

# Josephson effect in superconductor/ferromagnet- normal/superconductor structures

Karminskaya T. Yu., Golubov A. A., Kupriyanov M. Yu.,  
Sidorenko, A. S.

<https://doi.org/10.1103/PhysRevB.79.214509>

## Abstract

The critical current  $I_C$  of superconductor/ferromagnet-normal/superconductor (S/FN/S) Josephson junctions is calculated in the framework of linearized Usadel equations. The dependence of  $I_C$  on the distance  $L$  between superconductors and thicknesses  $d_{F,N}$  of ferromagnetic and normal layers is analyzed. It is shown that  $I_C(L, d_F)$  may exhibit damping oscillations as a function of both arguments. The conditions have been determined under which the decay length and period of oscillation of  $I_C(L)$  at fixed  $d_F$  are on the order of decay length of superconducting correlations in the N metal,  $\xi_N$ , that is much larger than in F film. We demonstrate also that the positions of the points  $L=L_n$ , at which  $I_C=0$  exhibit damping oscillations as a function of  $d_F$ . The number of transitions from 0 to  $\pi$  states in  $I_C(L, d_F)$  increases under  $L \rightarrow L_n$ . Outside these narrow intervals of  $L$  around  $L_n$  sign and value of  $I_C$  are independent on  $d_F$  for  $d_F \gtrsim \xi_F$ . This fact is important for possible applications of S/FN/S Josephson junctions and S/FNF/S spin valve Josephson devices.