# Spin filtering of triplet Cooper pairs and their interaction with triplet Cooper condensate.

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**Abstract**

We consider two types of magnetic Josephson junctions (JJ) in which filtering of different components of Cooper pairs (singlet and triplet) occurs, so that the coupling between superconductors is mediated via the long-range triplet component (LRTC). Filtering in the first type (M-type) is realized via a magnetic insulator, whereas in the second type (N-type)—via a strong diffusive ferromagnet. Both filters pass only electrons with spins parallel (or antiparallel) to the $z$ axis. Using the quasiclassical Green's functions approach we show that in the M-type of JJs the LRTC Cooper pairs interfere and the Josephson charge current $I_{\rm Q}$ is not zero only if the filters at the right and left banks are oriented in the same direction. In the N-type of JJs, the current $I_{\rm Q}$ does not depend on mutual orientation (parallel or antiparallel) of the exchange field in strong ferromagnets. The spin current $I_{\rm sp}$ in the M-type JJ is not zero at non-zero $I_{\rm Q}$ and changes sign with reversing the sign of the filtering axes. The current $I_{\rm sp}$ in the N-type JJ may be absent at $I_{\rm Q} \neq 0$.

We also show that the fully polarized triplet s-wave component is characterized not only by the spin direction but also by chirality. Interaction of a polarized triplet component and a singlet one results in creation of triplet Cooper pairs with opposite spin direction or of different chiralities. Such spin transformation leads to interesting phenomena in multiterminal magnetic Josephson junctions. In particular, we consider a three-terminal Josephson junction with an additional S superconductor attached to the normal wire. In the absence of this superconductor, the antiparallel filtering would block the current from the left to the right superconductor but now a finite current appears. The currents through the right (left) superconductors are opposite in sign, $I_{\rm R} \equiv I_{\rm J} = I_{\rm c}\sin(\chi_{\rm R} + \chi_{\rm L} - 2\chi) = -I_{\rm L}$, where $\chi_{\rm L/R}$ are phases of the left and right superconductors and $\chi$ is the phase of the additional superconductor. We discuss possibilities of experimental observation of the effect.