

Tunnelling spectroscopy and Josephson coupling through EuS/Al interfaces.

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Abstract

The magnetic proximity effect (MPE) between a ferromagnet (F) and a superconductor (S) mediates the emergence of spin-triplet correlations in the superconducting condensate, inducing a spin-dependent splitting of its density of states (DOS) [1,2]. Thus, F/S interfaces allow for studying the properties of unconventional superconducting systems, which have already demonstrated important quantum technology applications such as the π -shifted Josephson effect [3].

In this work, we study such F/S interfaces in superconducting tunnel junctions (STJs) in which in which a thin film of the ferromagnetic insulator (FI) EuS is evaporated on top of one of the Al superconducting electrodes. The STJs are defined by the evaporation through shadow masks of EuS/Al/AlOx/Al heterostructures. In the mK temperature regime, the current-voltage characteristics of the junctions reveal a spin-dependent DOS, from which the strength of the magnetic exchange field in the system can be estimated (Fig. 1).

Moreover, the junctions exhibit the Josephson effect, which is studied as a function of the magnetic configuration of the EuS film. We show that the Josephson current is strongly suppressed by a uniform magnetization of the EuS film, while the order parameter of the systems does not seem to be affected as much from the DOS analysis. We also show that the Josephson effect can be recovered by applying a magnetic field close to the coercive field of the EuS film.

We discuss the introduction of our EuS/Al based weak links in a DC-SQUID design, in which the current-phase relation of the system and its dependence on the EuS magnetic state can be revealed.

Our results shed light on the role of F/S interfaces in engineering Josephson effect-based devices and suggest the use of EuS/Al interfaces to mimic an external magnetic field in quantum transport experiments [4,5].

References

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Figures

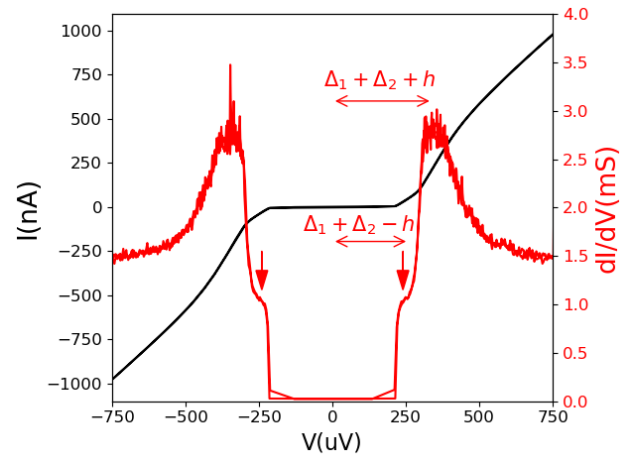


Figure 1: Current-Voltage characteristic of a EuS/Al/AlOx/Al STJ and corresponding dI/dV , revealing the DOS of the condensate.