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Hysteresis Design of Magnetic Materials for Efficient Energy Conversion

Tuesday, 30 June 2020, 10:00-11:00 s.t., Zoom (see below)

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Magnetic sensing at the single atom level

Unraveling many of the current dilemmas in condensed matter and nanoscience hinges on the advancement of techniques which can probe the spin degree of freedom with high spatial and temporal resolution. Scanning tunneling microscopy (STM) has been a preeminent method at probing magnetic properties with single atom precision. For example, we have shown that atomic-scale magnets can be built from individual atoms and its resultant magnetization can be measured (1, 2). Likewise, we have characterized the development of magnetic remanence and its response to spin-transfer torque (3). However, STM methods have traditionally been limited to certain classes of materials, and also face limitations in structural determination, energy and momentum resolution, as well as suffer from poor temporal resolution. In this talk, I will review a number of new state of the art developments in scanning tunneling microscopy, and its application to magnetic characterization of magnetic materials, including single atoms and magnetic films. First, I will discuss the evolution of spin-resolved STM, toward milliKelvin temperature enabling the highest resolution characterization of magnetic surfaces (4, 5). Then I will discuss the implementation of a microwave-wave source within this system, in order to perform GHz pump-probe and electron spin resonance spectroscopy with atomic-scale resolution. I will highlight how time resolution can be utilized to learn about the dynamics and structure of a radical molecule. I will then discuss a method to simultaneously perform spin-resolved STM as well as detect the local exchange force, and its application to detect magnetic interactions with atomic-scale precision (6-8). Finally, I will present an outlook on future perspectives in the field of surface magnetism and the promising application of single spin detection to broader scopes in nanoscience as a whole.

Zoom-Meeting: https://uni-due.zoom.us/j/95771110531?pwd=blY1dDJWT25iWERJc3lsdWIyOStaQT09
Meeting-ID: 957 7111 0531
Passwort: 843516

1. A. A. Khajetoorians et al., Atom-by-atom engineering and magnetometry of tailored nanomagnets. Nature Physics 8, 497-503 (2012).
2. A. A. Khajetoorians, J. Wiebe, B. Chilian, R. Wiesendanger, Realizing All-Spin–Based Logic Operations Atom by Atom. Science 332, 1062-1064 (2011).
3. A. A. Khajetoorians et al., Current-Driven Spin Dynamics of Artificially Constructed Quantum Magnets. Science 339, 55-59 (2013).
4. U. Kamber et al., Self-induced spin glass state in elemental and crystalline neodymium. Science 368, eaay6757 (2020).
5. H. von Allwörden et al., Design and performance of an ultra-high vacuum spin-polarized scanning tunneling microscope operating at 30 mK and in a vector magnetic field. Review of Scientific Instruments 89, 033902 (2018).
6. N. Hauptmann et al., Quantifying exchange forces of a spin spiral on the atomic scale. Nature Communications 11, 1197 (2020).
7. N. Hauptmann et al., Revealing the correlation between real-space structure and chiral magnetic order at the atomic scale. Physical Review B 97, 100401 (2018).
8. N. Hauptmann, J. W. Gerritsen, D. Wegner, A. A. Khajetoorians, Sensing Noncollinear Magnetism at the Atomic Scale Combining Magnetic Exchange and Spin-Polarized Imaging. Nano Letters 17, 5660-5665(2017).