Spin Fluctuations in F Doped LaOFeAs Studied by High-Field NMR Spectroscopy

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Introduction

$LaO_{1-x}F_xFeAs$ (La1111) was one of the first iron pnictides reported to show a superconducting phase transition upon fluorine doping with a critical temperature T_c of 26 K at fluorine a doping level of 10 % [1]. The phase diagram of pnictides in general shows a transition from a magnetic to a superconducting phase [2]. In La1111, this transition is very sharp, without any known coexistence between the two phases. This gives the opportunity to study the interplay of superconductivity and spin fluctuations (SF) without the complication of magnetic order.

Experimental

In order to shed light on the role of the SF for the superconducting pairing mechanism, we studied SF in superconducting La1111 with doping levels in close vicinity to the magnetic transition. We measured the temperature dependence of the ^{75}As-NMR spin-lattice relaxation rate divided by temperature $(T_1T)^{-1}$ which is directly proportional to the dynamic spin susceptibility. At the NHMFL, we measured $(T_1T)^{-1}$ for a 4.5 % F doped La1111 powder sample at fields of 23 T and 30 T in the resistive magnet located in Cell 2.

Results and Discussion

Figure 1 shows the temperature dependence of $(T_1T)^{-1}$ at different fields for the 4.5 % F doped La1111 powder sample (published in [3]). At low temperatures, a peak is observed in $(T_1T)^{-1}$. While the high temperature behavior remains unaffected by the application of higher fields, the position of the peak shifts to higher temperatures and the height of the peak is reduced. The field dependence of the peak follows the same phenomenology as the characteristic behavior of the BPP model, which describes the spin-lattice relaxation rate determined by local fluctuating fields. To analyze the data we, we therefore used the BPP model in a modified form:

$$(T_1T)^{-1} = a + bT + \frac{1}{T}\gamma^2 h_p \frac{\tau_c(T)}{1+\tau_c^2(T)\omega_L^2},$$

$$\tau_c(T) = \tau_0 \exp\left(\frac{E_a}{k_B T}\right),$$

where h_p is the fluctuating field, τ_c, the correlation time, which shows an activated behavior for a glassy spin freezing, and E_a is the activation energy. As can be seen in figure 1, the BPP fit agrees well with the data for all fields and temperatures in the normal conducting state.

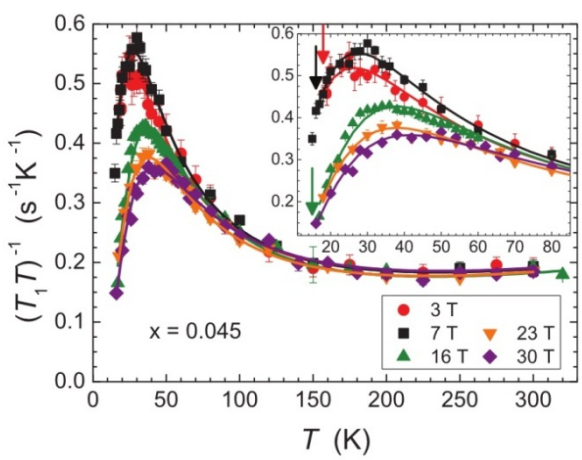

Fig 1: Temperature dependence of the spin-lattice relaxation rate divided by temperature. Upon increasing the magnetic field, the peak shifts to higher temperatures [3].

Conclusions

The consistence of our measurements with the BPP model points towards a progressive slowing of SF. The measurements at the NHMFL provide evidence that SF are strongly enhanced by high magnetic fields. For further insight we refer to our article [3].

Acknowledgements

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References

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