# Interference effects in layered superconducting structures

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It is known from the literature (see [1-3] and earlier references therein) that the quasiclassical Green's function theory of superconductivity fails to give correct observables, e.g, the density of states or the Josephson current, when the theory is applied to integrable geometries like mesoscopic layered structures. The purpose of the talk is to demonstrate the deviation of the quasiclassical predictions from "exact" theory and to clarify physics behind the difficulties met by the quasiclassical method.

To test the quasiclassical approach, "exact" results are derived by a two step procedure: (1) solving equation for the Gor'kov matrix Green's function [1,2] or, equivalently, the Bogoliubov - de Gennes equation [3]; (2) averaging the solution in a small region of the configurational space to evaluate "exact" coarse-grained observables free from irrelevant oscillations on the Fermi wave length. In the quasiclassical approach, the Green's function $\hat{g}$ is found from the Eilenberger type equations supplemented with the interface boundary condition [4]. Comparison shows a noticeable difference between the observables obtained by the two methods if the number of interfaces exceeds two [3]. Besides, it turns out that the quasiclassical normalization condition $\hat{g}^2 = 1$ is violated [2]. The failure of the quasiclassical method is attributed to the presence of loop-like trajectories, which are common in the multi-layer geometry with ideal interfaces. The interference of waves having different electron-hole character and propagating along a loop in the opposite directions, gives the contribution which is missing in the quasiclassical theory [4,5].

[1] M. Ozana, A. Shelankov, J. Low Temp. Phys. **123**, 223 (2001).
[2] M. Ozana, A. Shelankov, Phys. Rev. **B65**, 014510 (2002).
[3] M. Ozana, A. Shelankov, and J. Tobiska, Phys. Rev. **B66**, 054508, (2002)
[4] A. Shelankov, and M. Ozana, Phys. Rev. **B61**, 7077 (2000)