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TÉMA

Inelastic Electron Tunneling through an Adatom: Selection Rules and Orbital Exchange

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I investigate tunneling of electrons from an STM tip to a substrate through a magnetic adatom by means of the Anderson impurity model. I employ an approximation analogous to the cotunneling theory [1] and concentrate on f-electron adatoms with large spin-orbital coupling. I compare the obtained inelastic electron tunneling spectra (IETS) with predictions of the spin model that has been very successful in the case of transition-metal adatoms [2]. When the spin model is applied to f electrons, the adatom spin S is replaced with its angular momentum J [3,4]. The spectra calculated in the two models differ, and I trace the difference to the exchange interaction between the adatom and the tunneling electrons. The bilinear (Heisenberg) exchange J.s, assumed in the spin model, implies that the magnetic quantum number m can only change by zero or plus/minus one for single-electron scatterings. The Anderson model indicates a larger number of allowed scattering channels. The less restrictive selection rule originates in the orbital exchange that is active for the orbital contribution to the magnetic moment of the adatom. This more general exchange influences also the lifetime of the magnetic states since they are destabilized, among other mechanisms, by the exchange with substrate electrons [4].

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[3] T. Schuh et al., Phys. Rev. B 84, 104401 (2011),
[4] T. Miyamachi et al., Nature 503, 242 (2013).

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