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A 4D-XY model of the superfluid density of strongly underdoped cuprate superconductors ANDREW IYENGAR, Indiana University, MARCEL FRANZ, University of British Columbia — A new phenomenology is proposed for the superfluid density of strongly underdoped cuprate superconductors based on data for ultra-clean single crystals of YBCO. The data feature a puzzling departure from Uemura scaling and a decline of the slope as the $T_c = 0$ quantum critical point is approached. We argue that the proximity of a Mott insulator drives quantum fluctuations of the superconducting phase which are described by a (3+1)-dimensional XY model. The subsequent renormalization of the superfluid density is computed using variational methods and then studied systematically as a function of c-axis anisotropy, interaction strength, and doping. We find that non-critical phase fluctuations explain key features of the new cuprate phenomenology, which is expected to fail in the true critical regime.

Andrew Iyengar
Indiana University

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