MA 39: Overview Talk: Christopher Lutz (joint session O/MA)

Time: Thursday 9:30–10:15 Location: H15

Invited Talk MA 39.1 Thu 9:30 H15

Magnetic sensing by single-atom spin resonance in an STM

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Electron spin resonance (ESR) is widely used to obtain high energy resolution of magnetic properties in bulk samples. We use a low-temperature STM to perform ESR of individual magnetic atoms on a surface, and employ these atoms as atomic-scale magnetic sensors. This technique combines the high energy resolution of spin resonance with the single-atom control of STM. We drive spin resonance by using the large electric field available in the tunnel junction, and sense the spin by means of magnetoresistance, using a spin-polarized STM tip. Magnetic coupling between two iron atoms placed a few nanometers apart shows inverse-cube dependence on distance, which indicates dipole-dipole interaction. This yields a precise measure of the magnetic moment, which is then used to probe other atoms, such as the magnetic bits formed by individual holmium atoms. The STM can also drive spin resonance of titanium and copper atoms, which show free spin-1/2 behavior, in contrast to the large moment and easy-axis anisotropy of iron. Assembled arrays of low-spin atoms show exchange coupling that results in highly entangled magnetic states. Some isotopes exhibit hyperfine coupling, the interaction between the nucleus and the electrons of an atom, and the ESR spectrum reveals properties of the nucleus and the influence of the local atomic environment. The combination of STM with ESR thus provides a flexible tool for exploring nano-scale magnetism.