Optical conductivity of overdoped cuprate superconductors: application to LSCO

Hirschfeld, P.J. (U. Florida), Lee-Hone, N., Broun, D. (Simon Fraser) and Mishra, V. (ORNL)

Introduction

Recent measurements on both the superfluid density ρ_s and the optical conductivity σ_1 of high-quality LSCO films [1,2] showed properties apparently inconsistent with BCS theory, particularly a proportionality of ρ_s and T_c and a lack of any gap feature in $\sigma_1(\omega)$. These novel effects be understood almost entirely within the theory of disordered BCS d-wave superconductors[3,4]. The large scattering rates deduced from experiments are shown to arise predominantly from weak scatterers, probably the Sr dopants out of the CuO_2 plane, and correspond to significant suppression of T_c relative to a pure reference state with the same doping. Recently, we compared the results of dirty d-wave theory for LSCO and Tl-2201 against experimental data. Tl-2201 is found to be a factor of 3 cleaner, explaining the existence of quantum oscillations, but still follows dirty d-wave predictions in the weak scattering limit.

Results and Discussion

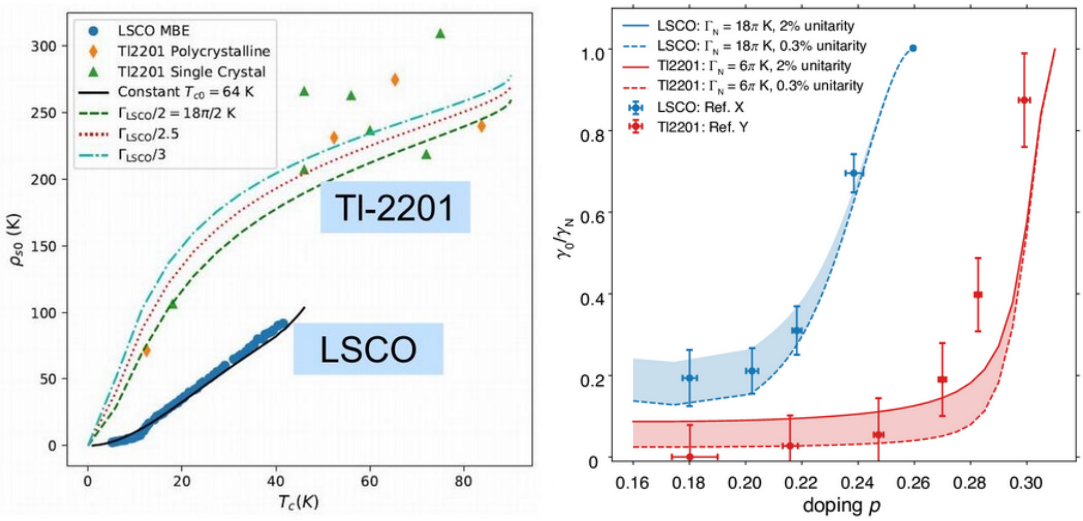

Figure: Superfluid density vs. T_c (left) and Sommerfeld coefficient vs. doping (right) for LSCO and Tl-2201.

Symbols experimental data, and solid lines represent ranges of theoretical scattering rates compatible with data (same for left and right panels).

Conclusions

Our results confirm the "conventional" viewpoint that the overdoped side of the cuprate phase diagram can be viewed as approaching the BCS weak-coupling description of the superconducting state, with significant many-body renormalization of the plasma frequency.

Acknowledgements

Supported by NSF-DMR-1407502.

References

1. I. Bozovic, X. He, J. Wu and A.T. Bollinger, Nature 536(7616), 309 (2016).
2. F. Mahmood, X. He, I. Bozovic, and N.P. Armitage, arXiv:1802.02101.
3.]. N. R. Lee-Hone, J. S. Dodge, and D. M. Broun, Phys.Rev. B 96, 024501 (2017).
4. N. R. Lee-Hone, V. Mishra, D. M. Broun, P. J. Hirschfeld, Phys. Rev. B 98, 054506 (2018).