Field Dependence of Spin Lattice Relaxation Rate in $NaFe_{0.975}Co_{0.025}As$ and $Ba_{0.67}K_{0.33}Fe_2As_2$ in High Magnetic Field

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Introduction

The common field dependence of spin lattice relaxation rates divided by temperature ($1/T_1T$) of $NaFe_{0.975}Co_{0.025}As$ and $Ba_{0.67}K_{0.33}Fe_2As_2$, respectively electron and hole doped superconductors, by ^{75}As NMR from 6.4 T to 28 T indicates an increase of the density of states due to an external field which has a common origin.

Experimental

Our samples were optimally Co doped $NaFe_{0.975}Co_{0.025}As$ (T_c = 21K) and slightly under doped $Ba_{0.67}K_{0.33}Fe_2As_2$ (T_c = 38 K), self-flux grown, single crystals with c-axis parallel to the magnetic field. We performed measurements of the spectrum and spin lattice relaxation rate using Hahn echo down to 4.2 K in the DC resistive magnet facility, cell 2 of the NHMFL, in superconducting magnets at the NHMFL, and at Northwestern University.

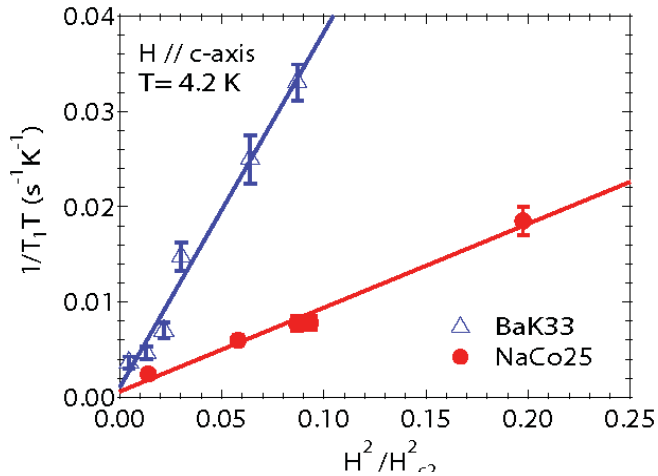

Figure 1. $1/T_1T$ at 4K from BaK_{33} and $NaCo_{25}$ in various magnetic fields are shown. Increased area ratio of local density of the states of outside of the vortex core and the vortex unit cell is main source for the $1/T_1T$ increase in the fields.

Results and Discussion

The spin lattice relaxation rate measurements in $NaFe_{0.975}Co_{0.025}As$ (NaCo25) and $Ba_{0.67}Fe_{0.33}Fe_2As_2$ (BaK33) are shown in **Figure 1**. Previously, multiple but different superconducting gap sizes in a pnictide superconductor were invoked to explain the field dependent density of the states in the superconducting state [1]. We found a quadratic increase of $1/T_1T$ in BaK33 in conflict with the theory [2]. But the different superconducting gap sizes in BaK33 and intermediate linewidth (70 kHz at 40 K in 6.4 T) made the interpretation more problematic. NaCo25 is known to have one superconducting gap size. Additionally, its linewidth from ^{75}As NMR is extremely narrow, 10 kHz at 20 K in 6.4 T. We measured $1/T_1T$ at various magnetic fields and found that $1/T_1T$ in the superconducting state to be field dependent proportional to H^2. One possible mechanism for the field dependence is due to extended states outside of the vortex cores [3, 4]. The ratio of the area outside of a vortex core to the area of a vortex unit cell is linear in field. Thus we believe that the increase of $1/T_1T$, quadratic in field, could be owing to these extended quasiparticle states. From Figure 1, we confirm that $1/T_1T$ is proportional to H^2 and appears to be an intrinsic and common characteristic of Fe-based pnictide superconductors.

Conclusions

We found that the $1/T_1T$ in the superconducting state is linear in H^2. This H^2 field dependence of $1/T_1T$ is attributed to a local density of the states that extend outside of the vortex core.

Acknowledgements

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References

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