Relativistic theory of superconductivity: BCS vs Bogolubov de Gennes approaches.

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Recently, the renewed interest in the relativistic formulation of the theory of superconductivity has been noted. The generalisations of the BCS theory in the Gorkov-Nambu Green’s functions formulation and the Bogolubov-de Gennes mean field approach have been proposed. In both cases one starts with the relativistic Dirac equations for fermions and constructs proper order parameter by making use of the relativistic four-spinors and symmetries. The full set of relativistic order parameters consist of 16 components which can be grouped in 5 different sets behaving as scalar (1 component), four-vector (4 components), pseudoscalar (1 component), axial vector (4 components) and antisymmetric tensor (6 components). (see: Klaus Cappele, ”Relativistic theory of superconductivity: Foundations and applications to magnetooptics”, PhD thesis, Würzburg, 1997).

In this work we shall present both above mentioned approaches and results of our numerical calculations of the superconducting parameters (temperature dependence of the gap function, transition temperature, specific heat etc.) for few different symmetries of the order parameter. We shall discuss relevance of the relativistic theory to newly discovered superconductors, particularly those containing heavy elements with strong spin orbit coupling.