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Anomalous quasiparticle transport in the superconducting state of $CeCoIn_5$

Y. Kasahara[1], Y. Nakajima[2], K. Izawa[2,3], Y. Matsuda[1,2], K. Behnia[2,4], H. Shishido[1,5], R. Settai[5] and Y. Onuki[5]

[1]Department of Physics, Kyoto University, Sakyo-ku, Kyoto 277-8581, Japan
[2]Institute for Solid State Physics, University of Tokyo, Kashiwa, Chiba 277-8581, Japan
[3]CEA-Grenoble, 38054 Grenoble cedex 9, France
[4]Laboratoire de Physique Quantique (CNRS), ESPCI, 10 Rue de Vauquelin, 75231 Paris, France
[5]Department of Physics, Osaka University, Toyonaka, Osaka 560-0043, Japan

To investigate the quasiparticle dynamics in the superconducting state of quasi-two dimensional heavy fermion superconductor $CeCoIn_5$, the thermal conductivity tensor is measured[1]. In zero magnetic field, thermal Hall angle shows up a steep increase below T_c, indicating that the quasiparticle mean free path is strongly enhanced. However, in spite of the presence of a periodic vortex lattice, this enhancement is easily suppressed by a very weak magnetic field.

We found that the density states of the delocalized quasiparticles $N_{\rm del}$, which is obtained from κ_{xx} and κ_{xy}, exhibits a $\sqrt{H}$-dependence, indicating a Volovik effect[2]. Moreover, κ_{xy} reveals the scaling relation with respect to $T/\sqrt{H}$, which is expected for d-wave symmetry[3]. These results provide a further support for d-wave superconducting symmetry in $CeCoIn_5$. We also argue that a small Fermi energy, a short coherence length, and a long quasiparticle mean free path all indicate $CeCoIn_5$ is in the superclean regime.

These results highlight that $CeCoIn_5$ is unique among superconductors.

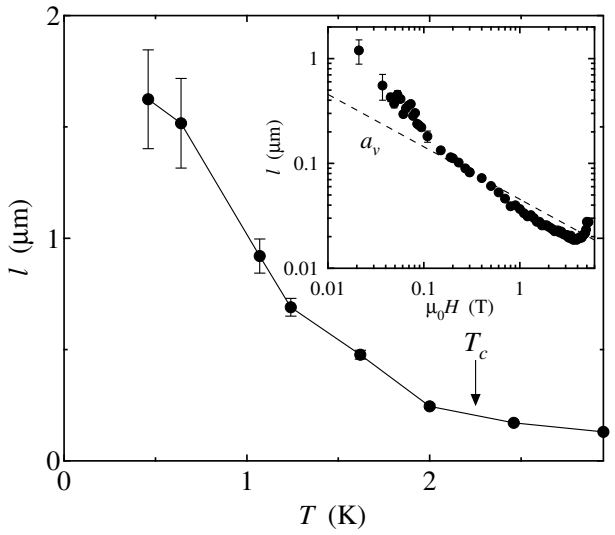

Figure 1: Quasiparticle mean free path ℓ as a function of temperature in zero magnetic field. Inset shows magnetic field dependence of ℓ. Dashed line indicates the inter-vortex distance $a_v = \sqrt{\Phi_0/B}$.

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[2] G. E. Volovik, JETP Lett. **58**, 469 (1993).
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