Kondo physics in non-local metallic spin transport devices

Liam O'Brien[1], M J Erickson[2], D Spivak[2], H Ambaye[3], R J Goyette[3], V Lauter[3], P A Crowell[2], C Leighton[4]

[1]*Thin Film Magnetism, Cavendish Laboratory, University of Cambridge*
[2]*School of Physics and Astronomy, University of Minnesota*
[3]*Spallation Neutron Source, Oak Ridge National Laboratory*
[4]*Department of Chemical Engineering and Materials Science, University of Minnesota*

Despite the maturity of metallic spintronics there remain large gaps in our understanding of spin transport in metals, particularly with injection of spins across ferromagnetic/non-magnetic (FM/NM) interfaces, and their subsequent diffusion and relaxation. The non-local spin-valve is an enabling device in this context as it allows for the separation of charge and spin currents. One particular issue in metallic non-local spin valves is the widely observed non-monotonicity in the *T*-dependent spin accumulation, where the spin signal actually decreases at low *T*, in contrast to simple expectations.

In this work, by studying an expanded range of FM/NM pairings we demonstrate that this effect is not a property of a given FM or NM, but rather of the FM/NM pair. The non-monotonicity is, in fact, strongly correlated with the ability of the FM to form a dilute local magnetic moment in the NM. We show that local moments, resulting in this case from the ppm-level tail of the FM/NM interdiffusion profile, suppress the injected spin polarization and diffusion length via a novel manifestation of the Kondo effect, explaining all observations associated with the low T downturn in spin accumulation[1]. Through *T*-dependent polarised neutron reflectometry measurements we are able to probe the interfacial magnetisation, crucially ruling out *T*-dependent freezing or non-colinear magnetisation states.

Finally, we discuss the use of thermal annealing to promote the effect, and quenching such suppression via the use of thin non-moment supporting inter layers. Important implications for room temperature devices will be discussed.

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References

1. L. O'Brien, M.J. Erickson, D. Spivak, H. Ambaye, R.J. Goyette, V. Lauter, P.A. Crowell and C. Leighton, Nature Communications 5, 3927 (2014).

Email corresponding author: lao24@cam.ac.uk