High-Field NMR Study of the Iron-Based High-T_c Superconductor

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Introduction

Since the discovery of high transition temperature (T_c) superconductivity in the iron pnictides, it has been an important task to elucidate the relationship between the normal-state properties and the superconductivity. The proximity of superconductivity to an antiferromagnetically ordered phase strongly suggests an interplay between the two ground states. Previous nuclear magnetic resonance (NMR) proved that antiferromagnetism can microscopically coexist with superconductivity in the under-doped regime.[1] The antiferromagnetic order disappears in the optimally-doped regime, but there exists strong antiferromagnetic spin fluctuations.[2] Therefore, investigation of the spin fluctuations in iron based superconductors will be helpful for the understanding of the mechanism of the superconductivity in these compounds. We have performed NMR measurements at high magnetic fields on the hole-doped compound $Ba_{0.68}K_{0.32}Fe_2As_2$ to explore the properties of the spin fluctuations.

Experimental

The single crystals of $Ba_{1-x}K_xFe_2As_2$ were grown by using the self-flux method. The samples with x=0.32 were selected for ^{75}As-NMR measurements. High magnetic fields up to 45 T are applied along the *c*-axis by using the Hybrid magnet in the National High Magnetic Field Laboratory, Tallahassee, Florida.

Results and Discussion

Figure 1 shows the field dependence of T_c for $Ba_{0.68}K_{0.32}Fe_2As_2$. 45 T can only suppress T_c by a few Kelvin, which indicates that the upper critical field H_{c2} is very high. By using the Werthamer-Helfand-Hohenberg equation, the H_{c2} is estimated to be as high as190 T. Figure 2 shows the ^{75}As-NMR spectra at 45 T and 12 T, respectively. The full width at half maximum (FWHM) of the spectrum increases with increasing the field, which suggests that some extent of inhomogeneity also exists as in the copper oxide superconductors, even though this compound is the cleanest among its class. Intriguingly, the spin fluctuation properties at high magnetic fields appear to be quite different as compared to those at low fields, which is under more quantitative analysis.

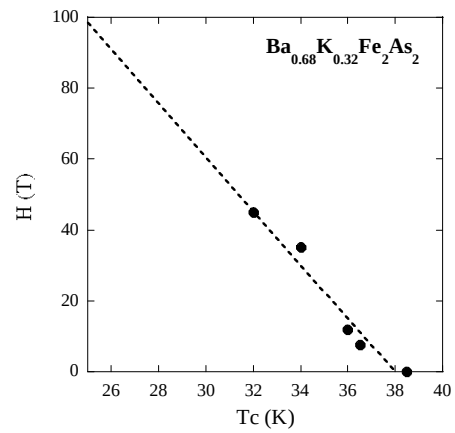

Fig. 1 Magnetic field dependence of T_c in $Ba_{0.68}K_{0.32}Fe_2As_2$.

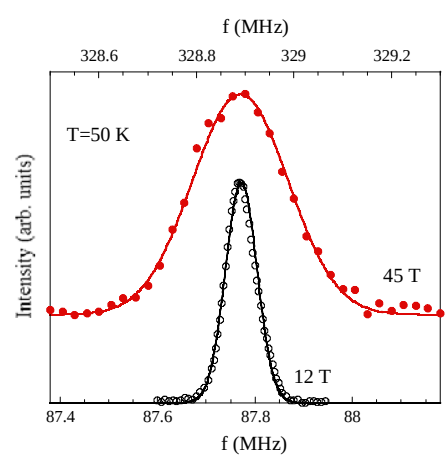

Fig. 2 ^{75}As-NMR spectra at 45 T and 12 T, respectively.

Conclusions

We have performed high field NMR measurements on the hole-doped iron-based superconductor $Ba_{0.68}K_{0.32}Fe_2As_2$. Our results indicate that the iron based superconductors have very high H_{c2} and suggest that the high magnetic field can possibly tune the electron correlations in this new class of materials.

Acknowledgements

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References

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[2] Z. Li, D. L. Sun, C. T. Lin, Y. H. Su, J. P. Hu, and G.-Q. Zheng, Phys. Rev. B **83**, 140506 (R) (2011).