MAR15-2014-020739

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

Time-resolved scanning tunneling microscopy for studies of nanoscale magnetization dynamics

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The time resolution of the scanning tunneling microscope can be boosted greatly by use of electronic pump probe measurement schemes. Pulse shaping of the input pulses can even overcome bandwidth limitations of the instrument and enables sub-nanosecond time resolution [1]. In this talk we will focus on applications of this technique for measurements of fast spin dynamics in nanomagnets. We use the probe tip of a low-temperature STM to arrange magnetic atoms into arrays of our own design. Thin insulating films decouple the atoms from the supporting metallic substrate so that the nanostructures show quantum-magnetic properties with discrete spin states. The time-domain information gained in pump probe spectroscopy quantifies the spin relaxation between metastable spin states [2]. It enables isolating the interaction between the nanomagnet and its environment. In particular, we find that the magnetic atoms of a spin-polarized STM tip interact significantly with the surface even at moderate tunneling conditions. This interaction acts analogously to a highly localized magnetic field. It depends exponentially on the tip-nanomagnet distance and can reach a strength of several tesla. We use this atomically localized magnetic field to control the spin state mixing of a nanomagnet in an avoided level crossing of low-energy spin states [3]. Furthermore, pump probe spectroscopy enables non-local measurements of magnetic states and highlights pathways to design and control magnetism at the single atom level.

[1] C. Grosse, M. Etzkorn, K. Kuhnke, S. Loth, K. Kern, Appl. Phys. Lett. 103, 183108 (2013).
[2] S. Loth, M. Etzkorn, C.P. Lutz, D.M. Eigler, A.J. Heinrich, Science 329, 1628 (2010).
[3] S. Yan, D.-J. Choi, J.A.J. Burgess, S. Rolf-Pissarczyk, S. Loth, Nat. Nanotechnol. doi:10.1038/nnano.2014.281 (2014).