Weak-Coupling BCS Theory of Skutterudite PrOs$_4$Sb$_{12}$

DAVID PARKER, KAZUMI MAKI, STEPHAN HAAS, University of Southern California — A weak-coupling theory of the A- and B-phases of the recently discovered heavy-fermion superconductor PrOs$_4$Sb$_{12}$ is developed. The BCS gap equation is solved assuming a p+$h$-wave pairing symmetry with an A-phase nodal gap function $\Delta(k) \sim e^{\pm i\phi_1}(1 - \hat{k}_x^4 - \hat{k}_y^4 - \hat{k}_z^4)$ and with a B-phase nodal gap function $\Delta(k) \sim e^{\pm i\phi_2}(1 - \hat{k}_y^4)$, where $e^{\pm i\phi_1} \sim \hat{k}_z \pm i\hat{k}_x$, $\hat{k}_x \pm i\hat{k}_y$ or $\hat{k}_y \pm i\hat{k}_z$ and $e^{\pm i\phi_2} \sim \hat{k}_z \pm i\hat{k}_x$.

The B-phase order parameter has similar thermodynamic properties as the recently proposed spin-singlet s+$g$-wave superconductor [Maki et al, Europhys. Lett. 64 496 (2003)]. However, there is accumulating evidence for spin-triplet pairing for superconductivity in PrOs$_4$Sb$_{12}$. Analytic limiting case results as well as numerical solutions for the whole temperature range $T \leq T_c$ are presented for the order parameter, the specific heat, the thermodynamic critical field, and the superfluid density. We compare these results with data from a few recent experiments.