In-plane Upper Critical Field of the Iron-based Superconductor LiFeAs Probed by ^{75}As NMR Spectroscopy

H. Kuehne, P.L. Kuhns, A.P. Reyes (NHMFL); H.-J. Grafe, S. Aswartham, S. Wurmehl, B. Buechner (IFW, Dresden, Germany)

In contrast to most of the other iron-based superconductors discovered so far, the stoichiometric "111" compound LiFeAs exhibits a superconducting phase transition at T_c = 18 K without the need for chemical doping or the application of external pressure [1]. Neither a magnetic ground state nor a structural transition were found, although the system is isoelectronic to some of the undoped "122" and "1111" compounds, such as $BaFe_2As_2$ or LaFeAsO. The upper critical fields $H_{c2||ab}$ for a magnetic field orientation parallel to the FeAs planes are reported to be in the field range of 26-30 T [2-4]. At present, the access to this thermodynamic parameter regime is only given by the usage of either resistive magnets or pulsed field facilities. Despite intense research with a number of experimental methods, no results of local probe techniques at fields in the regime of $H_{c2||ab}$ have been reported yet.

We performed high field ^{75}As NMR experiments on three high quality (NQR linewidths between 34 and 50 kHz at room temperature) single crystals at magnetic fields up to 30 T, oriented parallel to the FeAs layers. For these experiments, a 30 T resistive magnet (cell 2) at the NHMFL was used. Utilizing the anisotropic second order quadrupole shift of the ^{75}As center line, the samples could be aligned with an error smaller than 2°.

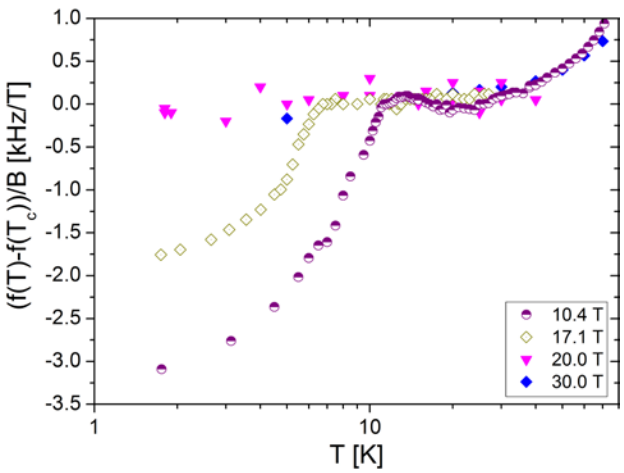

Figure 1: *Temperature dependence of the relative NMR center frequency at different external magnetic fields parallel to the FeAs planes.*

The results of our high field experiments indicate an upper critical field much lower than 26 T. **Figure 1** shows the temperature dependent nuclear ^{75}As center line frequency at different external fields. The data at 10.4 T drops below 11 K, indicating the onset of spin singlet superconductivity. At 17.1T, the superconducting phase transition is suppressed to 7 K. For fields of 20 T and higher, we find no decrease of the NMR frequency at temperatures down to 1.6 K. We confirmed this observation for all three single crystalline samples. These results are in contrast to several of the results reported from macroscopic techniques, such as TDO or resistivity [2,3]. The stabilization of superconducting order parameters with different symmetries, depending on slight variations of the lithium stoichiometry, is a subject of intense discussion in the research on LiFeAs. In this respect, the continuation of our experiments will help to shed light on this issue from a microscopic point of view.

Acknowledgements

H. K. was partially supported by a research fellowship from the German Research Foundation (KU 3066/1-1). The work at the NHMFL was supported by the National Science Foundation, the U.S. Department of Energy, and the State of Florida.

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