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Magnetic properties of rare earth single atoms on metal substrates APARAJITA SINGHA, ROMANA BALTIC, FABIO DONATI, CHRISTIAN WÄCKERLIN, École Polytechnique Fédérale de Lausanne, JAN DREISER, École Polytechnique Fédérale de Lausanne, Paul Scherrer Institute, LUCA PERSICHETTI, PIETRO GAMBARDELLA, ETH Zürich, STEFANO RUSPONI, HARALD BRUNE, École Polytechnique Fédérale de Lausanne — The interaction of individual rare earth (RE) atoms with single-crystal surfaces leads to magnetic ground and excited states that determine their magnetic properties, e.g., magnetic relaxation time, total magnetic moment, zero-field splitting, and magnetic anisotropy energy. We present a systematic study of several RE elements (Dy, Ho, Er, and Tm) on different metal surfaces (Pt(111), Cu(111), Ag(100), and Ag(111)). Using x-ray absorption spectroscopy and magnetic circular dichroism we reveal two $4f$ configurations, i.e., $4f^n$ and $4f^{n-1}$, where n corresponds to the free atom occupation. We identify two factors governing the valency of these adatoms: (a) the ionization potential of the $4f$ elements and (b) the substrate density of states at the Fermi level. Magnetization loops at 2.5 K reveal that all RE adatoms are paramagnetic, i.e., their magnetic relaxation is faster than about 10 s. Comparison of our experimental spectra with multiplet calculations identify the role of the crystal field in determining the magnetic quantum levels of RE adatoms.

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