Local Exchange Resonance in DC Magnetoresistance of Spin-Polarized Current Through a Dopant

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Components for quantum information processing and quantum sensing require localized spin-coherent states. These states can be realized in isolated magnetic dopants embedded in a non-magnetic semiconducting host. A critical requirement for utilizing a dopant-based system is an understanding of how the complex host environment influences the coherent spin dynamics at an individual site. In this work we consider the dc magnetoresistance through a spin-1/2 dopant that is addressed by a spin-polarized scanning tunneling microscope (SP-STM) and exchange coupled to an inert spin-1/2 center [1]. The stochastic Liouville formalism is employed to calculate the current through the individual dopant. We predict a substantial increase in resistance at finite magnetic fields due to the formation of a non-trivial bottleneck in the spin-correlated transport. Resonance between the Zeeman and exchange coupling leads to a cancelation in the coherent evolution of the dopant spin resulting in an on-site polarization opposing that of the SP-STM. This feature provides a precise method for measuring the dopant exchange coupling to a nearby electronic spin and by direct analog hyperfine coupling in the presence of nuclear spins. This technique does not require the use of ac electric or magnetic fields and is sensitive to exchange or hyperfine energies well below the thermal energy of the system.

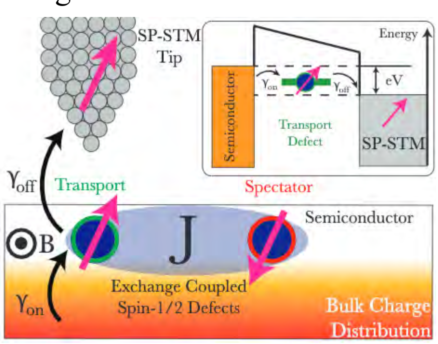

Figure 1: Schematic current path for and electron through a spin-1/2 dopant exchange coupled to a spin-1/2 center.

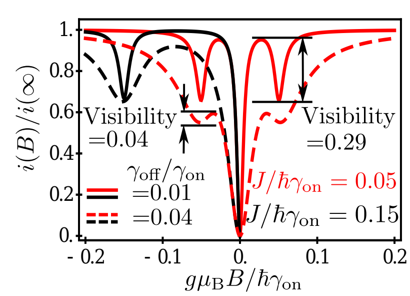

Figure 2: Magnetoresistance of current through spin-1/2 dopant. Features broaden for moderate extraction (dashed) compared to slow extraction (solid).

[1] S.R. McMillan, N.J. Harmon, M.E. Flatté, arXiv:1907.05509 **[cond-mat.mes-hall]**

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