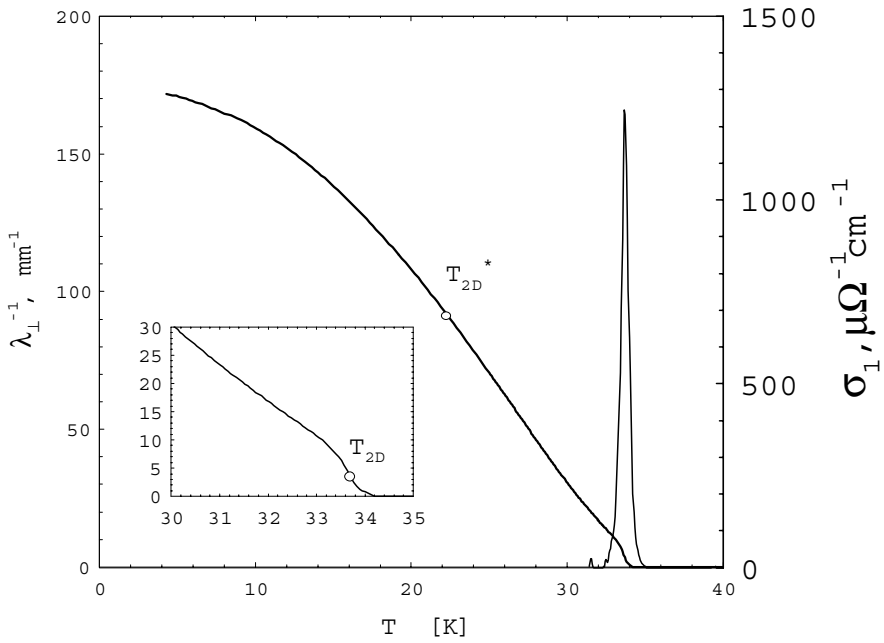
Dimensionality of Superconductivity in High-temperature Cuprate Superconductors

Thomas R. Lemberger, Ohio State Univ., DMR-0203739

Superconductivity is most stable in materials that are electronically three dimensional (3D). The layered structure of copper-oxide planes in cuprates suggests that superconductivity is quasi-2D and therefore frail. However, our measurements show conclusively that destabilizing fluctuations in cuprates are three-dimensional and therefore much weaker than expected. The mechanism by which superconductivity couples between layers remains to be explained.



If fluctuations were quasi-2D, then the measured superelectron density, proportional to $\lambda_\perp^{-1}$, would have dropped almost discontinuously to zero at T_{2D}^*. Instead, superconductivity survives to a much higher temperature.

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Education:

Two undergraduates, Michael Groseclose and Matthew Fisher, two graduate students, John Skinta and Yuri Zuev, and a postdoc, Mun-Seog Kim, participated in this research. The undergraduates were supported by an NSF REU site grant at OSU. Matthew Fisher is now a grad student at OSU, John Skinta works at Intel, and Mun-Seog Kim has taken a research position at the Korean NIST (called KIST).

Outreach:

The PI demonstrated superconductivity at the annual Physics Department Open House for high school seniors and their parents and science teachers. The picture below shows the PI demonstrating precession in a 7th grade science class.