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Bulk Superconductivity in PuCoGa_5 at 18.5 K^+

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Elemental plutonium is a fascinating metal yet poorly understood. A significant aspect of its complexity is the ambivalent nature of Pu's 5f electrons, which frequently appear to be neither completely localized nor fully itinerant. This issue is emphasized in PuCoGa_5 , the first Pu-based superconductor and with a T_c exceeding 18 K. Though conventional phonon-mediated pairing may be responsible for its superconductivity, this view must be reconciled with three observations: (1) above T_c , the static susceptibility of PuCoGa_5 is Curie-Weiss-like with an effective moment of $0.68 \mu_B$, close to that expected for Pu^{3+} ; (2) its Sommerfeld specific heat coefficient of 77 mJ/moleK^2 indicates that electronic correlations cannot be ignored; and, (3) isostructural UCoGa_5 is a Pauli paramagnet with much smaller Sommerfeld coefficient and is not superconducting above 0.3 K. Rather than a conventional superconductor, PuCoGa_5 appears to be more nearly analogous to the isostructural heavy-fermion superconductor CeCoIn_5 in which antiferromagnetic spin fluctuations mediate Cooper pairing. Also as in CeCoIn_5 , the $T=0$ orbital upper critical field of 74 T in PuCoGa_5 exceeds the Pauli limit by nearly a factor of two. In a scenario of magnetically mediated superconductivity, the almost order of magnitude higher T_c in PuCoGa_5 would be attributed to stronger 5f-ligand hybridization. Perhaps PuCoGa_5 bridges two classes of unconventional superconductors—the heavy-fermion systems and high- T_c cuprates.

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