Interplay of Spin Fluctuations and Superconductivity in $Ba(Fe_{1-x}Co_xAs)_2$ Probed by High-Field ^{75}As NMR

U. Gräfe, H.-J. Grafe, S. Wurmehl, B. Büchner (IFW Dresden, Germany); H. Kühne, A.P. Reyes, P.L. Kuhns (NHMFL)

Introduction

In the iron arsenide compound $Ba(Fe_{1-x}Co_xAs)_2$ (Ba122), the introduction of additional electrons via Co doping suppresses an antiferromagnetic phase and induces superconductivity with T_c = 22 K at an optimum Co doping level of 10% [1]. For doping levels smaller than 10%, a coexistence of magnetism and superconductivity was reported [2], but even for the optimally doped case, slow spin fluctuations (SF) are present [3].

Experimental

In order to shed light on the role of SF for the superconducting pairing mechanism in Ba122, we measured the temperature dependent ^{75}As-NMR spin-lattice relaxation rate divided by temperature, $(T_1T)^{-1}$, for a 10 % Co doped single crystal at a field of 30 T in the resistive magnet of cell 2.

Results and Discussion

Figure 1 shows the temperature dependence of $(T_1T)^{-1}$ for different magnetic fields and orientations for the 10 % Co doped Ba122 sample. $(T_1T)^{-1}$ increases with decreasing temperature and drops rapidly at or slightly below T_c (marked by arrows). The absolute values of $(T_1T)^{-1}$ are found to be higher for H || ab plane than for H || c. With increasing magnetic field, we find a suppression of T_c and, correspondingly, a strong decrease of $(T_1T)^{-1}$ at lower temperatures.

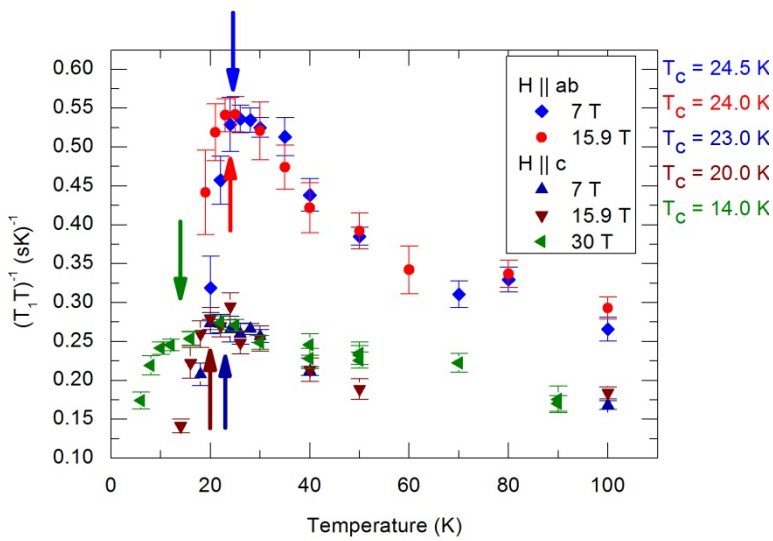

Fig 1: Temperature dependence of the nuclear spin-lattice relaxation rate divided by temperature. The arrows mark the field dependent critical temperatures T_c, determined from the detuning of the NMR resonance circuit at the transition to the superconducting phase.

Conclusions

The increase of $(T_1T)^{-1}$ for temperatures above T_c points towards the presence of pronounced SF in optimally Co doped Ba122. Other than in $LaO_{1-x}F_xFeAs$ (La1111), there is no field dependence of $(T_1T)^{-1}$, implying the absence of progressive slowing of SF [4]. An improved understanding of the contrasting behavior of SF in Ba122 and La1111 will be the subject of future investigations.

Acknowledgements

A portion of this work was performed at the National High Magnetic Field Laboratory, which is supported by National Science Foundation Cooperative Agreement No. DMR-1157490, the State of Florida, and the U.S. Department of Energy.

References

[1] Sefat *et al.*, PRL 101, 117004 (2008).
[2] Aswartham *et al.*, Journal of Crystal Growth 314, 341-348 (2011)
[3] Ning *et al.*, PRL 104, 037001 (2010)
[4] Hammerath *et al.*, PRB 88 104503 (2013)