Spin-Aharonov-Bohm Effect: Non-adiabatic Geometric Phase

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Introduction

An electron spin interferometer is designed and fabricated from a NLSV. The observation of the non-eigenstate precessing spin current AB effect will experimentally confirm the presence of Aharonov-Anandan's non-adiabatic geometric phase in a mesoscopic thin film [1]. It is also a generalization of Berry's phase which requires adiabatic evolution [2, 3]. Based on the fundamental importance of Berry phases in quantum computation, optics, gravitational field theory, and electronics, the experimental verification of Aharonov-Anandan's non-adiabatic geometric phase represents a major advance that will enable significant new directions for research into mesoscale spin systems and other areas.

Experimental Details, Results and Discussion

Experiments were conducted at the high B/T facility at the NHMFL facility at the University of Florida. Al/MgO/Py non-local spin valves were measured at temperatures from 50 mK to 4.2 K at fields ranging from -40 to +40 mT. Excitingly, for 0.5 uA currents, a very large non-local signal was observed, ~ 200 mOhms for injector and detector separation of 1.7 um. This result is an order of magnitude higher than the highest result reported in the literature to date [4]. On-going work centers on confirming this result at our facility at temperatures down to 1.9K, assuming we can adjust the field sweep rate and lock-in sensitivity appropriately. If we cannot verify these results locally, we would request additional time either at the High B/T Facility or a different NHMFL facility.

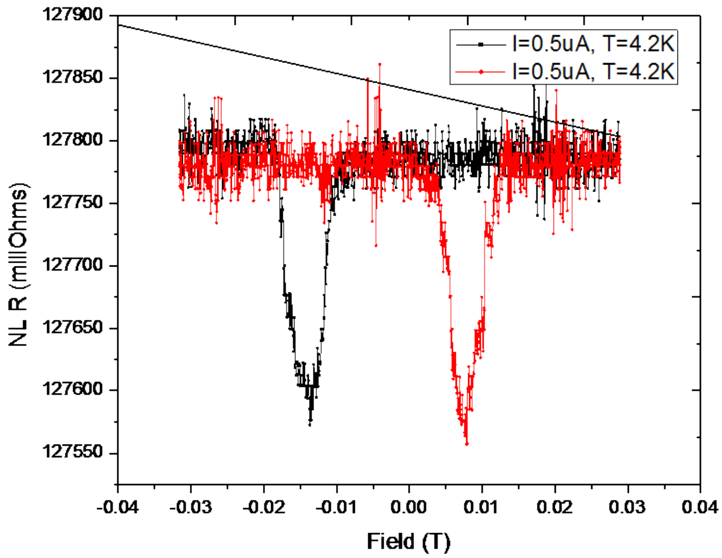

Fig.1 Nonlocal resistance as a function of magnetic field in plane at 4.2K. This DR of 201 mOhms is one order of magnitude larger than the best result reported [4]

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References

[1] Aharonov, Y. and Anandan,J.; *Phys. Rev. Lett.* 58, 1593 (1987).
[2] Webb, R. A., *et al*., *Phys. Rev. Lett.* **54**, 2696 (1985).
[3] Berry, M. V., *Proceedings of the Royal Society A*. **392**, 1802 (1984).
[4] Fukuma Y. *et al., Nature Materials* **10**, 527–531 (2011).