Field Dependent Penetration Depth in Unconventional Superconductors

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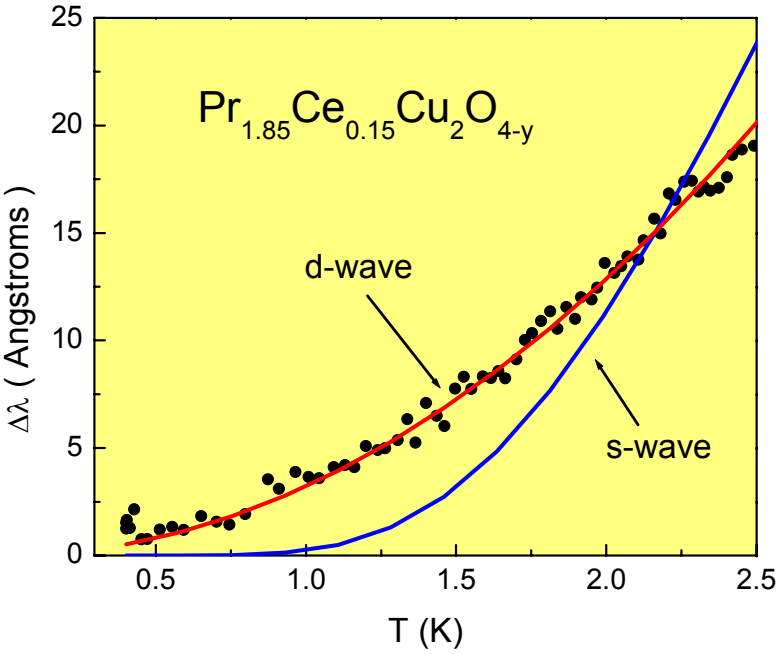
Superconductors reject magnetic fields - almost. Just how far a field is allowed into a superconductor is called the London penetration depth, λ. Precise measurements of λ reveal the internal quantum state of superconductors, e.g., the angular momentum of the "Cooper Pairs". For ordinary superconductors this angular momentum is zero or "s-wave".

In most copper oxide superconductors the Cooper pairs consist of holes in a "d-wave" angular momentum state. In copper oxide superconductors where the pairs consist of electrons (shown in the figure) our data indicate that d-wave pairing also holds. This result places a strong constraint on theories of high temperature superconductivity.



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Education

This work has involved two postdoctoral research associates - Ruslan Prozorov (now assistant professor of physics at University of South Carolina) and David Lawrie, currently finishing in January, 2004. Some of the electronic techniques used in the research have been incorporated into a course on electronic measurement techniques, physics 344. This course is taken by physics, engineering, chemistry and geology students. One student in the course, Shane Luttrell, has gone on to found Creare, an electronic consulting company based in Mississippi.

Outreach

During the summer of 2002 I hosted an exchange student, Ivana Loncarevic, from the University of Novi Sad, Yugoslavia. She analyzed experimental data and investigated new materials to be used in a low temperature version of our device. Each year I serve as a judge and advisor for the University of Illinois Engineering Open House - a campus wide competition of independent physics, computer science and engineering projects which is open to the public for two days.