Unified picture of electron correlations in Pu and Pu115 family of unconventional superconductors

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PuCoGa5, discovered in 2002, has the highest critical temperature of 18.5 K among heavy-fermion superconductors, that is one order of magnitude higher than for typical heavy-fermion compounds. In this work we address electron correlation effects in $PuCoGa_5$ making use of a combination of the local density approximation (LDA) with an exact diagonalization (ED) of the Anderson impurity model. The band structure obtained by the relativistic version of the full-potential linearized augmented plane wave method (FP-LAPW) is extended to account for the f-orbital atomic multiplets and their hybridization with the conduction bands. We show that the unconventional character of superconductivity in the Pu-115 compounds and the unusual physical properties of delta-Pu, in particular the unexpected absence of magnetism, may have a common origin in the intermediate-valence nature of the Pu 5f-electron ground state. The local 5f magnetic moment is compensated by a moment in the surrounding cloud of conduction electrons, and the Anderson impurity grounds state is a non-magnetic singlet. On the basis of these results, we discuss the role of spin and charge fluctuations for Cooper pairing, and the nature of the unconventional d-wave superconducting state in $PuCoGa_5$.