Proximity effect in thin-film superconductor/helimagnet bilayers

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Currently, some van der Waals (vdW) structures with non-collinear magnetic order are known. While collinear ferromagnetic and antiferromagnetic orders have been discovered in numerous 2D vdW magnets, the noncollinear magnetic order is rarely explored experimentally. Experiment [1] revealed helimagnetism in the NiI2 monolayer. Helimagnetism is a typical noncollinear magnetic order, in which constitute local spins gradually rotate on its spin spiral plane, causing the trajectory of the spin vectors to form a spiral. The proximity effect between a helimagnet and a superconductor causes unusual superconducting correlations that can lead to new phenomena in the system. This means that helimagnetic superconductors may have unique properties that are not found in conventional superconductors, which makes them promising candidates for spintronic applications.
In this paper, the proximity effect and spin current in a helimagnetic superconductor, which is the simplest model of a thin-film superconductor/helimagnet bilayer, are investigated. Considering the order parameter to be set, the flow of a non-dissipative spin current in a helimagnetic superconductor and the interaction of the current with a spin spiral are studied. In the formalism of Green's functions and Gorkov's equations, superconducting correlations are investigated and effects not inherent in previously studied structures with a collinear type of magnetic order: ferromagnetic and antiferromagnetic are revealed.

References

[1] Miao, M. P., Liu, N., Zhang, W. H., Wang, D. B., Ji, W., & Fu, Y. S. (2023). Spin-resolved imaging of atomic-scale helimagnetism in monolayer NiI2. arXiv preprint arXiv:2309.16526.