Josephson effect in superconductor/ferromagnet structures with a complex weak-link region

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Abstract

The critical currents IC of SNF-FN-FNS, SN-FN-NS, and SNF-N-FNS Josephson junctions (S—superconductor, F—ferromagnetic, N—normal metal) with complex SNF or SN electrodes (N or NF bilayer are situated under a superconductor) are calculated in the framework of linearized Usadel equations for arbitrary overlap length d of SN interface. We demonstrate that in these geometries, in the case of large resistances of SN interfaces, the critical current can exceed that in ramp-type junctions. Based on these results, the choice of the most practically applicable geometry is discussed. We predict that in a certain parameter range there is single $0-\pi$ transition with the increase in the overlap length d. This single transition can be realized also in SFN-N-FNS Josephson junctions, where the coherence length in the weak-link region is a real quantity. Further, we predict that in SNF-N-FNS Josephson junctions $0-\pi$ transition may take place with increase in distance between superconducting electrodes.