Journal of Physics: Conference Series 2012 vol.394 N1

The superconducting phase transitions for the asymmetrical FS superlattices with interelectronic interaction in ferromagnet layers

Khusainov M., Proshin Y.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

The superconducting and magnetic states coexistence in the FS superlattice, where F is ferromagnetic metal and S is superconductor, is investigated on base of microscopically derived boundary value problem for the Eilenberger function. The asymmetrical four-layered structure FSF' S' is considered as elementary cell. The second order phase transitions are explored for case of ideal boundary transparencies and clean Cooper limit. Each layer is characterized by its own thickness and electronic structure. Materials are also differed by electron-electron interaction constants (note these constants for ferromagnets are nonzero!). It is shown, that 0- and π-phase superconducting states of clean thin superlattices FS are defined by value and sign of electronic correlations in all four layers of elementary cell. The competition between uniform BCS pairing and non-uniform Fulde-Ferrell-Larkin-Ovchinnikov pairing are also taken into account. We predict that the complex system under consideration may have up to 8 different states which are characterized by phase shifts between superconducting order parameters in S(F) and S'(F') and mutual orientation of magnetizations in the F and F' layers. The states with π-phase magnetism can fully explain surprising experimental behavior of short-range Gd/La superlattice, i.e the coincidence of superlattice critical temperature Tc with Tc(La) = 5 K for different thickness of the Gd layers exceeding the La layer thickness.

http://dx.doi.org/10.1088/1742-6596/394/1/012017