

(27b2)

Symmetry of the superconducting gap function in $\text{PrOs}_4\text{Sb}_{12}$

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$\text{PrOs}_4\text{Sb}_{12}$ is the first Pr-based heavy-fermion compound which shows superconductivity. Since this compound has a non-magnetic ground state of f -electrons in the crystalline electric field, it is suggested that the quadrupole fluctuations play an important role for the occurrence of the superconductivity as well as for the formation of heavy electrons. Hence, $\text{PrOs}_4\text{Sb}_{12}$ is a candidate for the first superconductor mediated neither by electron-phonon nor magnetic interactions. The gap structure in $\text{PrOs}_4\text{Sb}_{12}$ is an unsolved issue although the symmetry of the gap function is crucial for the understanding of the pairing mechanism. Here, we studied the gap structure of $\text{PrOs}_4\text{Sb}_{12}$ by thermal conductivity measurement. The c -axis thermal conductivity κ_{zz} is measured in a magnetic field H rotated around the c -axis. As shown in Fig.1, a clear fourfold variation is observed below H_{c2} down to 0.8 T while κ_{zz} is essentially independent of field directions above H_{c2} . With further decreasing H , the amplitude of fourfold symmetry suddenly suppressed and a discernible fourfold variation is not observed below 0.7 T. At the same time, a twofold symmetry grows rapidly. These results provide a strong evidence of the occurrence of the change in the symmetry of the superconductivity, showing the presence of two distinct superconducting (SC) phases (Fig.2): the high field phase with 6 or 4 point nodes and low field phase with 2 or 4 point nodes. We demonstrate $\text{PrOs}_4\text{Sb}_{12}$ is the first superconductor with multiple SC phases in which the gap function has point nodes.

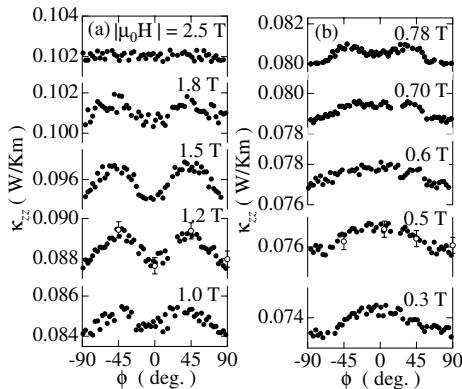


Figure 1: (a)(b) Angular variation of κ_{zz} at 0.52 K in the magnetic field rotated within the ab plane.

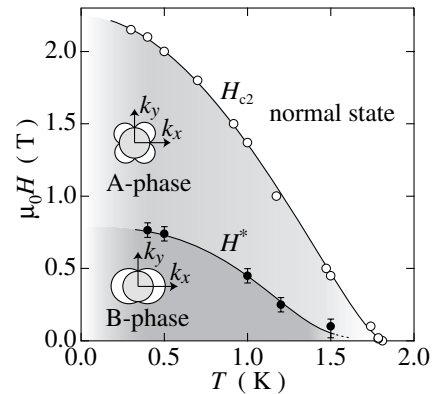


Figure 2: The phase diagram of the superconducting gap symmetry in $\text{PrOs}_4\text{Sb}_{12}$.

[1] K. Izawa, Y. Nakajima, J. Goryo, Y. Matsuda, S. Osaki, H. Sugawara, H. Sato, P. Thalmeier, and K. Maki, Phys. Rev. Lett. **90** (2003) 117001.