Are superconductivity and quantum criticality convoluted in heavy-fermion metals?

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Heavy-fermion (HF) metals have emerged as prototypical systems to study unconventional superconductivity and quantum criticality. The extent to which the existence of an antiferromagnetic (AF) quantum critical point (QCP) may assist HF superconductivity is discussed. As exemplary materials for the two different QCP scenarios discussed for HF metals, I have chosen the isostructural compounds $CeCu_2Si_2$ and $YbRh_2Si_2$. $CeCu_2Si_2$ shows superconductivity in the neighborhood of a spin-density wave (SDW) instability with three-dimensional critical fluctuations. Recent inelastic-neutron-scattering experiments strongly suggest that, in this material, SDW fluctuations are directly involved in the superconducting pairing mechanism. $YbRh_2Si_2$ exhibits a novel type of AF QCP which appears to coincide with a break down of the Kondo effect, i.e., a disintegration of the heavy charge carriers. In this compound, no sign of superconductivity can be detected down to mK temperatures. A brief survey on other HF superconductors is added which, however, does not allow one to conclude a clear-cut correlation between the type of quantum criticality and the occurrence of unconventional superconductivity.

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