PROBING THE SUPERCONDUCTING GAP SYMMETRY FROM PENETRATION DEPTH MEASUREMENTS IN $CeCoIn_5$

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Introduction

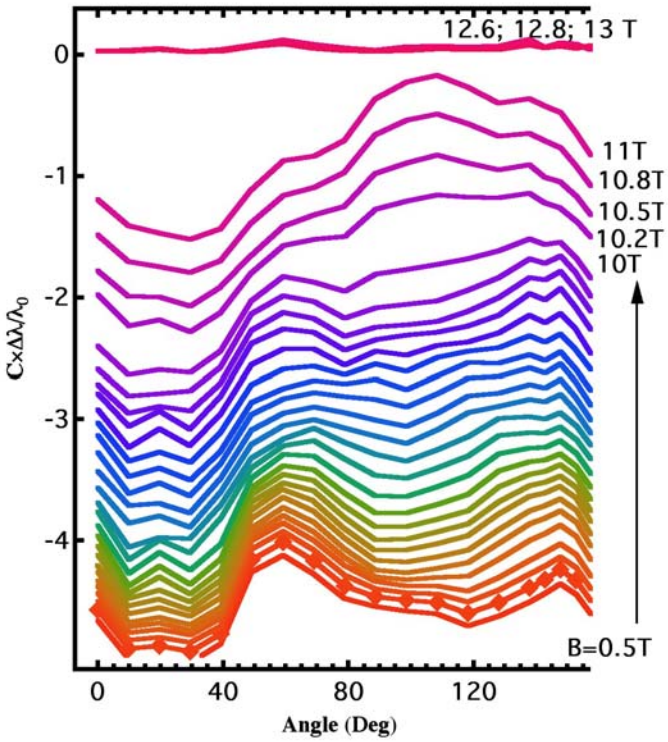
Theoretical work by S.K. Yip et al. [Ref. 1] has shown that filed dependence of the penetration depth in superconductors could provide a powerful tool for proving the symmetry of the superconducting gap. We present experimental study of penetration depth on the heavy fermion superconductor $CeCoIn_5$, in a magnetic field applied along the highly conducting *ab*-planes and with the sample rotating around the *c*-axis. There is experimental evidence that the gap has a $d_{x^2-y^2}$ symmetry in $CeCoIn_5$, therefore the penetration depth is expected to reveal a four-fold symmetry.

Experimental

The change in penetration depth with magnetic field was determined from the frequency change of a self-resonant LC circuit powered by a tunnel diode. The alignment of the field along the *ab*-planes was obtained by adjustments of the rotating platform at room temperature until we measured the highest critical field in the sample at 60 mK. The experiment was conducted using the SCM1 facility at the NHMFL.

Results and Discussion

The figure shows the relative change in penetration depth with angle up to 160 degrees, for different fields between 0.5T and 13T at T=60 mK. As it can be seen, up to about 10T, the data seems to show a relative minima and maxima every 45 degrees, consistent with a four-fold symmetry. Moreover, at fields higher than 10T but lower than the upper critical field, there is a change in symmetry, which would signal an additional filed modulation consistent with the FFLO state in $CeCoIn_5$ [Ref. 2].



Conclusions

Our measurement of the in-plane anisotropy of the penetration depth with magnetic field in $CeCoIn_5$ seems to be consistent with the symmetry of the superconducting gap. However, the accuracy of the data is drastically affected by the possible misalignment between the field and the ab-planes, which was estimated to be about 10 degrees.

Acknowledgements

This work was supported by the NNSA-DOE under DE-FG52-03NA0006

References

[1] Yip, S.K., *et al*., Phys. Rev. Lett., **69**, 2264 (1992) and Xu, D., *et al*., Phys. Rev. B, **51**, 16233 (1995).
[2] Radovan, H.A., *et al*., Nature, **425**, 51 (2003).