SUPERCONDUCTOR-FERROMAGNET NANOSTRUCTURES

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A strong exchange field acting on the Cooper pairs in the ferromagnetic (F) metal leads to the damping oscillatory behaviour of the superconducting order parameter inside the F layer. In consequence in the superconductor-ferromagnet (S-F) multilayers the critical temperature and Josephson current depend in an oscillatory manner on the exchange field and thickness of ferromagnetic metal [1].

These oscillations are related with the transition into the state where the phase of superconducting order parameter is opposite in S-F-S Josephson junction. Such π-junction incorporated in a superconducting circuit may generate a spontaneous current. Moreover, Josephson junction where the weak link is formed by a noncentrosymmetric ferromagnet has very interesting properties. The ground state of this junction is characterized by the finite phase difference φ_0, which is proportional to the strength of the spin-orbit interaction and the exchange field in the normal metal [2]. Such φ_0- junction gives a direct coupling between the superconducting current and the magnetic moment. The superconducting current could flip the magnetic moment and inversely the ac Josephson effect may generates a magnetic precession providing then a feedback to the current [3]. The superconductor-ferromagnet nanostructures open very interesting perspectives for the superconducting spintronics.

In addition the interplay between superconductivity and magnetism in (F/S/F) spin-valve sandwiches provides an interesting switching effect. When the superconductor layer thickness is smaller or of the order of the superconducting coherence length, its critical temperature is controlled by the proximity effect due to the strong exchange field in F region. Therefore the critical temperature and other superconducting characteristics strongly depend on the mutual orientation of the magnetization in F layers. This means that a weak magnetic field would trigger a very strong variation of the resistivity.

Domain structure in ferromagnet may provoke in S-F bilayer the appearance of the superconductivity localized near the domain wall. Inversely, under certain conditions, the superconductivity could trigger the transition into a short period domain state in the F layer.

References:

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