New material may reveal inner workings of hi-temp superconductors

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Measurements taken* at the National Institute of Standards and Technology may help physicists develop a clearer understanding of high-temperature superconductors, whose behavior remains in many ways mysterious decades after their discovery. A new copper-based compound exhibits properties never before seen in a superconductor and could be a step toward solving part of the mystery.

Copper-based high-temperature superconductors are created by taking a nonconducting material called a Mott insulator and either adding or removing some electrons from its crystal structure. As the quantity of electrons is raised or lowered, the material undergoes a gradual transformation to one that, at certain temperatures, conducts electricity utterly without resistance. Until now, all materials that fit the bill could only be pushed toward superconductivity either by adding or removing electrons—but not both.

However, the new material tested at the NIST Center for Neutron Research (NCNR) is the first one ever found that exhibits properties of both of these regimes. A team of researchers from Osaka University, the University of Virginia, the Japanese Central Research Institute of Electric Power Industry, Tohoku University and the NIST NCNR used neutron diffraction to explore the novel material, known only by its chemical formula of YLBLCO.

The material can only be made to superconduct by removing electrons. But if electrons are added, it also exhibits some properties only seen in

those materials that superconduct with an electron surplus—hinting that scientists may now be able to study the relationship between the two ways of creating superconductors, an opportunity that was unavailable before this "ambipolar" material was found.

The results are described in detail in a "News and Views" article in the August, 2010, issue of Nature Physics, "Doped Mott insulators: Breaking through to the other side."**

More information: * K. Segawa , M. Kofu, S.-H. Lee, I. Tsukada. H. Hiraka, M. Fujita, S. Chang, K. Yamada and Y. Ando. Zero-Doping State and Electron-Hole Asymmetry in an Ambipolar Cuprate. *Nature Physics,* August 2010, pp. 579-583, DOI 10.1038/NPHYS1717

** J. Orenstein and A. Vishwanath. Doped Mott insulators: Breaking through to the other side. *Nature Physics*, V. 6, August, 2010. DOI:10.1038/nphys1751

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