Topological phase transition between the gap and the gapless superconductors

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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 impurity's critical concentration nn_{SS} and show that the requirement for validity of its mean field description is unobtrusive: $\nabla \ln(nn_{SS}) \ll \xi\xi^{-1}$(here $\xi\xi$ 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.

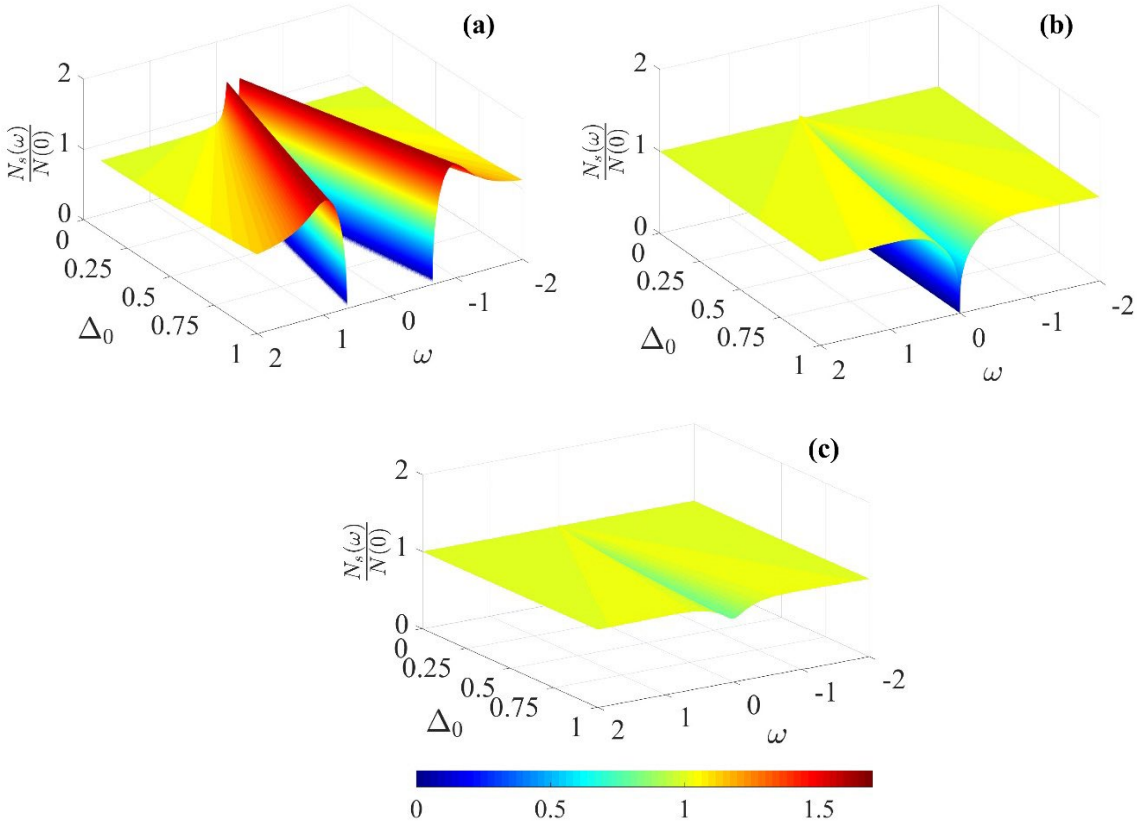

Figure. Topological evolution of the density of states in the phase space *order parameter-energy* during the gap-gapless transition.