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Charge Aspects of Composite Pair Superconductivity

REBECCA FLINT, Iowa State University

Conventional Cooper pairs form from well-defined electronic quasiparticles, making the internal structure of the pair irrelevant. However, in the 115 family of superconductors [1-3], the heavy electrons are forming as they pair and the internal pair structure becomes as important as the pairing mechanism. Conventional spin fluctuation mediated pairing cannot capture the direct transition from incoherent local moments to heavy fermion superconductivity, but the formation of composite pairs favored by the two channel Kondo effect can [4]. These composite pairs are local d-wave pairs formed by two conduction electrons in orthogonal Kondo channels screening the same local moment. Composite pairing shares the same symmetries as magnetically mediated pairing, however, only composite pairing necessarily involves a redistribution of charge within the unit cell originating from the internal pair structure, both as a monopole (valence change) and a quadrupole effect [5]. This redistribution will onset sharply at the superconducting transition temperature. A smoking gun test for composite pairing is therefore a sharp signature at Tc - for example, a cusp in the Mossbauer isomer shift in $NpPd_5Al_2$ or in the NQR shift in (Ce,Pu)$CoIn_5$.

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