High magnetic fields reveal hidden magnetism in a cuprate superconductor

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The nature of the pseudogap phase of hole-doped cuprate superconductors still eludes explanation. Several experiments have suggested that this phase ends at a critical hole doping level p^*~0.19, but the nature of the ground state for lower doping is still an open question.

In this work, this group of researchers used high magnetic fields to quench superconductivity in $La_{2-p}Sr_pCuO_4$ to access the ground state and study its magnetic properties with local (NMR) and bulk (ultrasound) measurements. The experiments discovered that the antiferromagnetic glass, known to be the ground state at low doping levels, actually survives up to a critical hole doping level, p^*~0.19 (Fig. 1). Thus the magnetic ground state is partially preempted by the appearance of superconductivity. This research required the resources of three high magnetic field laboratories: the LNCMI Grenoble, LNCMI Toulouse and the NHMFL. *The MagLab's 45T hybrid was used for NMR measurements between 20T and 45T. This MagLab asset uniquely enabled the NMR experiments above 35T for which superconductivity is suppressed, which is essential for detecting the upsurge of magnetism*.

These results imply that other high-field experiments near the pseudogap edge in $La_{2-p}Sr_pCuO_4$ are likely to be influenced by this glassy magnetism. *More fundamentally, it also shows that the antiferromagnetic glass phase spans from the doped Mott insulator at p = 0.02 all the way up to p* ~ 0.19, which suggests a connection between the pseudogap and the physics of Mott insulators.*

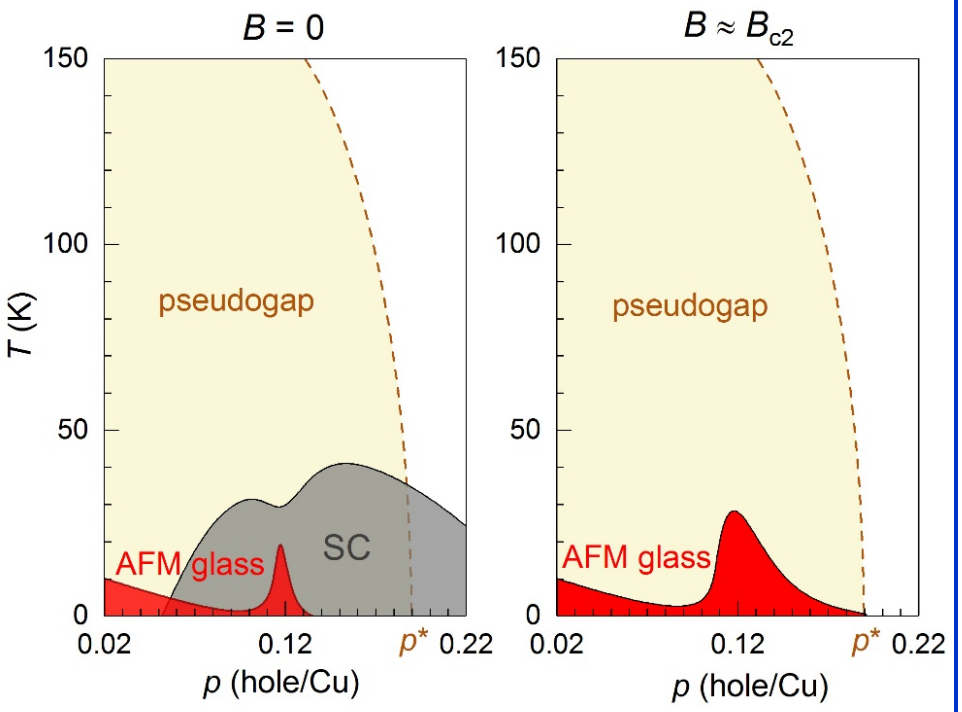

Figure 1. Left: the phase diagram of $La_{2-p}Sr_pCuO_4$ in zero external magnetic field (B = 0) shows no obvious connection between the antiferromagnetic (AFM) glass and pseudogap phases. Right: at magnetic fields sufficiently strong that superconductivity is suppressed, the AFM glass actually extends to the critical doping, p^*~0.19, of the pseudogap phase, thereby revealing a hitherto hidden connection between the two phases.

Facilities and instrumentation used: 45 T Hybrid magnet

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