Polarized neutron diffraction on Cu doped NaFeAs

Yu Song,[1] Zahra Yamani,[2] Pengcheng Dai[1]

[1] Department of Physics and Astronomy, University of Tennessee, Knoxville, Tennesse, USA
[2] Canadian Neutron Beam Centre, Canadian Nuclear Laboratories, Chalk River, Ontario, Canada

It has been a long-standing debate whether the magnetism in unconventional superconductors are better described by local moments or itinerant electrons. In the case of the cuprates, at least it is clear the parent compounds are Mott insulators with localized moments [1]. In the case of iron pnictides, even understanding the magnetism in the parent compounds present a challenge.

Using C5 and N5 at CNBC and instruments at NIST and ORNL, we have demonstrated that while NaFeAs is metallic, doping Cu drives it into an insulating state with antiferromagnetic order. Further, we showed when roughly half of Fe is substituted by Cu, Fe and Cu orders into stripes, giving rise to super-lattice peaks (Fig. 1). Since this super-lattice peak overlaps with the magnetic peak, using polarized neutrons at C5, we verified that both magnetic and nuclear peaks are present at (1,0,0.5) at 2K (Fig. 2). We further demonstrated for Cu doping smaller than 50%, the magnetic order is glassy and short ranged (Fig.3, 4). Taken together our results indicated that iron pnictides are in close proximity to a magnetic insulator where strong correlations are important. The paper is currently in review at Nature Communications. We are also doing several experiments following up on this work.

Reference: [1] R. Coldea et al. Phys. Rev. Lett. 86, 5377 (2001)

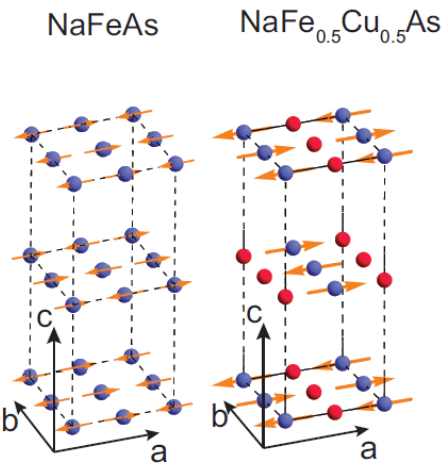

Figure 1 Our model for NaFe0.5Cu0.5As compared to NaFeAs based on data from CNBC, NIST and ORNL.

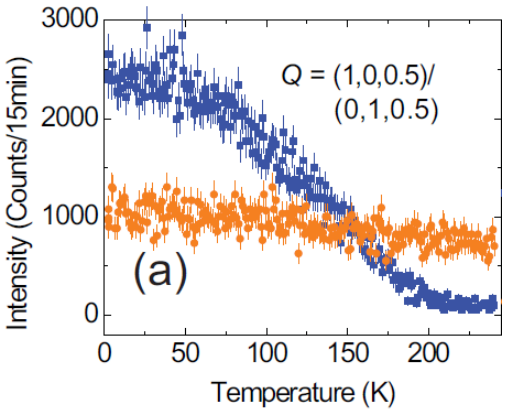

Figure 2 Orange symbols are due to nuclear signal and blue symbols are due to magnetic signal. They overlap due to twinning.

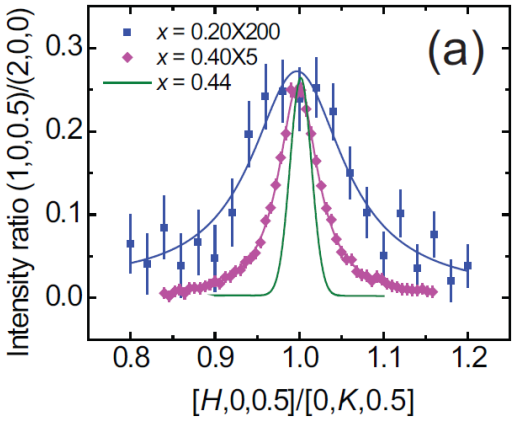

Figure 3 the magnetic order is short ranged for doping smaller than 50%.

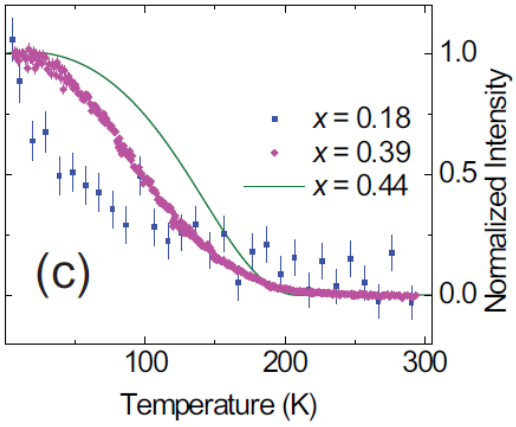

Figure 4 The magnetic order shows spin-glass behavior for doping smaller than 50%