NMR Investigation of Spin Fluctuations near H_{c2} in $Ba(Fe_{1-x}Co_x)_2As_2$

A.P. Dioguardi, M.M. Lawson, B.T. Bush, D.M. Nisson, K.R. Shirer, N.J. Curro (UC Davis, Physics); S. Ran, S.L. Bud'ko, P.C. Canfield (Ames Lab); P.A. Kuhns, S. Yuan, A.P. Reyes (NHMFL)

Introduction

The Iron-based superconductors display rich phase diagrams that include magnetism, superconductivity, and both Fermi and non-Fermi liquid metallic phases. Upon Cobalt doping, the stripe antiferromagnetic phase of $BaFe_2As_2$ is suppressed and superconductivity emerges at temperatures up to 23 K for $x \approx 0.07$. For $0.03 < x < 0.06$ the energy scales of the antiferromagnetic order and superconductivity are comparable and interaction occurs in the form of coexistence and competition of order parameters. Mapping this region of the phase diagram is especially important for determining the Cooper paring mechanism in the Iron-based superconductors.

Experimental

We measured the spin-lattice relaxation rate T_1^{-1} of ^{75}As by saturation recovery with $H \perp c$-axis at 25 T at four different doping levels for $0.058 \leq x \leq 0.066$ and at 30.4 T for $x = 0.059$ using the high-homogeneity resistive magnet in Cell 2 at the DC field center. A Helium flow cryostat was used to control temperature.

Results and Discussion

The data show strong field dependence at lower doping, but nearly no change over the measured temperature range for higher doping levels. This field dependence is the result of glassy behavior, which was previously inferred from stretched exponential relaxation behavior and signal wipeout in these samples. [1] Glassy dynamics has also been observed in the 1111 Iron-based compounds. [2] However, the data are not well fit by activated Bloembergen-Purcell-Pound, (BPP) or Vogel-Fulcher glassy relaxation models. In fact, above the peak, the data are well fit by a combination of Korringa and Curie-Weiss behavior. To model the data, we must take into account the complex interactions of magnetic domains—which vary in size over many orders of magnitude—with (possibly filamentary) superconductivity. [3, 4]

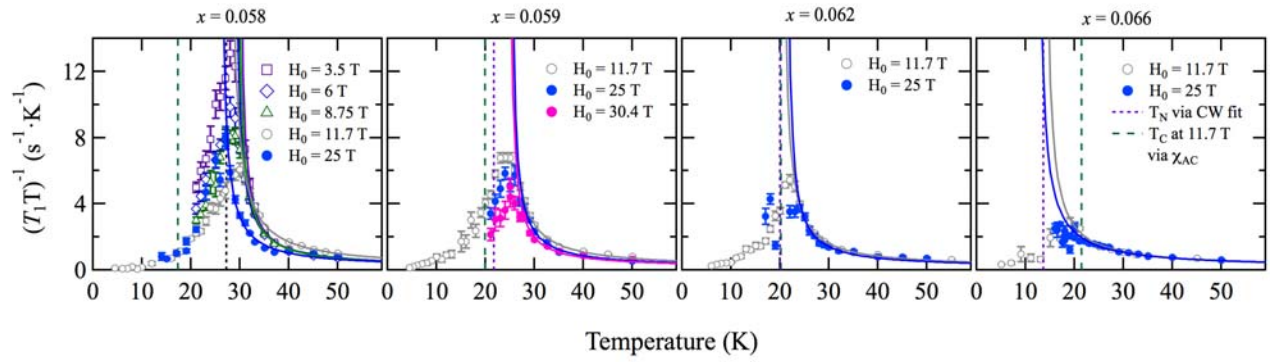

Fig. 1: Spin-lattice relaxation rate divided by temperature of ^{75}As in $Ba(Fe_{1-x}Co_x)_2As_2$ with $H \perp c$-axis for x = 0.058, 0.059, 0.062 and 0.066. Closed markers indicate data acquired at the NHMFL and solid lines are Curie-Weiss fits to the data.

Conclusions

Field dependence indicating glassy behavior was observed in single crystals of in $Ba(Fe_{1-x}Co_x)_2As_2$ with $H \perp c$-axis for x = 0.058, 0.059, 0.062 and 0.066. However, this glassy behavior is not well characterized by simple BPP or Vogel-Fulcher dynamics. Further theoretical advancement is required to fully understand these data.

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References

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