Spin-Resolved Tunneling Studies of the Exchange Field in Ferromagnetic/Superconductor Bilayers

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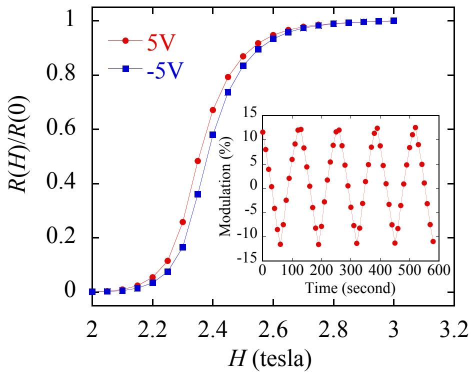
I will give an overview of our spin-resolved studies of the exchange field produced in ferromagnetic/superconductor bilayers [1, 2, 3, 4]. In particular, we are using spin-resolved electron tunneling to probe the exchange field in the Al component of EuS/Al bilayers, in both the superconducting and normal-state phases of the Al. Contrary to expectation, we have found that the exchange field is a non-linear function of applied field, even in applied fields that are well beyond the EuS coercive field. Ours results suggest that interface mechanism that produces the exchange field is not well understood.

We have also incorporated a gate onto our EuS/Al bilayer structures in order to apply an electric field to the EuS-Al interface. The idea is to modulate the interface coupling with an electric field in order to produce a gate-controlled exchange field. So far we have had reasonable success. Below is a plot of the parallel critical field transition in a EuS/Al bilayer where the Al is superconducting, $T_c = 2.7$ K. The data was taken at 0.6 K and the transition occurs when the total internal magnetic field is about 5.5 T. So the exchange field in this case was about 3 T. The two curves in the figure represent the critical field transitions with gate voltages of 5V and -5V respectively. Note that the critical field transition is shifted, indicating that the gate is affecting the exchange field. In the inset we show the resistance of the Al component as a function of gate voltage at the midpoint of the critical field transition. In this case the gate voltage was a triangle wave with a magnitude of 5 V. I will discuss our ongoing efforts to optimize this gating effect, with the goal of producing a gate-controlled superconducting switch.



[1] G. Catelani, Y.M. Xiong, X.S. Wu, and P.W. Adams, Phys. Rev. B **80**, 054512 (2009)
[2] Y.M. Xiong, S. Stadler, P.W. Adams, and G. Catelani, Phys. Rev. Lett. **106**, 247001 (2011).
[3] T.J. Liu, J. C. Prestigiacomo, Y.M. Xiong, and P.W. Adams, Phys. Rev. Lett. **109**, 147207 (2012).
[4] T.J. Liu, J.C. Prestigiacomo, and P.W. Adams, submitted.