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Competition between FFLO and BCS superconducting states in clean asymmetrical ferromagnet-superconductor structures

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Abstract

The theory of proximity effect, based on the boundaryvalue problem for the Eilenberger function in view of the in-plane Fulde-Ferrell-Larkin-Ovchinnikov (FFLO) states, is proposed for thin asymmetrical structures FS, where F is a ferromagnetic metal and S is a BCS superconductor. The dependencies of critical temperature on an exchange field of the F metal, electronic correlations in the S and F metals, and thicknesses of layers F and S are calculated for four-layered FS systems and FS superlattices. A proposed classification of states includes up to 8 different states which are characterized by phase shifts between superconducting order parameters for neighboring S(F) layers and mutual orientation of magnetizations in adjacent F layers. For asymmetrical FS systems the solitary reentrant superconductivity is predicted. It is shown that the 2D-FFLO state prevails over the BCS one on the solitary peaks wings. The real candidate for observing predicted phenomena is Gd/La system, for which we found the sign and value of the constant of electronelectron interaction in gadolinium and explain the experimentally observed absence of the suppression of three dimensional superconductivity for symmetrical Gd/La superlattice. © 2014 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.

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Keywords

BCS, Ferromagnetism, FFLO, Layered heterostructure, Proximity effect, Superconductivity