Experimental observation of Multiple Andreev Reflection at the interface with a spin-split superconductor

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At the interface between a superconductor and a magnetic insulator the magnetic proximity effect induces the emergence of exotic superconducting correlations [1]. These non trivial superconducting phenomena shows significant potential in classical and quantum information processing implications[2,3]. Since the first pioneering experiments on FI/S-interface-based tunnelling junctions, most experimental efforts were focused on the study of S/FI/S structures. At the same time, work on incorporating FI/S interfaces as superconducting electrodes in FI/S/N/S and FI/S/I/S junctions is rather scarce both on the experimental and theoretical side. In such heterostructures, the EuS/Al interface case is particularly relevant in this context, as the fabrication of EuS/Al/AlOx/Al Josephson junctions can benefit from established EuS/Al and Al/AlOx previous work and processing methods [4].

Here, we present a characterization of the electrical properties of vertical EuS/Al/AlOx/Al junctions, in which we observe superconducting transport effects such as multiple Andreev reflection (MAR) resonances and the Josephson effect. By varying the oxidation of the AlOx barrier, we manage to characterize the device in both insulating and highly transparent tunnel barriers. By comparing the experimental data with theoretical modelling, we identify the hallmarks of the interfacial magnetic exchange field in the MAR processes. Our work provides the first experimental characterization of in-gap superconducting transport effects in junctions comprising the EuS/Al interface. Considering that the thickness of the vertical junctions is lesser than the superconducting coherence length of the Al electrodes, our EuS/Al/AlOx/Al junctions could prompt further the study of unconventional superconducting transport phenomena mediated by the proximity effect.

References

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Figures

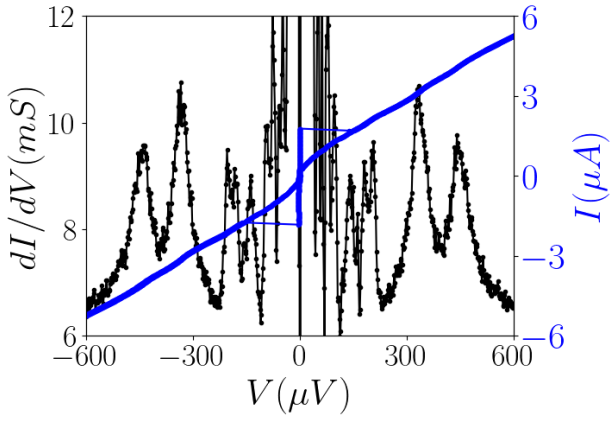

Figure 1: IV and dIdV curve of the EuS/Al based JJ on the transparent regime at 0 B field and base T of 10mK.