MAR16-2016-020467

Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

Richard L. Greene Dissertation Award in Experimental Condensed Matter or Materials Physics Talk: Towards single atom magnets

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Magnetic anisotropy is a fundamental property of magnetic materials that governs the stability and directionality of their magnetization. At the atomic level, magnetic anisotropy originates from anisotropy in the orbital angular momentum (L) and the spin-orbit coupling that connects the spin moment of a magnetic atom to the spatial symmetry of its ligand field environment. Generally, the ligand field, that is necessary for the anisotropy, also quenches the orbital moment and reduces the total magnetic moment of the atom to its spin component. However, careful design of the coordination geometry of a single atom can restore the orbital moment while inducing uniaxial anisotropy, as we present here for single atoms deposited on top of a thin MgO film. Scanning tunneling spectroscopy and x-ray absorption spectroscopy measurements show a large magnetic anisotropy of 19 meV for iron and 58 meV for cobalt, as well as relaxation times of many milliseconds. These results offer a strategy, based on symmetry arguments and careful tailoring of the interaction with the environment, for the rational design of nanoscopic permanent magnets and single atom magnets.