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Abstract

Suppression of Magnetization Tunneling in Rare-Earth Atoms on Surfaces of Various Symmetry †

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In the classical world, it is easy to store a bit of information. One needs a bistable system with a high enough barrier between the two ground states. Such a system is exemplified by a magnetic cluster with uniaxial anisotropy, so that the direction of the magnetic moment encodes the information.

On the nanoscale, a high barrier is not enough. Fourteen years ago, P. Gambardella et al. found that single Co atoms on Pt (111) have high enough anisotropy energy to have stable magnetization at low temperatures [1]. Later investigations [2,3] showed, however, that the magnetization of those atoms and similar systems switches on nanosecond timescales. Interaction with the electron bath of the substrate allows "magnetization tunneling", where the system switches between two ground states aided by elastic electron scattering.

The probability of such switching depends on the symmetry of the ground state wavefunctions, which in turn is determined by the symmetry of the adsorption site and the total angular momentum of the magnetic atom. An appropriate combination of these symmetries leads to a first-order suppression of the tunneling process, stabilizing the magnetic state.

We classify the possible symmetry combinations and analyse recent experimental reports of magnetically stable rare-earth atoms in light of this theory.

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