Triplet pairing mechanisms from hund's-kondo models - applications to heavy fermion superconductors

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Almost all heavy-fermion candidate-triplet superconductors share the common structural motif of two or more U/Ce sublattices in the unit-cell separated by an inversion center. We present a pairing mechanism for triplet superconductivity that is enabled by such a locally non-centrosymmetric structure. Extremely high upper critical fields in these materials suggest the importance of local pairing scenarios with coherence lengths comparable to the lattice spacing. For instance, UTe_2 remains superconducting at fields above 60T, suggesting a coherence length shorter than 2nm. A legitimate driver of these local triplet pairing correlations is atomic Hund's coupling, which leads to pre-formed triplet pairs between the electrons trapped inside local moments. The sublattice degree of freedom allows these onsite spin-triplet pairs to acquire odd-parity form factors as they Kondo-hybridize with the dispersive electrons, leading to a pairing instability in a triplet channel. We show how the Hund's coupling modifies the Kondo hybridization leading to an anisotropic ``triplet'' Kondo coupling. Using a simple two-channel Kondo model, derived from a minimal mixed-valent construction with Hund's coupling, we demonstrate the emergence of odd-parity spin-triplet superconductivity in a mean-field calculation, and estimate the scaling of the superconducting critical temperature with the Kondo temperatures. This unifies the emergence of triplet superconductivity with the Kondo hybridization in a coherent framework, and we discuss the experimental implications of this pairing mechanism, and its broad implications for a diverse class of heavy fermion materials that share this structural motif.

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