Superfluid Density and Condensation of Exotic Superconductors: Bose-Einstein, Kosterlitz-Thouless, BCS, and else ?

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Since 1987, we have measured the muon spin relaxation rate σ in high-T_c cuprates and other exotic superconductors to determine the magnetic field penetration depth λ. We noticed universal correlations between T_c and $\sigma(T \rightarrow 0) \propto 1/\lambda^2 \propto n_s/m^*$ (superconducting carrier density / effective mass) in underdoped cuprates [1]. Combining this observation with the "pseudo-gap" behavior, we proposed a picture for high-T_c cuprates based on crossover from Bose-Einstein to BCS condensation [2,3].

In this talk, we would like to consider relationship of these results and picture to Kosterlitz-Thouless transition. For this purpose, we examine (1) models regarding phase fluctuations [4]; (2) variation of T_c in YBCO-PrBCO films [5] and Bi2212 system intercalated with organic molecules [6]; and (3) recent high-frequency conductivity studies on Bi2212 [7]:

We will also discuss similarities of HTSC, organic BEDT, A_3C_{60} and intercalated HfNCl superconductors. In particular, we notice that superfluid density n_s/m^* diminishes when the system crosses over from superconductor to simpler metal by overdoping / application of pressure, contrary to the behavior expected for BCS superconductors.

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[4] V.J. Emery and S. Kivelson, Nature 374 (1995) 434.

[5] O. Fisher *et al.*, Physica B169 (1991) 116.

[6] J.H. Choy *et al.*, Science 280 (1995) 1589.

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