UNH Materials Science Seminar

2:10-3:00 pm, Friday, Nov. 2, 2007
Nesmith Hall Room 110
University of New Hampshire

Imaging the magnetization of individual atoms

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Spin-resolved scanning tunneling spectroscopy (SP-STS) has proven to be the unrivaled method to investigate the magnetism of nanostructures on conducting substrates at the atomic scale. It has been applied to study complex spin structures like magnetic vortices [1], domain walls in antiferromagnets [2], or spin spirals [3]. I will show that we were recently able to increase the magnetic sensitivity of SP-STS to the limit of individual magnetic atoms adsorbed on a nonmagnetic substrate. We measure magnetization curves of cobalt atoms adsorbed on a platinum(111) surface and derive their individual magnetic moments directly. Although the magnetization reversion of the adatoms is hindered by a large barrier corresponding to 100 Kelvin [4], they behave paramagnetic even at a temperature of 0.3 Kelvin, pointing at a temperature independent mechanism. The magnetic moments of the adatoms show an astonishing variance from 2 to 6 Bohr magnetons at very low temperature. We ascribe this variance to a kind of molecular field induced by the statistical distribution of the adatoms together with their mutual RKKY-type indirect exchange mediated by the

substrate. It would be highly desirable to apply this method to magnetic defects in semiconductors, in order to improve our understanding of the local coupling between magnetic acceptors in diluted magnetic semiconductors. As the first step in this direction I will show our recent detailed investigation of the Mn acceptor in InAs using spin-averaged STS in comparison with tight-binding calculations [5].

[1] A. Wachowiak, J. Wiebe, et al.; Science 298, 577 (2002) [2] M. Bode et al.; Nature Materials 5, 477 (2006) [3] M. Bode et al.; Nature 447, 190 (2007) [4] P. Gambardella et al.; Science 300, 1130 (2003) [5] F. Marczinowski, J. Wiebe, J.-M. Tang, et al.; PRL 99, 157202 (2007).

Dr. Jens Wiebe is a subgroup leader in the scanning probe methods group of the Institute of Applied Physics and Microstructure Research Center at the University of Hamburg, Germany. He received his Ph.D. in 2003 from the University of Hamburg where he developed a 300-mK ultra-high-vacuum scanning-tunneling-microscopy facility with a 14-Tesla magnet to study disordered two-dimensional electron systems. He did his diploma thesis on photoacoustic spectroscopy via resonant detection of second sound in superfluid He II at the Ruprecht Karls University of Heidelberg.

Host: Professor Jian-Ming Tang