Spin screening of magnetization due to inverse proximity effect in superconducting/ferromagnetic bilayers

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When ferromagnetic (F) films are deposited on top of the superconductors (S) they acquire certain superconductor properties. This is well known proximity effect which gives rise to a number of spectacular phenomena: superconductor critical current oscillations versus the thickness of the ferromagnet, long range triplet superconductivity, *etc.* These effects have been already observed experimentally. However, the inverse proximity effect, namely when the superconductor inherits the ferromagnetic properties is the subject which so far has not attracted as much attention by the experimentalist.

Here, we present the transport and optical studies of the inverse proximity effect in superconductor ferromagnetic bilayers. We have measured magnetoresistance of a e-beam lithographically patterned 200 nm thick Pb discs with diameters in the range 2–5 μm, deposited on the top of a 5 nm Ni film. The magnetoresistance curve exhibits relatively strong anomalous hysteresis (10 G wide). The direction of the hysteresis coincides with the direction of magnetization in Ni, indicating that the field induced in Pb has opposite direction to Ni magnetization, and it is a result of the magnetization induced in Pb. The hysteresis increases as the diameter of the superconductor (Pb) disc decreases. This is expected since the demagnetization factor is reduced when the ratio of the height of the disc to its diameter is decreased.

Magneto-optical measurements of the polar Kerr effect using a zero-area-loop Sagnac magnetometer on Pb/Ni and Al/(Co-Pd) proximity-effect bilayers show unambiguous evidence for the "inverse proximity effect," in which the ferromagnet (F) induces a finite magnetization in the superconducting (S) layer [1]. To avoid probing the magnetic effects in the ferromagnet, the superconducting layer was prepared much thicker than the light's optical penetration depth. The sign (diamagnetic) and size of the effect, as well as its temperature dependence agree with recent theoretical predictions [2] and they are consistent with our transport studies.

1. Jing Xia, V. Shelukhin, M. Karpovski, A. Kapitulnik and A. Palevski, accepted to *Phys. Rev. Lett* (2008); cond-mat arXiv:0810.2605.
2. F. S. Bergeret, A. F. Volkov, and K. B. Efetov, *Phys. Rev. B* **69**, 174504 (2004).