Award Achievements

The 3rd Heinrich Rohrer Medal –Grand Medal–

Prof. Andreas Heinrich

"For his ground-breaking development of scanning tunneling microscope methods to study the spin properties of magnetic atoms on surfaces for revealing the quantum nature of the magnetism at the atomic scale"

Prof. Heinrich is a world-leading researcher in the field of quantum measurements at the atomic-scale in solids. He designed and constructed a low-temperature ultra-high-vacuum scanning tunneling microscope to provide the energy resolution required to measure a spin excitation of an atom and the Zeeman splitting of a free electron. It paved the way for the science to follow: i)Spin Excitation Spectroscopy – a method to measure the energies of spin excitations of an atom or assembly of atoms such as the Zeeman splitting of individual atoms on surfaces, the magnetic anisotropy energy of individual atoms and custom-assembled clusters of atoms, spin-spin coupling in engineered chains, the exchange energy between coupled magnetic atoms, and the ground and excited state spin configurations of chains of magnetic atoms, and the Kondo effect. ii)An all-electric pump-probe technique for measuring the lifetimes of spin excitations of those atoms. He outlined a totally unconventional all-electronic pump-probe scheme that completely bypassed the bandwidth limitations of the STM's current amplifier. The key idea was to use a voltage pulse applied across the tunnel junction to excite the spin (the "pump" voltage pulse) followed by a variably-delayed voltage pulse (the "probe" voltage pulse) to monitor the state of the spin system at a known time after the excitation. He demonstrated the ability to measure the longitudinal spin relaxation time, T_1, of an iron atom on a surface. The temporal resolution of this technique is then limited by fast enough pulses, not by the bandwidth of the amplifier. iii)A novel method that enables Electron Spin Resonance (ESR) measurements of individual atoms with the STM. He demonstrated that radio-frequency voltages applied between the tip of the tunneling microscope and the sample could be used to excite and detect the Electron Spin Resonance of individual atoms on surfaces. As with Nuclear Magnetic Resonance and Electron Spin Resonance, Spin Excitation Spectroscopy could now measure both energetics and dynamics but with single atom spin sensitivity and combined with the atomic-resolution imaging and manipulation abilities of the STM. Its significance is that it opened the door not only to the study of the spin coherence properties of atoms on surfaces, but also the coherent control of atomic-scale quantum systems that are engineered to have desirable functionality and then assembled using the atom manipulation abilities of the STM.