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# M1Po2D-05 [48]: The implementation of Rashba-type asymmetric spin-orbit coupling in the theory of superconductivity: the strong-coupling approach

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The analysis of superconducting properties in the presence of spin-orbit coupling is the subject of many scientific papers published in recent years. Unfortunately, the understanding of the problem is insufficient due to the fact that the theoretical results have been obtained using too simple models.

The main purpose of the research is to derive full thermodynamic equations for phonon-induced superconducting state in the presence of Rashba-type asymmetric spin-orbit coupling. Conventional Eliashberg approach, based on the 2x2 matrix Green's function, does not take into account thermodynamic functions related to the spin-orbit interaction. Currently, even the most advanced works on phonon-induced superconducting state, formed in the presence of spin-orbit coupling, use classical Eliashberg equations, while the spin-orbit interaction is included only in the Eliashberg function. Therefore, the analysis of the problem is incomplete as the additional interaction also changes the very form of Eliashberg equations.
The starting point of our generalized formalism is the Fröhlich Hamiltonian complemented by the spin-orbit coupling operator. The fundamental element of the analysis is also the definition of the four-component Nambu spinors, which allow to create a 4x4 matrix Green's function (taking into account Green's scalar functions corresponding to the spin-orbit interaction). During the calculations, no additional approximations were used, except those that are normally used in the derivation of classical Eliashberg equations, i.e. the Migdal's and Wick's theorems.

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