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Controlling the Dynamics of a Single Atom in Lateral Atom Manipulation

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The ability to manipulate single atoms with the scanning tunneling microscope (STM) stirs one's imagination because of the vast opportunities made possible for building atomic scale devices and nanostructures. Understanding the host of interactions in the STM tunnel junction, and their optimization, is required for efficient and reliable atom manipulation. In this talk I will discuss our work on using atom manipulation imaging and the noise characteristics of the tunneling current as probes of the physics of the atom manipulation process [1]. I will first discuss the dynamics of the Co atom in the context of a manipulated atom image, which is obtained by scanning a single Co atom across the surface. When the Co atom is positioned over the hcp site, dynamic behavior is observed both in the manipulated atom image and in the tunnel current. This site dependent noise in the tunneling current is in the audio range and can be heard as the atom is dragged over the surface. This dynamic behavior corresponds to the Co atom switching between the neighboring fcc and hcp sites of the Cu(111) surface. This occurs by the creation of an ideal, tunable, multi-well potential by the tip-adatom interaction. An ideal double well potential is created by positioning the probe tip slightly off center from the hcp site. Two-state transfer rates between the hcp and fcc sites are obtained by measuring the distribution of residence times in each state. The transfer rates show two distinct regimes. A transfer rate independent of tunneling current, voltage and temperature that is ascribed to quantum tunneling between the two wells, followed by a transfer rate with a strong power law dependence on current or voltage, indicative of vibrational heating by inelastic electron scattering. 1. J.A. Stroscio and R. J. Celotta, Science **306**, 242 (2004).