

Freie Universität  Berlin

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A detailed illustration of a molecular structure, possibly a protein or a complex polymer, rendered in a ball-and-stick model. The structure is composed of numerous spheres (atoms) connected by lines (bonds). It features a large, rounded, multi-layered head at the top left, a long, thin, and slightly curved neck in the middle, and a broad, flat, multi-layered base at the bottom right. The background is light gray with faint, circular patterns and lines, suggesting a scientific or technical context.

Forces and Photons in Molecular Junctions

Berlin, 23-25 September 2013

Introduction

The electronic and optical properties of matter are considerably changed due to quantum effects when the size of the objects is reduced to atomic-scale dimensions. The focus area NanoScale “Functional Materials at the Nanoscale” in the Freie Universität Berlin, aims at a profound understanding of these properties and to develop functional materials (in particular consisting of organic molecules) which may lay the basis for future nanotechnology.

This workshop will bring together experts from two communities investigating properties of single-molecule junctions: the first one investigates the electronic properties and mechanical flexibility of molecules by using a combination of scanning tunneling microscopy (STM) and atomic-force microscopy (AFM). Whereas STM is a standard tool for electronic structure determination with atomic-scale precision, AFM has recently been shown to provide information of electrostatic potentials with unprecedented resolution. This information is crucial for the design of molecular junctions with specifically desired conductance properties. Furthermore, the combination of STM and AFM provides insight into the flexibility and mechanical stability while a current is flowing through the molecular junction.

The second community investigates the optical properties of nanoscale junctions by a combination of light spectroscopy and STM. The light emission from molecule-metal junctions gives insights into the plasmon spectrum of the nanoscale cavity and its interaction with the molecule placed inside the junction. The interplay of electronic excitations and light forms a basis for the development of optical devices.

Both communities have recently shown rapid progress towards the understanding of elementary processes in single molecules at the atomic-scale. This knowledge provides a basic playground for design strategies of nanoscale devices - a vision also pursued within the focus area NanoScale.

This workshop aims to unify the two scientific communities in light and atomic force spectroscopy which up to date are unrelated, despite the common field of research through the combination with scanning tunneling microscopy.

| | Monday | Tuesday | Wednesday |
|--------------|---|---|---|
| 9:00 | | R. Berndt Meandering with STM and light | S. Sadewasser Spatially resolved surface photovoltage spectroscopy |
| 9:45 | | J. Aizpurua Nanooptics in subnanometric gaps: from single molecule imaging to quantum tunneling plasmonics | R. Temirov How much control over single molecules could we get with the junction of a scanning probe microscope? |
| 10:30 | | Coffee Break | Coffee Break |
| 11:00 | | M. Ternes The mechanical properties of a monoatomic layer investigated by combined STM and AFM measurements | S. Fölsch Manipulating atoms and molecules on a III-V semiconductor surface by cryogenic STM |
| 11:45 | | P. Jelínek AFM/STM measurements of atomic and molecular contacts | G. Meyer Scanning probe microscopy of single molecules on insulating films: molecular geometry and intramolecular charge distribution |
| 12:30 | | Lunch | Closing Remarks |
| 14:00 | | | Lunch |
| 14:00 | Registration Welcome | | |
| 14:30 | F. J. Giessibl Atomic forces, currents and spins measured by simultaneous STM and AFM | C. Grosse Exploring luminescence on submolecular length scales and nanosecond time scales | |
| 15:15 | A. Schwarz Forces, Tips, Cantilevers and Light | C. Lotze Fundamental Processes in Single Molecule Junctions: Interplay of Forces and Electronic Effects J. Li Tunneling electrons induced light emission in electronic systems | |
| 16:00 | Coffee Break | Coffee Break | |
| 16:30 | M. Heyde The Impact of Atomic Force Microscopy and Spectroscopy to Illuminate Complex Oxide Surfaces | J. Repp Dynamic Force Microscopy and Spectroscopy of Individual Molecules on thin insulating films | |
| 17:15 | F. Stavale Cathodoluminescence spectroscopy using a STM: a powerful tool for nano-oxides characterization Z. Majzik Simultaneous AFM and STM analysis of surface reactions on silicon surfaces | S. Kawai Mechanical properties of a single long molecular wire | |
| 19:00 | Posters Snacks and Drinks | | |
| 20:00 | | Dinner | |

Oral Presentations:

Monday Afternoon

14:30-15:15 **Franz. J. Giessibl**

Atomic forces, currents and spins measured by simultaneous STM and AFM

15:15-16:00 **Alexander Schwarz**

Forces, Tips, Cantilevers and Light

16:30-17:15 **Markus Heyde**

The Impact of Atomic Force Microscopy and Spectroscopy to Illuminate Complex Oxide Surfaces

17:15-17:35 **Fernando Stavale**

Cathodoluminescence spectroscopy using a STM: A powerful tool for nano-oxides characterization

17:35-18:00 **Zsolt Majzik**

Simultaneous AFM and STM analysis of surface reactions on silicon surfaces

Tuesday Morning

9:00-9:45 **Richard Berndt**

Meandering with STM and light

9:45-10:30 **Javier Aizpurua**

Nanooptics in subnanometric gaps: from single molecule imaging to quantum tunneling plasmonics

11:00-11:45 **Markus Ternes**

The mechanical properties of a monoatomic layer investigated by combined STM and AFM measurements

11:45-12:30 **Pavel Jelinek**

AFM/STM measurements of atomic and molecular contacts

Tuesday Afternoon

14:30-15:15 **Christoph Grosse**

Exploring luminescence on submolecular length scales and nanosecond time scales

15:15-15:35 **Christian Lotze**

Fundamental Processes in Single Molecule Junctions: Interplay of Forces and Electronic Effects

15:35-16:00 **Jingcheng Li**

Tunneling electrons induced light emission in electronic systems

16:30-17:15 **Jascha Repp**

Dynamic Force Microscopy and Spectroscopy of Individual Molecules on thin insulating films

17:15-18:00 **Shigeki Kawai**

Mechanical properties of a single long molecular wire

Wednesday Morning

9:00-9:45 **Sascha Sadewasser**

Spatially resolved surface photovoltage spectroscopy

9:45-10:30 **Ruslan Temirov**

How much control over single molecules could we get with the junction of a scanning probe microscope?

11:00-11:45 **Stefan Fölsch**

Manipulating atoms and molecules on a III-V semiconductor surface by cryogenic STM

11:45-12:30 **Gerhard Meyer**

Scanning probe microscopy of single molecules on insulating films: Molecular geometry and intramolecular charge distribution

Posters:

Gelavizh Ahmadi

Monitoring a ring-closure reaction on the ligand of an Fe-Porphyrin Molecule

Wibke Bronsch

Self-assembling and electronic structure of metallocenes on Pb(111) and Pb(100)

Robert Drost

The interface of graphene with hexagonal boron nitride

Nino Hatter

Diarylethene molecules on a Ag(111) surface: stability and electric field-induced switching of single molecules

Nils Krane

Charge Localization in Merocyanine on Au(111)

Jesús Martínez Blanco

STM light emission from the InAs(111)A surface: First Results

Marten Piantek

Manipulation of the electronic structure in a Ruthenium complex by an STM/AFM tip

Celia Rogero Blanco

Reshaping of Cu(110) by phthalocyanine molecules

Michael Ruby

Electron Momentum Anisotropy in Superconducting Tunnel Junctions

Fabian Schulz

Local doping and lifetime modulation of molecular electronic states on monolayer hexagonal boron nitride

Evan Spadafora

Simultaneous nc-AFM/STM investigation of the B:Si(111) $\sqrt{3}\times\sqrt{3}$ surface

Paul Stoll

Bistable charge states in the acceptor-donor complex Tetracyanoethylene-Tetrathiafulvalene on Au(111)

Martina Svec

Highly ordered silicon triplets within a platinum surface alloy

Tobias Umbach

Charge distribution of alkali-organic monolayers on a metal surface

Ben Warner

Exploring the magnetic properties of metallophthalocyanines on a thin insulator

Ping Yu

Nanoscale photoelectron mapping and spectroscopy with an atomic force microscope

Yang Zechao

Gold-Adatom-Mediated Bonding and Molecular Orbitals of Self-Assembled DCV5T-Me₂ Nanostructures on Au(111)

List of Participants:

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|---------------------------|---|
| Gelavizh Ahmadi | Department of Physics, Free University Berlin (Germany) |
| Javier Aizpurua | Center of Material Physics, San Sebastián (Spain) |
| Richard Berndt | Institute of Instrumental and Applied Physics University of Kiel (Germany) |
| Wibke Bronsch | Department of Physics, Free University Berlin (Germany) |
| Bo Chen | Department of Physics, Free University Berlin (Germany) |
| Rory Chen | Department of Physics, Free University Berlin (Germany) |
| Martina Corso | Center of Material Physics, San Sebastián (Spain) |
| Robert Drost | Department of Applied Physics, Aalto University School of Science (Finland) |
| Stefan Fölsch | Paul Drude Institut für Festkörper Elektronik, Berlin (Germany) |
| Isabel Fernandez Torrente | Department of Physics, Free University Berlin (Germany) |
| Katharina Franke | Department of Physics, Free University Berlin (Germany) |
| Lukas Gerhard | Karlsruhe Institute of Technology (Germany) |
| Franz J. Giessibl | Department of Physics, University of Regensburg (Germany) |
| Toby Gill | London Center for Nanotechnology (UK) |
| Christoph Grosse | Max Planck Institute for Solid State Research, Stuttgart (Germany) |
| Nino Hatter | Department of Physics, Free University Berlin (Germany) |
| Benjamin Heinrich | Department of Physics, Free University Berlin (Germany) |
| Markus Heyde | Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin (Germany) |
| Pavel Jelinek | Institute of Physics of Czech Academy of Science, Prague (Czech Republic) |
| Shigeki Kawai | Institute of Physics, University of Basel (Switzerland) |
| Nils Krane | Department of Physics, Free University Berlin (Germany) |
| Janina Ladenthin | Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin (Germany) |
| Jingcheng Li | CIC-nanoGUNE, San Sebastián (Spain) |
| Christian Lotze | Department of Physics, Free University Berlin (Germany) |
| Zsolt Majzik | CIC-nanoGUNE, San Sebastián (Spain) |
| Jesús Martínez Blanco | Paul Drude Institut für Festkörper Elektronik, Berlin (Germany) |
| Jose Martinez | Instituto de Nanociencia de Aragón, Zaragoza (Spain) |
| Gerhard Meyer | IBM, Zürich (Switzerland) |

| | |
|---------------------|--|
| J. Ignacio Pascual | CIC-nanoGUNE, San Sebastián (Spain) |
| Olof Peters | Department of Physics, Free University Berlin (Germany) |
| Marten Piantek | Instituto de Nanociencia de Aragón, Zaragoza (Spain) |
| Jascha Repp | Department of Physics, University of Regensburg (Germany) |
| Celia Rogero Blanco | Center of Material Physics, San Sebastián (Spain) |
| Michael Ruby | Department of Physics, Free University Berlin (Germany) |
| Sascha Sadewasser | International Iberian Nanotechnology Laboratory, Braga (Portugal) |
| Fabian Schulz | Department of Applied Physics, Aalto University School of Science (Finland) |
| Alexander Schwarz | Department of Physics, University of Hamburg (Germany) |
| Violeta Simic | SPECS, Berlin (Germany) |
| Evan Spadafora | Institute of Physics of Czech Academy of Science, Prague (Czech Republic) |
| Fernando Stavale | Brazilian Center for Physics Research, Rio de Janeiro (Brazil) |
| Paul Stoll | Department of Physics, Free University Berlin (Germany) |
| Martin Svec | Institute of Physics of Czech Academy of Science, Prague (Czech Republic) |
| Ruslan Temirov | Forschungszentrum Jülich (Germany) |
| Markus Ternes | Max Plank Institute for Solid State Research, Stuttgart (Germany) |
| Tobias Umbach | Department of Physics, Free University Berlin (Germany) |
| Ben Warner | London Center for Nanotechnology (UK) |
| Ping Yu | Department of Physics, University of Regensburg (Germany) |
| Yang Zechao | Department of Physics, Free University Berlin (Germany) |

Hotel:

Seminaris CampusHotel Berlin
Takustr. 39
14195 Berlin
(next to Department of Physics of Freie Universität Berlin)

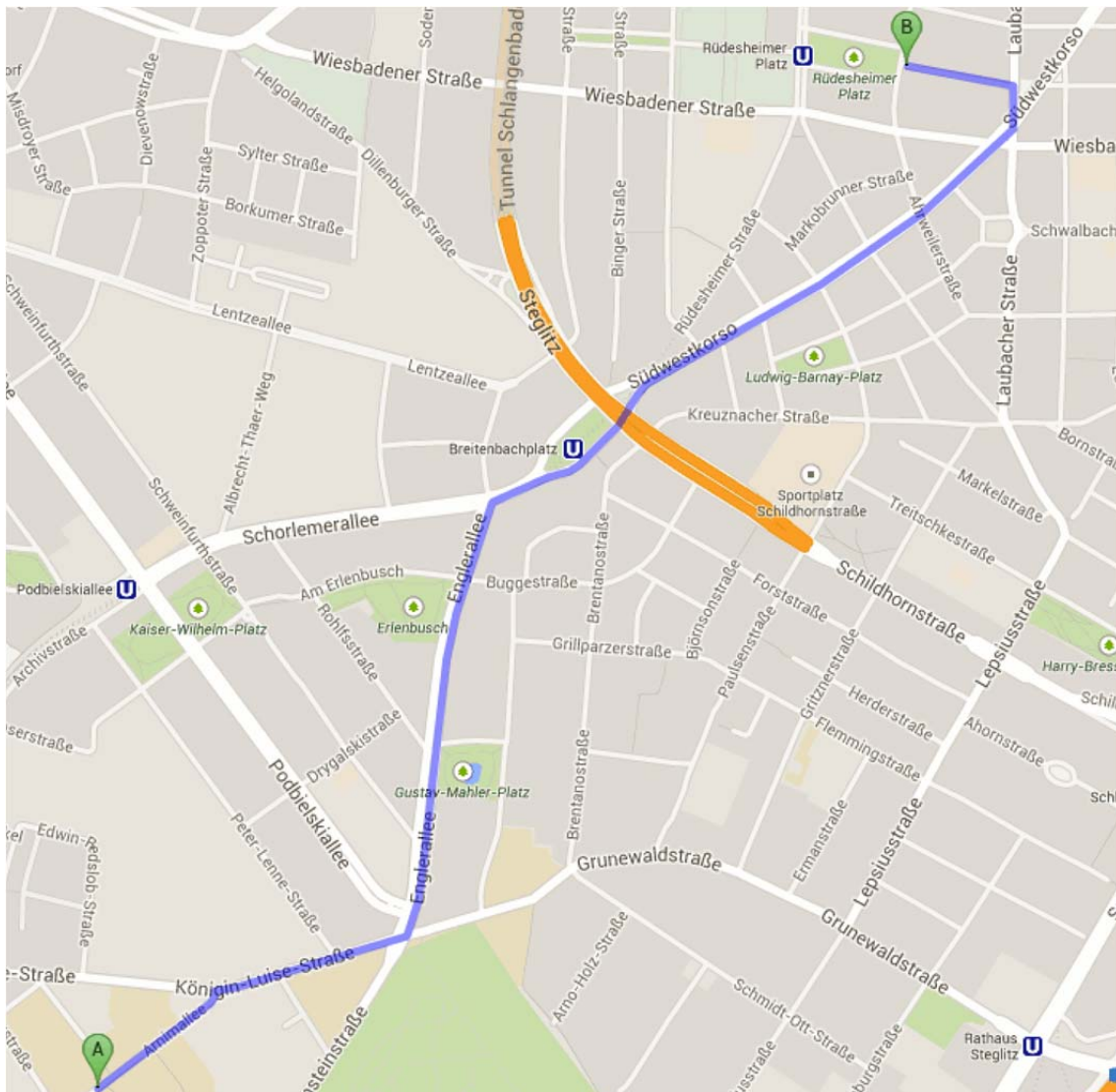
Workshop Dinner:

Gasthaus Landauer
Landauer Strasse 8
147197 Berlin

Best way to get there:

U3 from Dahlem Dorf to Rüdeshheimer Platz

Restaurant



FU workshop site