MAR11-2010-000295

Abstract for an Invited Paper
for the MAR11 Meeting of
the American Physical Society

Imaging and Manipulating Single and Interacting Spins on Surfaces: Towards Atomic-Scale Spin Devices

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Spin-Polarized Scanning Tunneling Microscopy (SP-STM) provides new insight into spin structures at a length scale and a sensitivity level which are inaccessible by other magnetic-sensitive measurement techniques [1]. The combination of atomic resolution in direct space, single spin sensitivity, and high energy resolution nowadays offers unique possibilities for probing spin-dependent states and interactions in natural or artificially created nanostructures [2]. The ultimate goal has been the combination of spin-resolved imaging with atomic resolution and magnetometry at the single-atom level in order to probe spin states and magnetic interactions of individual adatoms and nanostructures at solid surfaces quantitatively and in a most direct way. This challenging goal has been achieved by operating a SP-STM system at temperatures below 1 Kelvin and in external magnetic fields up to several Tesla. The new method of single-atom magnetometry with an unprecedented degree of magnetization measurement sensitivity is applicable to metallic [3, 4] as well as to semiconducting [5] and molecular systems [6]. The combination of single-atom manipulation techniques and single-atom magnetometry has recently led to the first demonstration of atomic-scale spin logic devices based solely on spin- rather than charge-transport for realizing computation and information transmission at the atomic level.

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