Controlling the magnetic moment of individual atoms with a STM tip

D. Serrate[1,2], P. Ferriani[2], Y. Yoshida[2], S.-W. Hla[2,3], M. Menzel[2], K. von Bergmann[2], S. Heinze[2,4], A. Kubetzka[2], R. Wiesendanger[2]

1 *Instituto of Nanoscience of Aragon, University of Zaragoza, Campus Rio Ebro, 50018 Zaragoza, Spain*

2 *Institute of Applied Physics and Microstructure Research Center, University of Hamburg, Jungiusstrasse 11, D-20355 Hamburg, Germany*

3 *Nanoscale & Quantum Phenomena Institute, Physics & Astronomy Department, Ohio University, Athens, Ohio 45701, USA*

4 *Institute of Theoretical Physics and Astrophysics, Christian-Albrechts-Universität zu Kiel, Leibnizstraße 15, 24098 Kiel, Germany*

Individual magnetic atoms adsorbed on surfaces are the smallest conceivable units for data storage based on the direction of their magnetic moments. In principle, high magnetic anisotropy might stabilize single atom spins at low temperatures by effectively suppressing thermal switching and quantum tunneling between bistable states. Here, we demonstrate that it is even possible to detect, control, and manipulate the spin of individual atoms in arbitrary directions. We apply spin-polarized scanning tunneling microscopy to investigate single Co atoms adsorbed on an antiferromagnetic spin-spiral formed by a Mn layer on W(110). Because of a strong exchange coupling, the spin of Co atoms is controlled by the position relative to the underlying Mn layer. Remarkably, the net spin directions of individual atoms are manifested in the height and shape of the atoms in spin sensitive images due to the electronic states with spin-dependent orbital symmetry at the Fermi level. We show that atom manipulation by maintaining a magnetic contrast is feasible, thereby enabling the control of atomic spin by lateral atom positioning, which opens a novel route to spin-polarized experiments on artificially designed atomic-scale magnetic structures.