MAR15-2014-020405

Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

Spatially-resolved measurement of spin transport across nanoscale interfaces

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Spintronics uses spin for information processing and storage. Mechanisms for spin relaxation in bulk systems have been extensively studied. However, a clear understanding of few-spin systems remains challenging. We report spatially-resolved magnetic resonance studies of a "spin nanowire" formed by nitrogen vacancies in diamond. The result reveals that the lifetime of the spin ensemble is dominated by spin transport from the ensemble into the adjacent spin reservoir, which is in striking contrast to conventional spin-lattice relaxation measurements of isolated spin ensembles. Electron spin resonance spectroscopy corroborates spin transport in strong field gradients. These experiments, supported by microscopic Monte Carlo modelling, provide a unique insight into the intrinsic dynamics of pure spin currents needed for nanoscale devices that seek to control spins. In addition, we observe a dependence of the damping of a confined mode of precessing ferromagnetic magnetization on the size of the mode. The micron-scale mode is created within an extended, unpatterned YIG film by means of the intense local dipolar field of a micromagnetic tip. The damping of the confined mode scales like the surface-to-volume ratio of the mode, indicating an interfacial damping effect (similar to spin pumping) due to the transfer of angular momentum from the confined mode to the spin sink of ferromagnetic material in the surrounding film. Though unexpected for insulating systems, the measured intralayer spin-mixing conductance of 3×10^{19} m^{-2} demonstrates efficient intralayer angular momentum transfer.