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Manipulation of magnetic anisotropy of individual metal-organic complexes and their interaction with the substrate

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The magnetic properties of atoms and molecules on a surface are significantly affected by details in the atomic-scale surrounding. Manipulation of this surrounding provides the possibility to tune the electronic and magnetic functionality of surfaces on the nanometer scale. Here, we use scanning tunneling spectroscopy to resolve the magnetic properties of individual paramagnetic metal-organic complexes on normal metal and superconducting surfaces.

Fe-octaethylporphyrin-Cl (FeOEP-Cl) is a paramagnetic complex with ethyl groups, which lift the Fe core from the surface and render the molecule flexible. When these molecules are adsorbed on a Pb(111) or a Au(111) surface, they retain their magnetic moment as evidenced by inelastic spin excitations.

The magnetic anisotropy of the individual molecules can be varied by the proximity of the STM tip. Approaching the tip to FeOEP-Cl leads to an increase in the axial anisotropy. We ascribe this behavior to a modification of the crystal field resulting in a shift of the d-level energies. On a Au(111) surface, additionally, a Kondo resonance appears once the tip is in contact to the molecule, indicating a stronger coupling of the Fe core to the substrate electrons. The Kondo coupling strength continuously increases upon further tip approach.

Removing the central Cl ligand changes the oxidation and spin state, respectively. The spin excitation spectra reveal a notable axial and transverse anisotropy, which are also affected by the presence of the STM tip.