Monte Carlo and exact diagonalization. We can identify that it belongs to (2+1)-XY universality class similarly to the superfluid-normal transition in hard-core bosons. Moreover, we show a crossover of charge excitations, in finite systems, from a fermionic to bosonic character when the attraction between the fermions is increased.

Rubem Mondaini
The Pennsylvania State University

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