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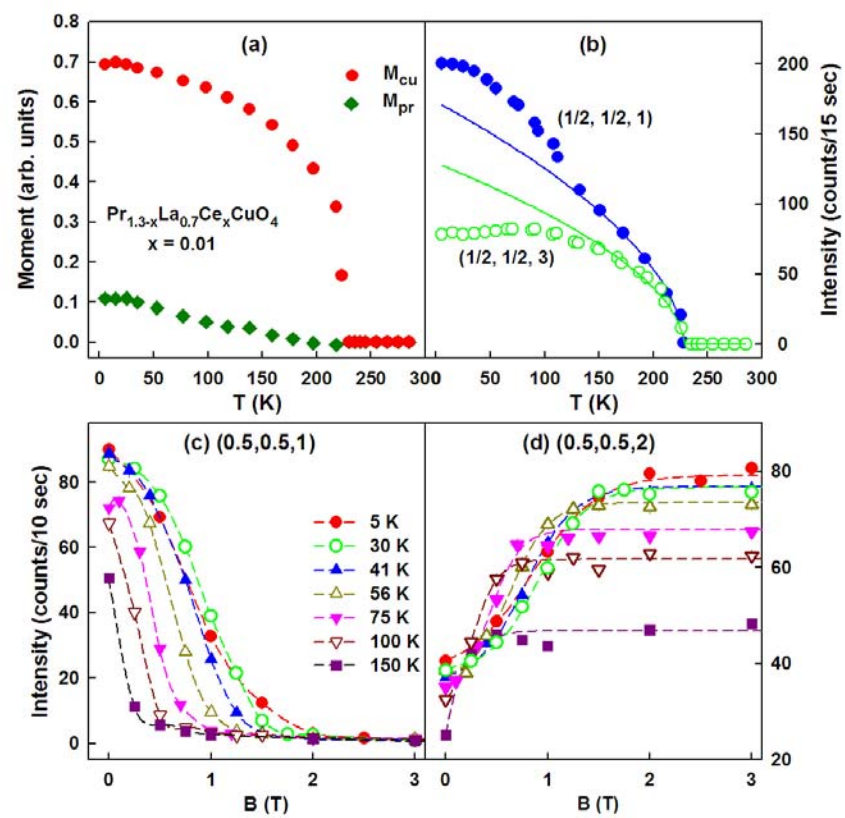
It is believed that the mechanism responsible for superconducting pairing in high-T_c cuprates is a coupling between doped charge carriers and antiferromagnetic (AF) spin fluctuations. While many experimental results in hole-doped cuprates support this idea, it is not clear whether electron-doped materials would also have strong electron-spin coupling. Here we use transport and neutron scattering measurements to show that a magnetic-field-induced transition from noncollinear to collinear spin arrangement in adjacent CuO_2 planes of electron-doped $Pr_{1.3-x}La_{0.7}Ce_xCuO_4$ also affects the significantly both the in-plane and out-of-plane resistivity of the material. So our results indicate a strong spin-charge coupling in electron-doped cuprates, thus suggesting that superconductivity in both systems may have the a universal origin. See ***Physical Review Letters 92,*** 227003 (2004).

Magnetic order and spin-flop transition in $Pr_{1.3-x}La_{0.7}Ce_xCuO_4$



The vast potential for utilizing superconductivity in both societal and scientific pursuits has fueled a great deal of research into understanding the phenomenon more completely. In 1986 a new class of superconducting materials with transition temperatures above liquid nitrogen temperature (78 K) was discovered, yet the precise physics governing this new phenomenon of high temperature superconductivity (high-Tc) materials remains controversial. Specifically the interplay between magnetism and the mechanism of superconductivity itself is a subject of ongoing debate, which is one of the primary motivations for the study of nonsuperconducting $Pr_{1.3-x}La_{0.7}Ce_xCuO_4$. $Pr_{1.3-x}La_{0.7}Ce_xCuO_4$ can superconduct once it is annealed under specific conditions. Studying the nonsuperconducting compound of $Pr_{1.3-x}La_{0.7}Ce_xCuO_4$ before annealing allows us to investigate the properties of these parent materials without the complication of superconductivity and hence grants us greater insight into why these copper oxides are so special. This parallels in much the same way doctors ask a patient for his or her family's history of medical ailments in an attempt to help diagnose the patient himself/herself.

In addition to providing a platform for the study of the parent compounds of high-Tc superconductors, $Pr_{1.3-x}La_{0.7}Ce_xCuO_4$ also displays interesting properties related to its spin structure and electrical resistance. In a similar way that modern hard drives store data, a magnetic field applied in a given direction induces a change in the electrical resistance of the compound. We have shown that these changes in electrical resistance as a function of magnetic field are coupled to the magnetic field induced reordering of electron spins in the sample. This could hold potential application for needed components in spin based electronic devices such as spin valves. For a thorough explanation of our study please see ***Physical Review Letters 92,*** 227003 (2004).

Spin-flop transition in a superconductor can affect electrical resistivity in electron-doped cuprates

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Education:
Hye Jung Kang, a graduate student at the Department of Physics and Astronomy, The University of Tennessee, performed most of the neutron scattering measurements at the NIST center for neutron research. She is helped by Drs. Jeff Lynn and S.-H. Lee at NIST. She will obtain her Ph. D degree in the spring semester 2005. Two other graduate students, Stephen Wilson and Thom Enck, are current working electron-doped high-Tc superconductors.

Societal Impact:
The discovery of strong electron-spin coupling in electron-doped high-Tc superconductors supports the notion that superconductivity in both hole and electron doped materials may have the same origin. The magnetoresistance effect found here may also be used as spin valves.