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Temperature dependence of the pair coherence and healing lengths for a fermionic superfluid throughout the BCS-BEC crossover

The pair correlation function and the order parameter correlation function probe, respectively, the intra-pair and inter-pair correlations of a Fermi gas with attractive inter-particle interaction. Here, these correlation functions are calculated in terms of a diagrammatic approach, as a function of coupling throughout the BCS-BEC crossover and of temperature, both in the superfluid and normal phase across the critical temperature T_c . Several physical quantities are obtained from this calculation, including the pair coherence and healing lengths, the Tan's contact, the crossover temperature T^* below which inter-pair correlations begin to build up in the normal phase, and the signature for the disappearance of the underlying Fermi surface which tends to survive in spite of pairing correlations. A connection is also established with experimental data on the temperature dependence of the normal coherence length as extracted from the proximity effect measured in high-temperature (cuprate) superconductors.

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