Quantum critical properties in the topological Ginzburg-Landau theory of self-dual Josephson junction arrays

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I examine the multicritical behavior of a generalized $U(N_1) \times U(N_2)$ Ginzburg-Landau theory containing two multicomponent complex fields which couple differently to two gauge fields described by two Maxwell terms and one mixed-Chern-Simons term. This model is relevant to the dynamics of Cooper pairs and vortices in a self-dual Josephson junction array system near its superconductor-insulator transition. I analyze the renormalization group flow at fixed dimension and obtain the beta functions at one loop when both disorder fields are critical. Two sets of infrared-stable charged fixed points solutions are found for $N > N_c$: partially charged solutions with respect to the gauge fields exists with $N_c = 35.6$, and fully charged solutions exist with $N_c = 12.16$. I show that fine tuning the ratio of the two energy scales in the model has the effect of reducing the critical number N_c and thus enlarges the region where the quantum phase transition is continuous.It is also found that the decoupled fixed point which is stable in the neutral case is no longer attainable in the presence of fluctuating gauge fields. I probe the conductivity at the critical point and show that it has a universal character determined by the renormalization group infrared-stable fixed-point values of the gauge couplings.

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