Anomalous Effect of Disorder on Spin fluctuations in Noncentrosymmetric Superconductors

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The spin susceptibility tensor $\chi_s^{ij}(T)$ of an impure superconductor with broken mirror symmetry has been evaluated and a great effect of impurity scattering has been shown. The absence of central symmetry is known to give rise to the band spin-orbit coupling. In the case of SCs of polar symmetry, the corresponding term in the one-particle Hamiltonian has the form

$$H_{so} = \alpha(\mathbf{p} \times \mathbf{c}) \cdot \vec{\sigma},$$

where $\mathbf{p}$ and $\vec{\sigma}$ are, respectively, the electron momentum and the Pauli matrices, and the unit vector $\mathbf{c}$ points along the polar axis. This coupling lifts the spin degeneracy of the conduction electrons forming the energy branches with positive and negative helicities - the projections of the spin of an electron with the momentum $\mathbf{p}$ on the direction $\mathbf{c} \times \mathbf{p}$. The one-particle Green's function averaged over impurities positions is diagonal in the helicity index. However, off-diagonal components of two-particle Green's function which determines $\chi_s(T)$ appear to be just as important as diagonal components. All possible scattering channels are shown to contribute comparably into the susceptibility. As a result, as opposed to conventional singlet superconductors, where the ordinary impurity scattering is known to have no effect on $\chi_s(T)$, the spin susceptibility of a polar symmetry superconductor with s-wave pairing can be isotropic and equal to its value in the normal state in the "dirty" limit $T_c\tau \ll 1$, while the superconductor stays in a full-gap state. The effect is bound up with spin-flip transitions which accompany the electron scattering in conductors with the band spin-orbit coupling.

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