Sonderforschungsbereich 1277

Emergent Relativistic Effects in Condensed Matter -
From Fundamental Aspects to Electronic Functionality

SFB – Colloquium

Speaker: **Dr. Artem Odobesko**
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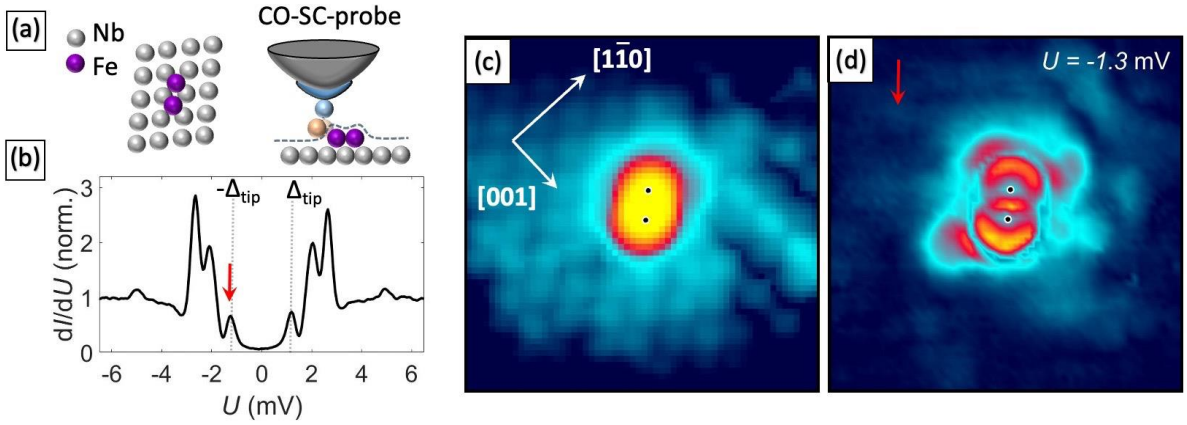
Date: Tuesday, 23.04.2024, 14:15, H34

Topic: Boosting the STM's spatial and energy resolution with double-functionalized probe tips

Abstract:

The functionalization of the STM probe with a CO molecule to achieve a better spatial resolution in topography or with superconducting cluster to improve the energy resolution in spectroscopy (STS) are well-established techniques. Here, we combine a CO molecule with a superconducting cluster pre-attached to an STM tip to maximize at the same time both spatial and energy resolution. The superior properties of such a double-functionalized probe are demonstrated by imaging the spatial distribution of scattered Cooper pairs on magnetic impurities such as Fe atoms on a superconducting Nb(110) surface. Scattering of superconducting pairs by magnetic impurity leads to pairs of sharp in-gap resonances, known as Yu-Shiba-Rusinov (YSR) bound states. Similarly to the interference of itinerant electrons scattered by defects in normal metals, these resonances reveal a periodic texture around the magnetic impurity. However, the wavelength of these resonances is often too short to be resolved even by methods capable of atomic resolution, like STM. Our double-functionalized probe approach reveals rich interference patterns of the hybridized YSR states, previously inaccessible with conventional STM probes. This advancement extends the capabilities of STM techniques, providing insights into superconducting phenomena at the atomic scale.

Host: Prof. Dr. Franz Giessibl



a) Sketch representing a Fe dimer in $[1\bar{1}\bar{1}]$ direction on top of a Nb(110) surface and CO-SC-probe scanning in soft-contact tunneling regime, undergoing Pauli repulsion. b) Single dI/dU spectrum measured in the center of Fe representing two pairs of hybridized YSR states measured with CO-SC-probe. c) STM topography of Fe dimer along the $[1\bar{1}\bar{1}]$, scale 3x3 nm². d) Spatial dI/dU map of the low-energy YSR state at zero-energy.