

Erratum: Quasiclassical theory of superconducting spin-splitter effects and spin-filtering via altermagnets [Phys. Rev. B **110, L140506 (2024)]**

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In this Erratum, we correct one of the predictions made in the original paper.

We consider a two-dimensional SC-AM-SC heterostructure, schematically shown in Fig. 1. The out-of-plane direction is denoted by z , while x labels the direction of the supercurrent, shown with a purple arrow in Fig. 1. In the original paper, we found that a supercurrent flowing along the x direction induces opposite magnetizations polarized along the $\pm z$ axis at the upper and lower AM-vacuum interfaces. Such an effect is consistent with a phenomenological relation of the form

$$\mathbf{M} \sim \alpha \mathbf{j} \times \mathbf{n}, \quad (1)$$

where $\mathbf{j}$ is the supercurrent density, $\mathbf{n}$ is the interface normal, and α parametrizes the altermagnetic coupling.

We now show that this effect is forbidden, as Eq. (1) is not internally consistent with respect to time-reversal symmetry. Consider the minimal altermagnetic Hamiltonian

$$\hat{H}_{\text{AM}}(\alpha) = \alpha \sigma_z T_{ij} \hat{p}_i \hat{p}_j, \quad (2)$$

where σ_z is the Pauli- z matrix, T_{ij} is a symmetric tensor, and the summation is implied by repeated indices. Under application of the time-reversal operator $\hat{T}$, $p_i \rightarrow -p_i$ and $\sigma_z \rightarrow -\sigma_z$, the altermagnetic term changes sign, such that

$$\hat{T} \hat{H}_{\text{AM}}(\alpha) \hat{T}^{-1} = H_{\text{AM}}(-\alpha). \quad (3)$$

The magnetization operator $\hat{\mathbf{M}}$, arising from spin accumulation, is odd under time reversal,

$$\hat{T} \hat{\mathbf{M}} \hat{T}^{-1} = -\hat{\mathbf{M}}, \quad (4)$$

and the same holds for the supercurrent,

$$\hat{T} \hat{\mathbf{j}} \hat{T}^{-1} = -\hat{\mathbf{j}}. \quad (5)$$

At zero temperature, the expectation value of the magnetization operator is

$$\mathbf{M}(\alpha) = \langle \psi(\alpha) | \hat{\mathbf{M}} | \psi(\alpha) \rangle, \quad (6)$$

where $|\psi(\alpha)\rangle$ is the lowest energy eigenstate of the full Hamiltonian $\hat{H}(\alpha)$. It follows from Eq. (3) that $\hat{T} |\psi(\alpha)\rangle$ is an eigenstate of $\hat{H}(-\alpha)$, i.e., we identify

$$\hat{T} |\psi(\alpha)\rangle = |\psi(-\alpha)\rangle. \quad (7)$$

Consequently, using this result (7) and the symmetry of the magnetization operator (4), we find that the expectation value of the magnetization satisfies

$$\mathbf{M}(\alpha) = \langle \psi(\alpha) | \hat{\mathbf{M}} | \psi(\alpha) \rangle = -\langle \psi(\alpha) | \hat{T} \hat{\mathbf{M}} \hat{T}^{-1} | \psi(\alpha) \rangle = -\langle \psi(-\alpha) | \hat{\mathbf{M}} | \psi(-\alpha) \rangle = -\mathbf{M}(-\alpha), \quad (8)$$

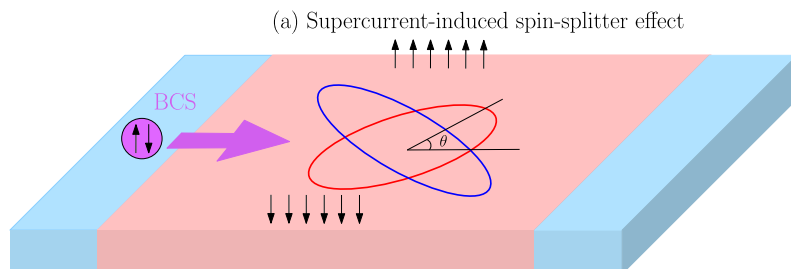


FIG. 1. The first of three predicted effects made in the original paper.

and analogously for the expectation value of the supercurrent, $\mathbf{j}(\alpha) = -\mathbf{j}(-\alpha)$. Combining these relations with the phenomenological form in Eq. (1), we obtain

$$\mathbf{M}(\alpha) = c\alpha\mathbf{j}(\alpha) \times \mathbf{n} = -\mathbf{M}(-\alpha) = -c(-\alpha)\mathbf{j}(-\alpha) \times \mathbf{n} = -\mathbf{M}(\alpha), \quad (9)$$

where c is some constant.

Equation (9) implies that any magnetization generated by the supercurrent must vanish, i.e., $M_z = 0$. Consequently, the spin-splitter effect shown in Fig. 1(a) and plotted in Fig. 2 of the original paper is incorrect. This discrepancy arises from an incorrect application of the boundary conditions.

We emphasize, however, that the other two effects predicted in the original paper, Cooper-pair spin splitting and Cooper-pair spin filtering, remain valid and are not affected by this issue.

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[1] T. Kokkeler, I. Tokatly, and F. Sebastian Bergeret, [SciPost Phys.](#) **18**, 178 (2025).