Topological phase transition between the gap and the gapless superconducting states

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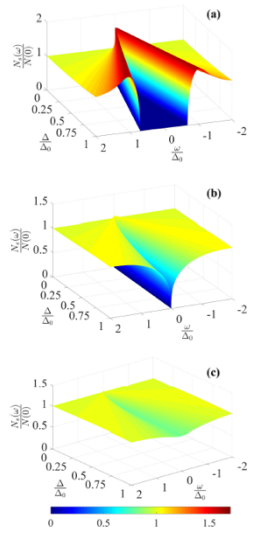
It is demonstrated that the quantum phase transition between the gap and gapless superconducting states in the Abrikosov-Gor'kov theory of superconducting alloy with paramagnetic impurities is of the Lifshitz type, i.e. of the $2\,{}^{1}/_{2}$ order. This phase transition has a topological nature and is characterized by the corresponding change of the topological invariant, namely the Euler characteristic. We study the stability of such a transition with respect to the spatial fluctuations of the magnetic impurities critical concentration n_s and show that the requirement for validity of its mean field description is unobtrusive: $\nabla \ln(n_s) \ll \xi^{-1}$(here ξ is the superconducting coherence length). Finally, we show that, similarly to the Lifshitz point, the $2\,{}^{1}/_{2}$ order phase transition should be accompanied by the corresponding singularities, for instance, the superconducting thermoelectric effect has a giant peak exceeding the normal value of the Seebeck coefficient by the ratio of the Fermi energy and the superconducting gap.



Topological evolution of the quasiparticle density of states.