(29c1)

Unconventional superconducting states in $PrOs_4Sb_{12}$

S. H. Curnoe and I. A. Sergienko

Department of Physics and Physical Oceanography, Memorial University of Newfoundland, St. John's, NL, A1B 3X7, Canada

We classify all possible superconducting states for crystals with T_h symmetry, including those which may be accessed via an additional phase transition within the superconducting state. The gap function nodes and superfluid density are found for each state. By comparing with experiment, we find that the superconducting order parameter in $PrOs_4Sb_{12}$ is best described by the three-dimensional representations of point group T_h (singlet or triplet). We propose possible phase transition sequences for $PrOs_4Sb_{12}$, which may be differentiated by elastic measurements [1].

State	Symmetry		Nodes		Nodes
(1)	$T \times \mathcal{K}$	A_g	none	A_u	none
(1, 0)	$T(D_2)$		8 points $\langle 111 \rangle$		8 points $\langle 111 \rangle$ (1)
(ϕ_1, ϕ_2)	$D_2 \times \mathcal{K}$	E_g	8 points $\langle 111 \rangle$	E_u	none
(η_1, η_2)	D_2		8 points $\langle 111 \rangle$		none
(1, 0, 0)	$D_2(C_2) \times \mathcal{K}$		2 lines $k_y = 0$, $k_z = 0$		2 points [100](2)
(1, 1, 1)	$C_3 \times \mathcal{K}$		6 points $\langle 001 \rangle$		none
$(1, \epsilon, \epsilon^2)$	$C_3(E)$		6 points $\langle 001 \rangle$, 2 points [111]		2 points [111](1)
$(\lvert\eta_1\rvert, i\lvert\eta_2\rvert, 0)$	$D_2(E)$		1 line $k_z = 0$, 2 points [001]		none
$(\lvert\eta_1\rvert, \lvert\eta_2\rvert, 0)$	$C_2(E) \times \mathcal{K}$	T_g	1 line $k_z = 0$, 2 points [001]	T_u	none
$(\eta_1, \eta_2, 0)$	$C_2(E)$		1 line $k_z = 0$, 2 points [001]		none
$(\lvert\eta_1\rvert, i\lvert\eta_2\rvert, \lvert\eta_3\rvert)$	$C_2'(E)$		6 points $\langle 001 \rangle$		none
$(\lvert\eta_1\rvert, \lvert\eta_2\rvert, \lvert\eta_3\rvert)$	$\mathcal{K}$		6 points $\langle 001 \rangle$		none
(η_1, η_2, η_3)	E		6 points $\langle 001 \rangle$		none

Table 1: Superconducting states described by one irreducible representation of the point group T_h. The first column defines the relative magnitudes and phases of the components of the order parameter, where $\eta_{1,2} = |\eta_{1,2}| \exp(i\phi_{1,2})$ are arbitrary complex numbers and $\epsilon = \exp\left(\frac{2\pi i}{3}\right)$. The second column lists the symmetry group of the SC state ($\mathcal{K}$ is time reversal symmetry). The third and fourth columns list nodes of the gap function associated with the primary order parameter for even and odd parity respectively.

[1] I. A. Sergienko and S. H. Curnoe, cond-mat/0309382.