Phase coherence in a coupled boson-fermion model

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We consider a coupled boson-fermion model in two dimensions, that describes itinerant fermions hybridizing with localized bosons composed of pairs of tightly bound opposite-spin fermions. We trace out the fermionic degrees of freedom and perform a Monte Carlo simulation for the effective classical Hamiltonian of boson phases. We find that the fermions generate an effective long-range temperature-dependent boson-boson coupling that at low temperature generates a quasi long range order. With increasing temperature the stiffness drops to zero and the bosonic subsystem undergoes the Kosterlitz-Thouless transition. Also the fermionic subsystem has non-trivial properties, what results from the interactions with the classical phases. At low temperature the phases are uniform and the fermions form a BCS state for any boson-fermion coupling. However, at higher temperature the fermions interact with inhomogeneous distribution of the boson phases. Depending on the coupling they form a metallic state, Anderson insulator or a disordered bosonic insulator.

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