

MAGNETORESISTANCE STUDIES OF HIGHLY UNDERDOPED SUPERCONDUCTING $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$ FILMS

Zhenzhong Shi¹, H. Raffy², Z. Z. Li², P. Senzier², V. Jovanovic² and Dragana Popović¹

¹National High Magnetic Field Laboratory, Florida State University, Tallahassee, Florida 32310, USA

²Laboratoire de Physique des Solides, CNRS-UMR 8502, Université Paris-Sud, 91405 Orsay, France

Underdoped cuprate superconductors feature rich phase diagrams due to their high anisotropy and the presence of various competing orders [1, 2]. The normal state is often probed by an application of a perpendicular magnetic field (H). However, the nature of the H -induced resistive state and the existence of a zero-temperature H -tuned superconductor-insulator transition (SIT) in these quasi-2D materials have been controversial. A recent work on highly underdoped $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$ (LSCO) has provided striking evidence [3] for an H -driven SIT with an intermediate phase, *i.e.* for two quantum critical points (QCPs) that separate the superconductor and the insulator. This discovery goes beyond the conventional scenario for the SIT and bridges the gap between quantum criticality and vortex line physics that had been previously studied at higher temperatures (T) in the classical regime. To explore the universality of this behavior, we extend studies to Bi-based cuprates, in particular to $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$ (Bi-2212), which has a much higher anisotropy and much higher upper critical fields than La-based cuprates.

Bi-2212 epitaxial thin films with very low oxygen doping (transition temperature $T_c < 1$ K) have been studied at low T and high H . We show that the in-plane resistance $R_{ab}(T)$ of the Bi-2212 thin film (Fig. 1) has similarities to that of highly underdoped LSCO [3]. For example, there is a T -independent R_{ab} at high T (crossing point at ~ 16.3 T in the magnetoresistance curves between 20 K and 30 K in Fig. 1 inset). At low T , superconductivity is suppressed with increasing H , but $H > 18$ T are needed to reach the insulating regime and study the quantum critical behavior associated with the SIT. The results should provide important insight into the effects of disorder and anisotropy on the SIT.

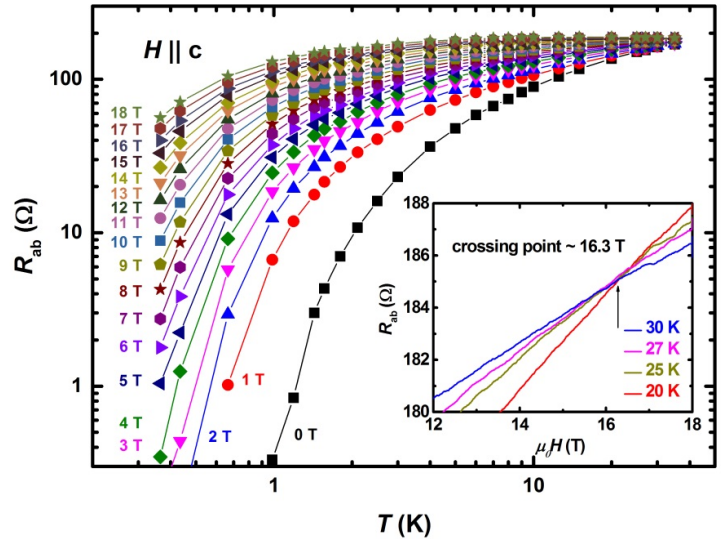


Fig 1. In-plane resistance $R_{ab}(T)$ of the Bi-2212 thin film sample at various H . Inset: T -independent crossing point of $R_{ab}(H)$ between 20 K and 30 K.

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Email: zshi@magnet.fsu.edu