Planar Tunneling Spectroscopy of the Heavy-Fermion Superconductor $CeCoIn_5$

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Introduction

The heavy-fermion superconductor $CeCoIn_5$, whose order parameter is known to have d_{x2-y2}-wave symmetry [1], exhibits an interesting wave-vector modulated spin density wave-like *Q*-phase in the low-temperature high-field region of the phase diagram [2]. Despite several recent scanning tunneling spectroscopic (STS) measurements [3], the detailed spectroscopic nature of the *Q*-phase remains to be unveiled. Here, we report the results from planar tunneling spectroscopy (PTS) along the (001) direction of $CeCoIn_5$ over a wide temperature range down to 20 mK.

Experimental

High-quality tunnel junctions were prepared by depositing AlO_x as a tunnel barrier onto polished $CeCoIn_5$ crystals and superconducting Pb as the counter-electrode. They were mounted on a rotator sample probe, which was inserted into SCM-1. The conductance measurements were carried out using our own electronic setup.

Results and Discussion

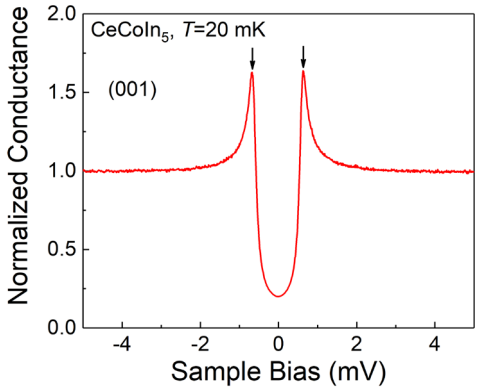

Fig. 1 Normalized tunneling conductance of $CeCoIn_5$ at *T*=20 mK along the (001) direction with the Pb driven normal by an applied magnetic field of 0.2 T.

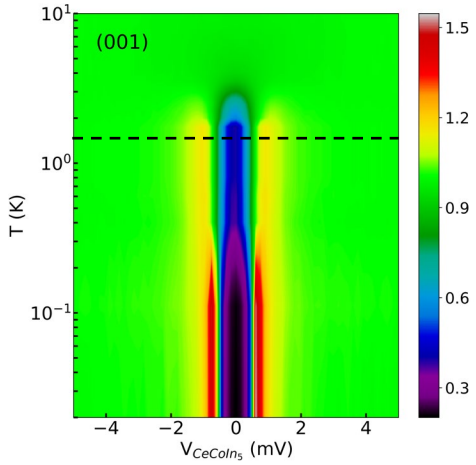

Fig. 2 Colored-contour plot of the conductance data at different temperatures with the Pb kept in the normal state.

Figure 1 shows a conductance curve taken at the lowest temperature of 20 mK with the Pb driven normal. The sharp coherence peaks marked by the arrows indicate that the junction is of high quality. The gap energy is estimated to be 0.65 meV at T = 20 mK, consistent with STS results [3]. Figure 2 shows a colored-contour plot of the temperature-dependent tunneling conductance from 20 mK up to 10 K. The superconducting gap-like feature (pseudo-gap) is observed even at temperatures up to ~4 K which is well above the bulk superconducting transition temperature indicated by the dashed line (T_C = 2.3 K), which has also been observed in STS studies [3].

Conclusions

We have successfully adopted PTS to investigate the superconducting order parameter in $CeCoIn_5$. The gap size is found to be 0.65 meV from tunneling spectra along the (001) direction. A pseudo-gap is observed to persist well above the superconducting transition temperature. Further investigations are underway to pin down its origin as well as the sign changing nature of the superconducting order parameter along with its evolution in the *Q*-phase.

Acknowledgements

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References

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