Angular dependence of upper critical field H_{c2} in single crystals of the magnetically ordered superconductor $RbEuFe_4As_4$ in fields up to 65 T

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Introduction

The angular dependence of the upper critical field H_{c2} in the magnetically ordered superconductor $RbEuFe_4As_4$ (T_c ~36.5 K, T_m ~ 15 K) [1-3] has been measured at 20 K in pulsed magnetic fields up to 65 T. A continuous, sinusoidal evolution is observed, indicating a smooth Fermi surface.

Experimental

The proximity detector oscillator (PDO) technique was used to measure superconducting transitions on single crystals of $RbEuFe_4As_4$ with a rotator stage used to move from H // (110) to H // (001) in 5° increments at 20 K in pulsed magnetic fields up to 65 T using the NHFML 65 T Pulse Field Facility at Los Alamos National Laboratory.

Results and Discussion

In **Fig. 1** we show the temperature dependence of the PDO resonator frequency, which is proportional to the magnetic susceptibility, of a single crystal of $RbEuFe_4As_4$ at 20 K with pulsed magnetic fields up to 65 T. 20 K was chosen because the upper critical field exceeds the instrument limit of 65 T quickly at lower temperatures. As the field rotates from the (001) to (110) direction, the transition moves to higher field. The transition value is taken as where a line tangent to the transition crosses zero field. In **Fig. 2**, we show the upper critical field H_{c2} vs polar angle. The red line is a sinusoidal fit to the extracted H_{c2} values. Continuous behavior is observed, indicating a smooth Fermi surface with mild warping.

Conclusions

No strong angular variation in the upper critical field was observed. This suggests a mildly warped, continuous Fermi surface, and may place limits on the symmetry of the superconducting order parameter. Due to strong ferromagnetic fluctuations [2,3] the Eu spin lattice is fully ordered in high fields well below H_{c2} at 20 K, obviating the need to perform the experiment at temperatures below T_m. Due to the high H_{c2} values at low temperature, it is not possible to see quantum oscillations at 65 T, but prior results by our group suggest that it may be possible to see quantum oscillations and thus map the true Fermi surface at ~80 T.

Acknowledgements

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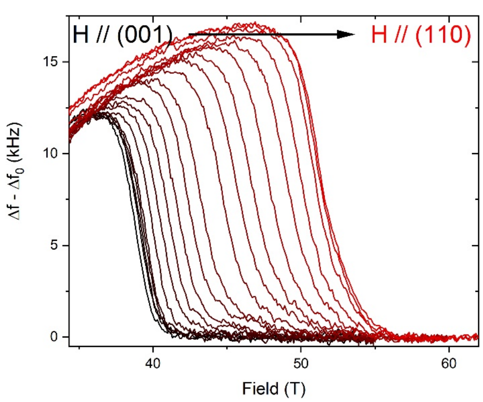

Fig.1 Background-subtracted PDO resonator shift vs field at 20 K showing the SC transition shift as the field is rotated from the (001) to the (110) direction

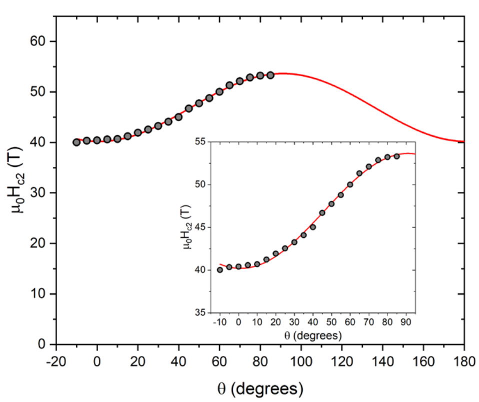

Fig.2 H_{c2} as a function of polar angle, with 0° along the (001) direction in the crystal. Continuous, sinusoidal behavior is observed, suggesting a smooth Fermi surface.