Electromagnetic proximity effect in planar superconductor-ferromagnet structures

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The spread of Cooper pairs in a ferromagnet in proximity coupled superconductor-ferromagnet structures is shown to cause a strong inverse electromagnetic phenomenon, namely, the long-range transfer of the magnetic field from the ferromagnet to the superconductor. Contrary to the previously investigated inverse proximity effect resulting from the spin polarization of a superconducting surface layer, the characteristic length of the above inverse electrodynamic effect is of the order of the London penetration depth, which usually is much larger than the superconducting coherence length. The corresponding spontaneous currents appear even in the absence of the stray field of the ferromagnet and are generated by the vector-potential of magnetization near the S/F interface, and they should be taken into account in the design of nanoscale S/F devices. Similarly to the well-known Aharonov-Bohm effect, the discussed phenomenon can be viewed as a manifestation of the role of vector potential in quantum physics.