Nanoscale physics

Emergence of long-range triplet correlations in a nanoscale metallic ferromagnet/singlet superconductor bilayer

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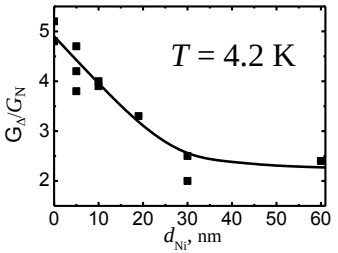
Coexistence of superconductivity and ferromagnetism is a long-standing problem in solid-state physics. One of the possibilities to observe the interplay between itinerant electron ferromagnetism (F) and superconductivity (S) is to put the two metallic nanoscale films into a contact. In this case, spin-mixing effects can arise at the FS interface as a result of different matching conditions for spin-up and spin-down wave functions and lead to long-range triplet components in the F layer [1]. These effects are most effective at interfaces with strong ferromagnets especially when spin-flip centers are present in the FS boundary region.

The aim of our work has been to demonstrate the presence of such triplet correlations in a bilayer formed by a nanoscale strong ferromagnetic Ni film and a conventional singlet superconducting Pb layer. To characterize the effect of the proximized F layer on an S film, we have fabricated a tunnel junction on the S side. The quantity of interest was the ratio of the junction conductance in the S state $G_\Delta = dI(V \cong 2\Delta_{Pb}/e)/dV$, where Δ_{Pb} is the energy gap in Pb, to the normal (N) state conductance G_N assumed to be constant.

In the figure we present our data for a 150 nm-thick Pb layer in contact with a Ni film measured at 4.2 K. It is evident that up to $d_{Ni} \cong 30$ nm the ratio $G_S(V)/G_N$ considerably depends on d_{Ni}. This finding is unexpected since penetration of singlet superconducting correlations into a strong ferromagnet is known to be short-ranged (not more than a few nanometers). We compare the observation with the data obtained for NS bilayers of the same thicknesses. The only explanation can be related to long-range triplet components which are induced in F as well as in S layers due to the FS proximity effect and decay into the two layers on a length scale of the same order as in NS hybrids.



1. *Krivoruchko V. N., D'yachenko A. I., Tarenkov V. Yu.* Point-contact Andreev-reflection spectroscopy of doped manganites: Charge carrier spin-polarization and proximity effects. // Fizika Nizkikh Temperatur.-2013.-**39.**-P. 276-292.