University of Basel

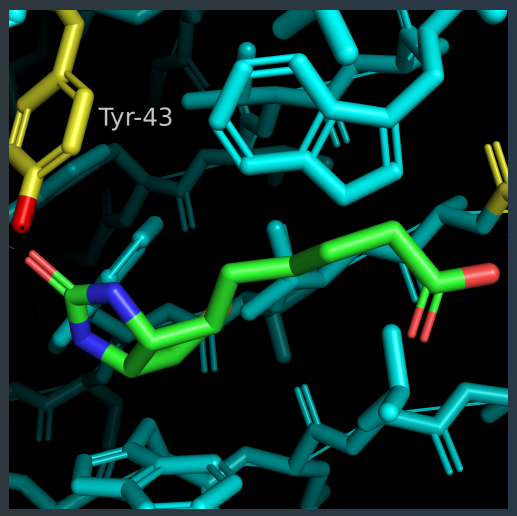
Swiss Nanoscience Institute

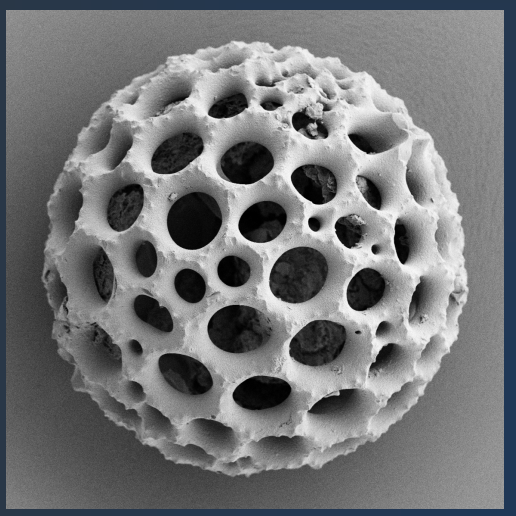
Swiss Nanoscience Institute
Center of Excellence supported by the University of Basel and the Canton of Aargau

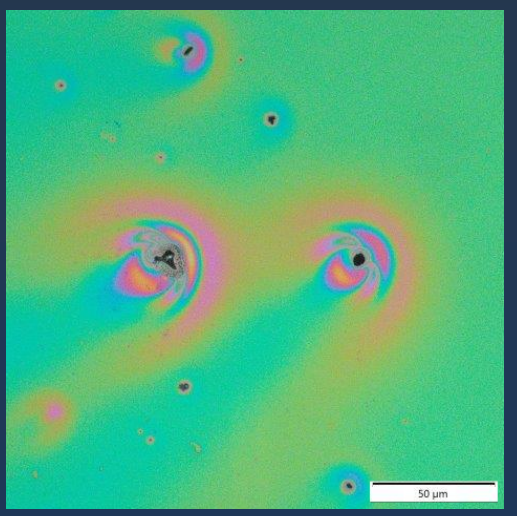
Small Talk

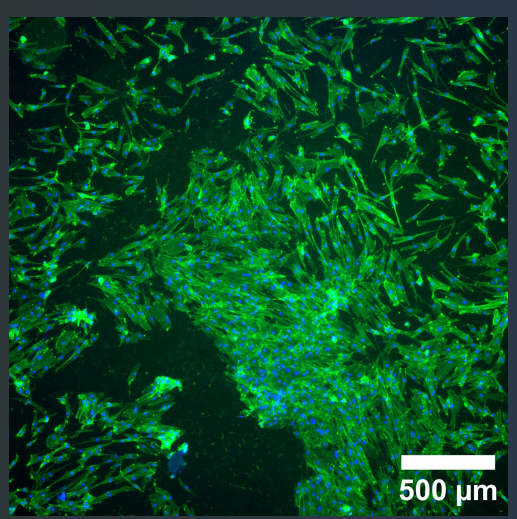
14. Mai 2025

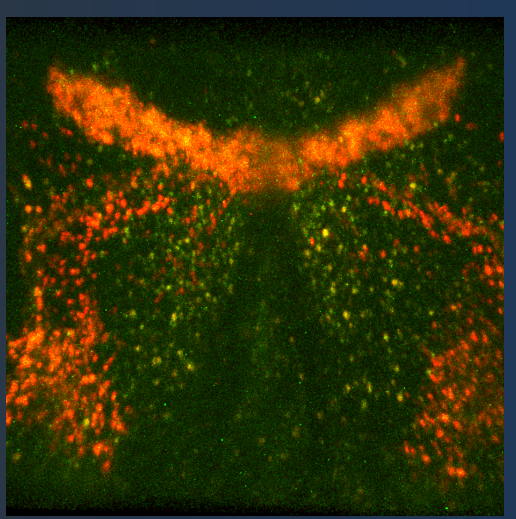
Klingelbergstrasse 82, 4056 Basel
Physik Mensa; 8:00 - 15:15











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8:00 - 8:25	Registration and Introduction Anja Car
8:30 - 8:45	Artificial Metallonezymes - Protein Hosts for Transition Metal Catalysis Sarah Vogel
8:45 - 9:00	Studying Holliday Junction Interconversion Dynamics with Increasing Concentration of Magnesium Chloride using smFret Lea Studer
9:00 - 9:15	Nanoscopic Imaging and Analysis Natalie Walser
9:15 - 9:30	Synthesis of Zr Oxo Clusters and Metal Organic Framework Meret Benninger

Coffee Break (15 min.)

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9:45 - 10:00	Optimization of Lipid Nanoparticles for Gene Delivery Louis Schulz
10:00 - 10:15	Quantum dots in a silicon-on-insulator nanowire Judith Leu
10:15 - 10:30	Biophysics of water uptake in bacterial biofilms Eduard Basler
10:30 - 12:00	Poster Session

Lunch Break (60 min.)

13:00 - 13:15	Smart microgels for iridescent materials Valeria Gempler

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13:15 - 13:30	Static Compensation of Magnetic Fluctuations in Ca^+ Traps Linus Wesp
13:30 - 13:45	$SrTiO_3$ Nano Membrane research using Raman Spectroscopy Xaver Hohmann

Coffee Break (15 min.)

14:00 - 14:15	Analyzing the Stability and Capacity Limits of Hopfield Networks Dominik Kaufmann
14:15 - 14:30	Thermoresponsive Polymers Josefine Dünhöft
14:30 - 14:45	Voltage Tuneability of Varactor Diods on STO Substrate Sarah Stalder

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Closing Remarks & Awards

Prof. Martino Poggio

Nano-Merch 2025

Available at the Jubilāumsfeier 28.06

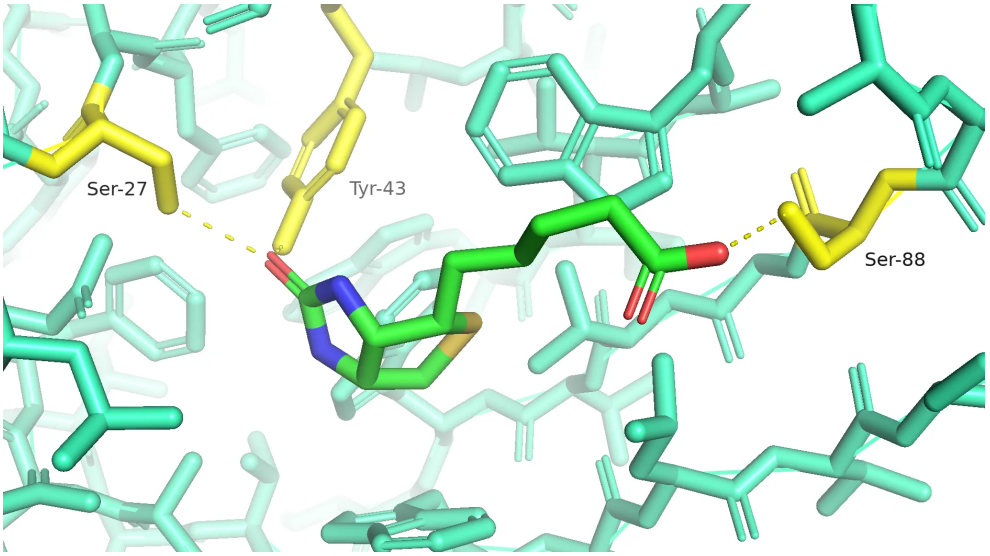
See you there See you there See you See you See you there See you there See

Artificial Metallonezymes - Protein Hosts for Transition Metal Catalysis

Sarah Vogel

8:30 - 8:45

Artificial metalloenzymes combine the protein cavity environment with the catalytic potential of transition metals, offering a promising strategy for enantioselective reactions in synthetic chemistry. Streptavidin, a protein with high binding affinity to biotin, serves as a robust scaffold for incorporation of a metal catalyst. The precise engineering of these metalloenzyme systems enables control over the stereochemical outcome of the reaction. The Block-course report presents, that a biotinylated copper (+I) complex embedded in a strepravidin catalyzes a cascade cylclization reaction, yielding δ-lactams with tunable enantioselectivity. While the protein scaffold was expected to enhance product enantioselectivity, our result reveals that streptavidin, including experiments with different cavity mutations, reduce enantioselectivity compared to the free co-factor. This finding suggests that the steric binding pocket may not always favor optimal alignment of the reactive intermediates. The presentation highlights the complexity of designing artificial metalloenzymes and induces the need for a deeper understanding in protein-complex interactions to reveal their full potential.

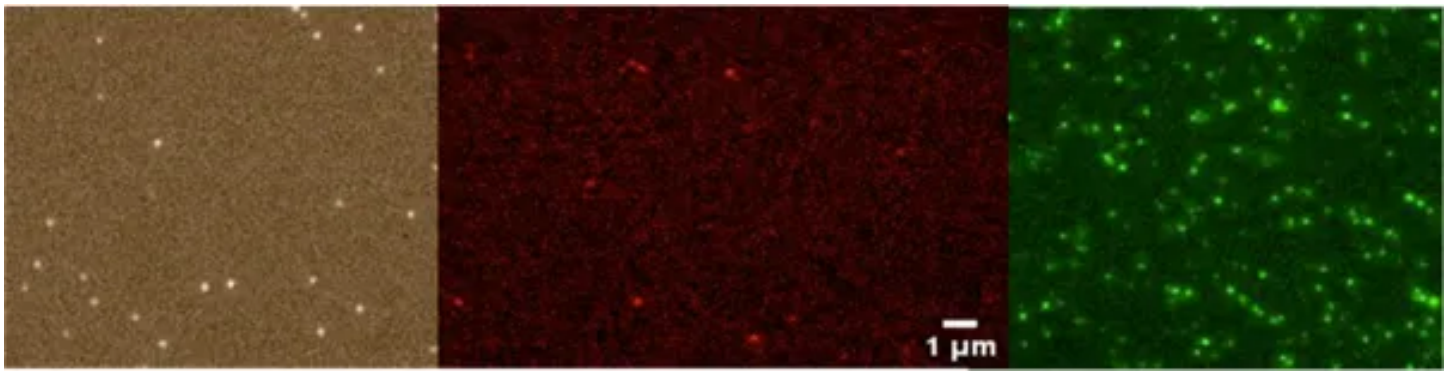


Studying Holliday Junction Inter-conversion Dynamics with Increasing Concentration of Magnesium Chloride using smFret

Lea Studer

8:45 - 9:00

Fluorescence resonance energy transfer (FRET) can be used to study interconversion dynamics by attaching fluorophores to a molecule. The excitation efficiency of the acceptor fluorophore by a donor fluorophore scales inversely to the sixth power of the distance between them and is therefore extremely sensitive to changes in the conformation of the investigated molecule. The emission of the acceptor after it was excited by the emission of the donor fluorophore is called the FRET signal. Here, the FRET signal of modified DNA Holliday junctions is used to examine its behavior at different concentrations of magnesium chloride ($MgCl_2$). A 50 mM and 200 mM MgCl2 solution were used to study the interconversion dynamics of Holliday junctions.

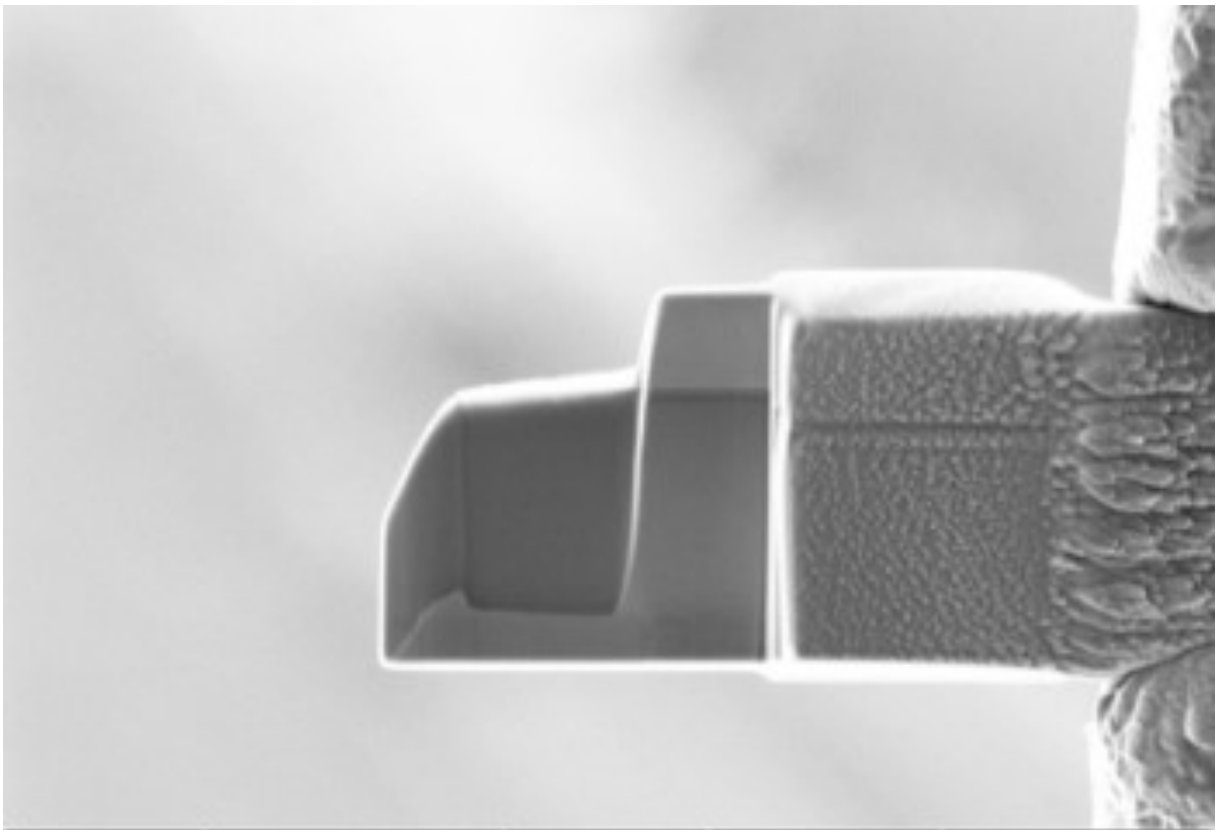


Nanoscopic Imaging and Analysis

Natalie Walser

9:00 - 9:15

A strontium titanate sample has been prepared using focused ion beam (FIB) milling and protected with a platinum layer. The sample has then been characterized by high-resolution transmission electron microscopy (HRTEM), electron diffraction, and energy-dispersive X-ray spectroscopy (EDX). HRTEM images have revealed the atomic structure of the crystal lattice, while electron diffraction has confirmed its crystalline quality. The EDX analysis has verified the expected chemical composition of the sample.

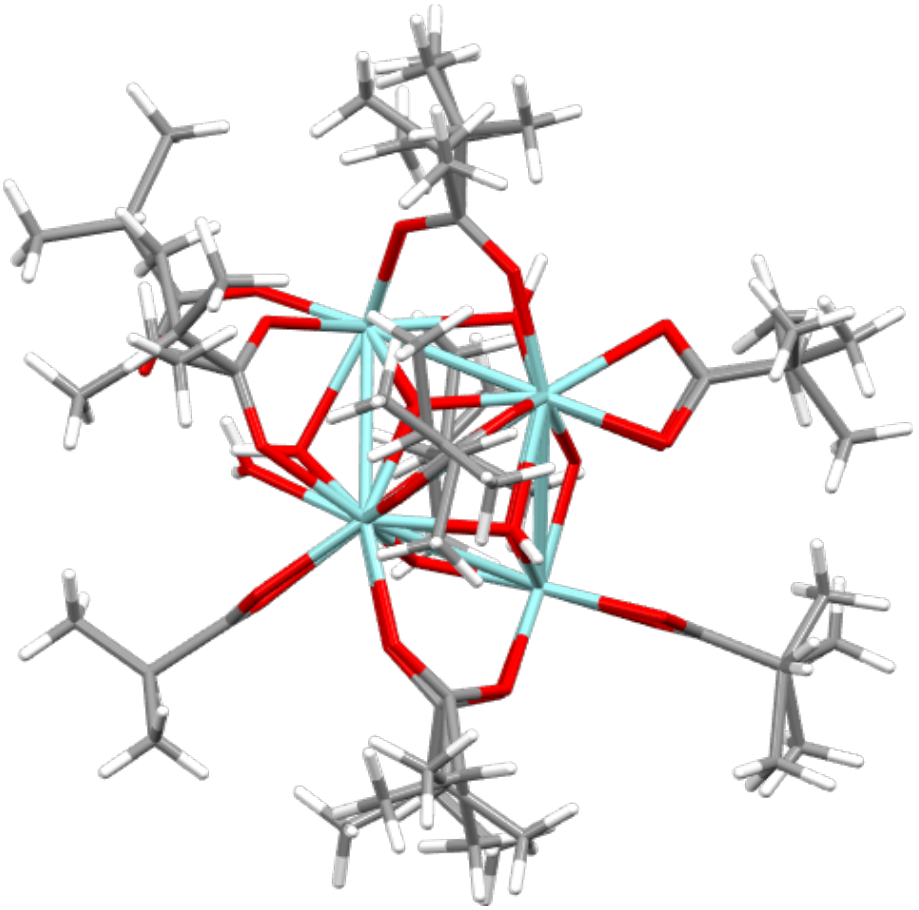


Synthesis of Zr Oxo Clusters and Metal Organic Framework

Meret Benninger

9:15 - 9:30

The presentation gives an overview of the synthesis and characterization of zirconium-based oxo clusters. It also explains how metal-organic frameworks (MOFs) can be synthesized from the oxo clusters. Three types of Zr oxo clusters were synthesized: Zr_{12}-acetate, Zr_{12}-butanoate and Zr_6-2-methylbutanoate. They were then characterized using NMR and FTIR spectroscopy. In addition, two ligand exchanges were carried out with the Zr_{12}-acetate to form Zr_{12}-butanoate and Zr_6-2-methylbutanoate. For the MOFs, an hcp-Zr_{12}-UiO-66 MOF was synthesised from a Zr precursor and characterized using powder X-ray diffraction analysis. This revealed that the resulting structure resembled Zr_6-UiO-66 rather than the targeted hcp-Zr_{12}-UiO-66 structure.

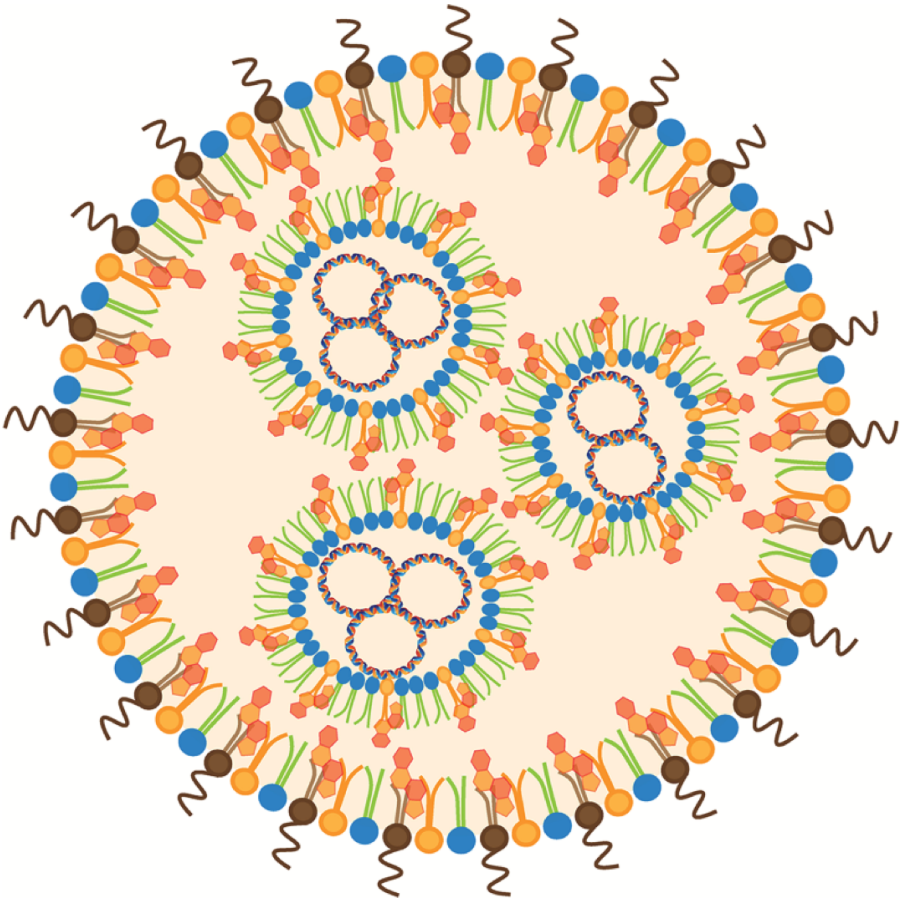


Optimization of Lipid Nanoparticles for GeneDelivery

Louis Schulz

9:45 - 10:00

Encapsulating DNA plasmids in lipid nanoparticles is a promising approach for gene therapy. This block course aims to show an excerpt of an optimization study on lipid nanoparticle formulations. For decades, the disease citrullinemia type I has presented a rare but devastating threat for newborns. Gene therapy using the investigated platforms is a potential approach for treating this disease by artificially replacing the missing gene. Here, it is shown how ionizable lipids contribute to the unique properties of the DNA-encapsulating nanoparticles. A comparison of two formulations containing the lipids DLin-MC3-DMA (MC3) and SM-102 revealed that SM-102 provided significantly more efficient transgene expression, while MC3 exhibited a larger hydrodynamic diameter and greater cellular uptake after 4 hours. The results of other experiments yielded similar findings for both formulations.

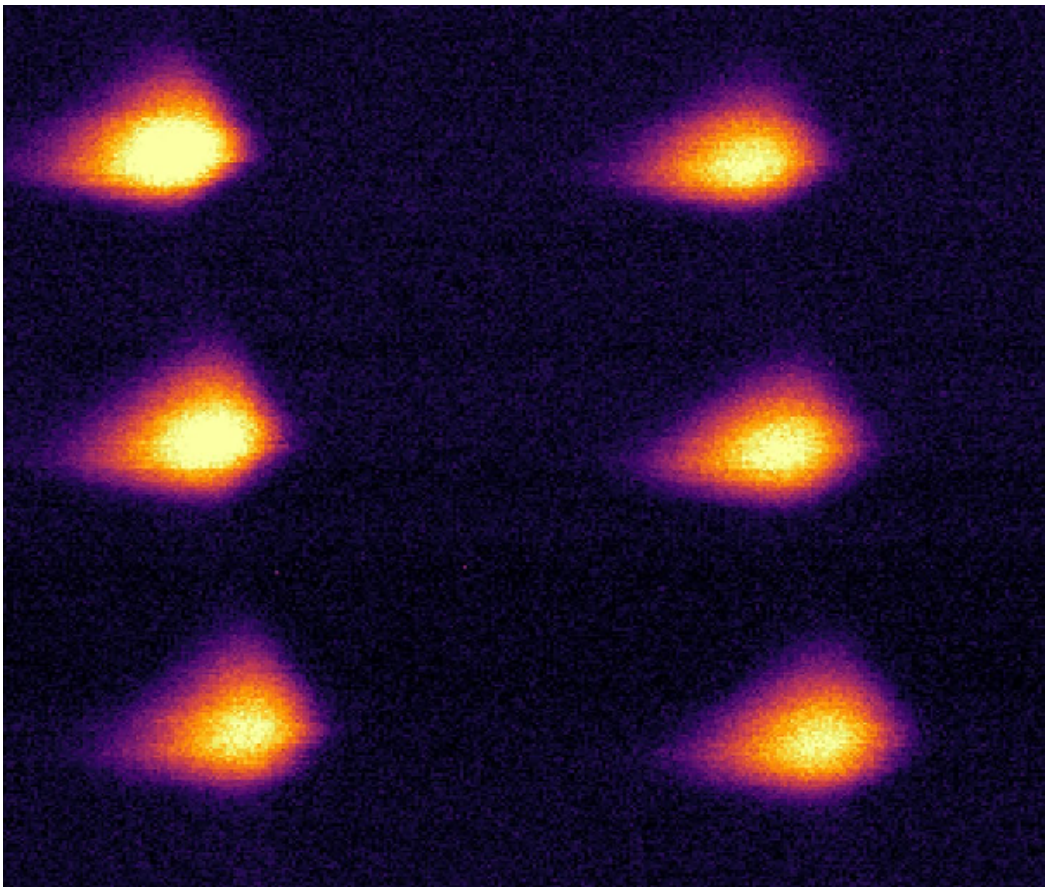


Quantum dots in a silicon-on-insulatornanowire

Judith Leu

10:00 - 10:15

Quantum dots (QDs) in silicon are nano-scale structures that confine electrons or holes. These structures can be utilized as spin qubits that form the fundamental building blocks of quantum computing. An advantage of quantum dots in silicon-on-insulator (SOI) devices is the scalability, stemming from the classical computer industry's reliance on silicon chips that host billions of transistors. In this project, a semi-industrial device from Semiqon was used to study ambipolar, gate-defined single and double quantum dots to explore their fundamental characteristics including bias triangles, as depicted in the figure.

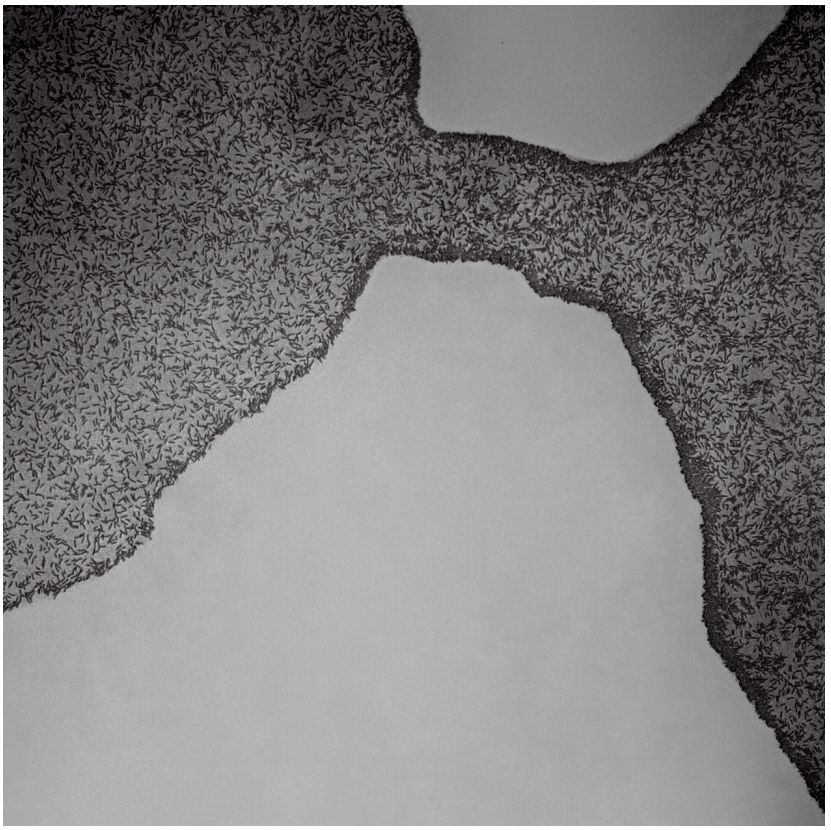


Biophysics of water uptake in bacterial biofilms

Eduard Basler

10:15 - 10:30

Bacterial swarming is defined as a rapid multicellular movement powered by rotating flagella. It facilitates the rapid colonization of environments and contributes to bacterial virulence. However, the precise mechanisms underlying swarm expansion, specifically the influence of liquid availability on the swarm front, are not fully understood. To investigate the impact of liquid availability, specifically if liquid availability limits the expansion speed of a Bacillus subtilis swarm, small drops of lysogeny broth (LB) were introduced directly in front of swarms in different stages of expansion. Swarms in the early expansion phase exhibited a rapid, pressure driven influx into the LB drop. This result validated the hypothesis, proving that liquid availability plays a role in determining the speed of the leading edge, contributing to a better understanding of the mechanics underlying swarm expansion.



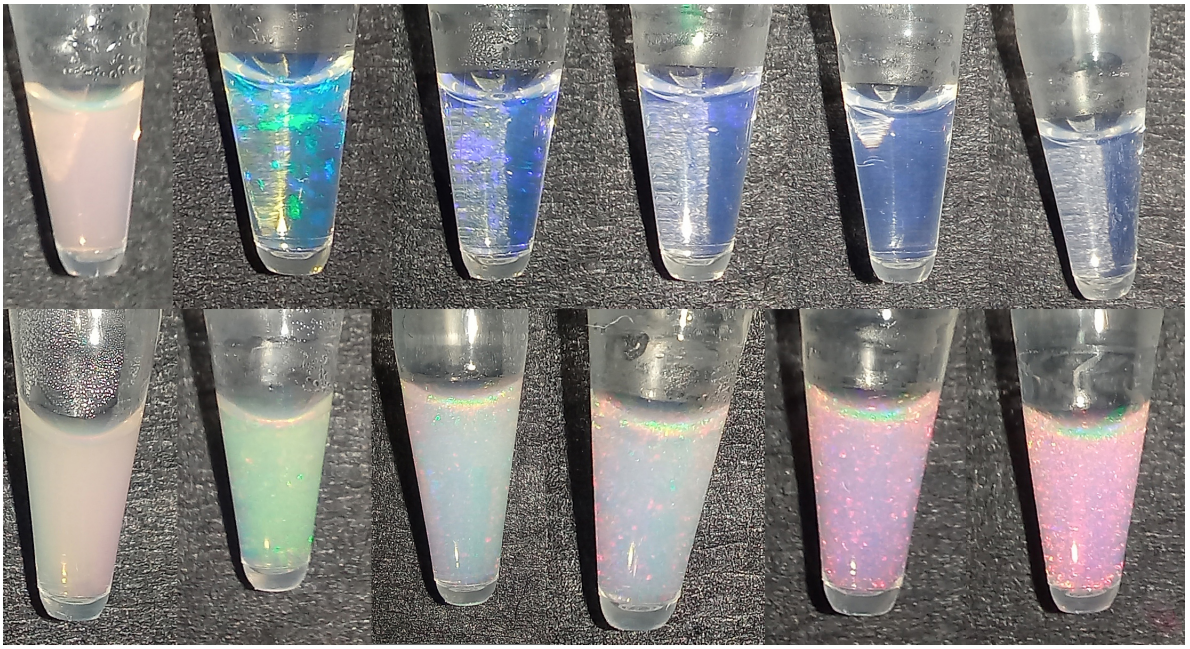
The figure shows the formation of an interconnecting bridge structure allowing the influx of the Bacillus Subtilis swarm from the main swarm body into a lysogeny broth drop.

Smart microgels for iridescent materials

Valeria Gempler

13:00 - 13:15

Microgels consist of cross-linked polymer chain networks whose morphology is highly sensitive to external stimuli, which allows fine-tuning of physical properties. Additionally, microgel particles form ordered crystalline structures in suspension, which reflect specific wavelengths based on microgel size. In this course two microgel libraries were synthesized and characterized. For the N-isopropylacrylamide (NIPAm) library the surfactant sodium dodecylsulfate (SDS) concentration was varied, while in the acrylamide (AAm) library the monomer content was changed. Further, colorful microgel composites were produced, which reflected different colors. Results showed that higher AAm concentrations increased the average particle size, while higher surfactant content led to smaller particles. Both libraries were synthesized and characterized successfully by size and surface charge as well as their temperature and pH responsiveness. The observed correlation between particle size, temperature and crystal color promises potential for the application of microgels especially in tunable optical sensors but also other fields of research.

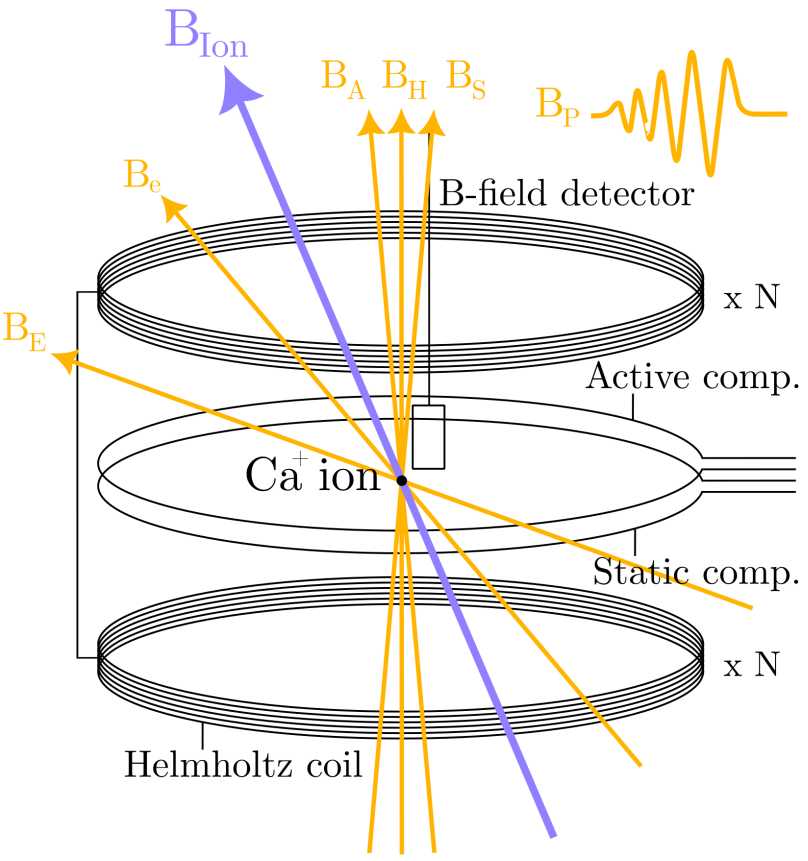


Static Compensation of Magnetic Fluctuations in Ca^+ Traps

Linus Wesp

13:15 - 13:30

Trapped Ca^+ ion experiments are sensitive to magnetic field fluctuations, particularly 50 Hz harmonics from power lines, which disrupt energy levels through the Zeeman effect. Magnetic field noise limits coherence times by causing phase drift on the x-y plane of the Bloch sphere. Compensation techniques necessary to address this issue have been proposed by Hu et al. [1]. This study evaluates active and static compensation methods to reduce magnetic field fluctuation caused by power lines to reproduce the results from Hu et al. [1]. It is shown that static compensation reduces magnetic field fluctuations by up to 78 ± 4 % and extends coherence times from 160 µs to 270 µs. This is achieved using harmonic fits applied via an arbitrary waveform generator and confirmed through Ramsey sequence measurements.



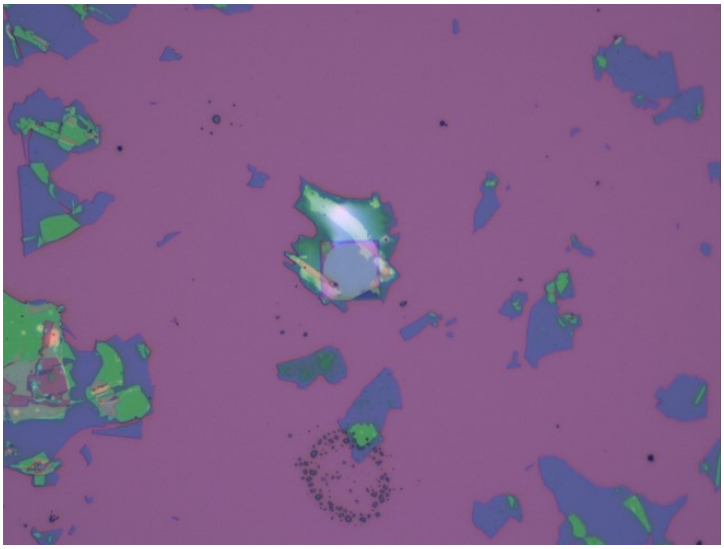
[1] https://link.springer.com/article/10.1007/s00340-023-08106-8

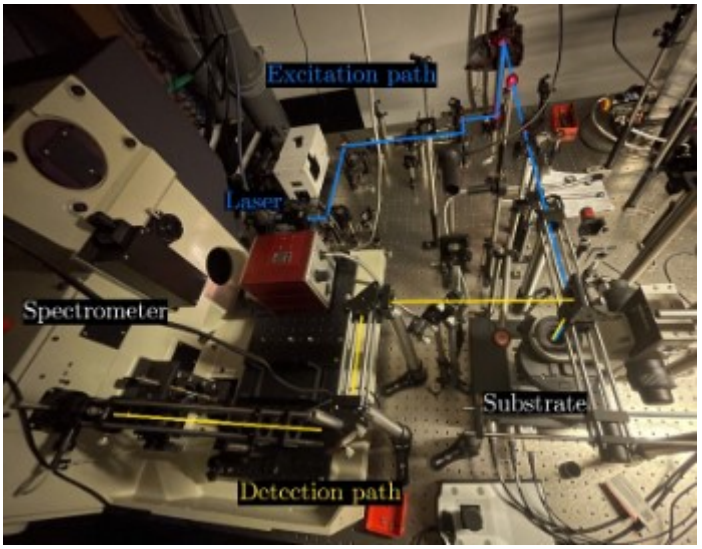
$SrTiO_3$ Nano Membrane research using Raman Spectroscopy

Xaver Hohmann

13:30 - 13:45

Strontium titanate ($SrTiO_3$) is a well-known perovskite material with rich vibrational properties and relevance for future electronic and thermal devices. In this study we investigated its phonon modes using Raman spectroscopy to better understand how they are influenced by sample structure and measurement conditions. Experiments were carried out on both bulk crystals and ultrathin suspended membranes using lasers at 532 nm and 633 nm. We examined how laser power and polarization affect the Raman signal and identified differences between supported and suspended regions. Mapping across the membrane revealed spatial variations in phonon features. The results show how certain vibrational modes depend on polarization and highlight the advantages of working with suspended samples. This project combined practical experience in Raman techniques with a focused investigation into how material structure affects phonon behavior contributing to broader efforts in controlling heat and vibrations at the nanoscale.



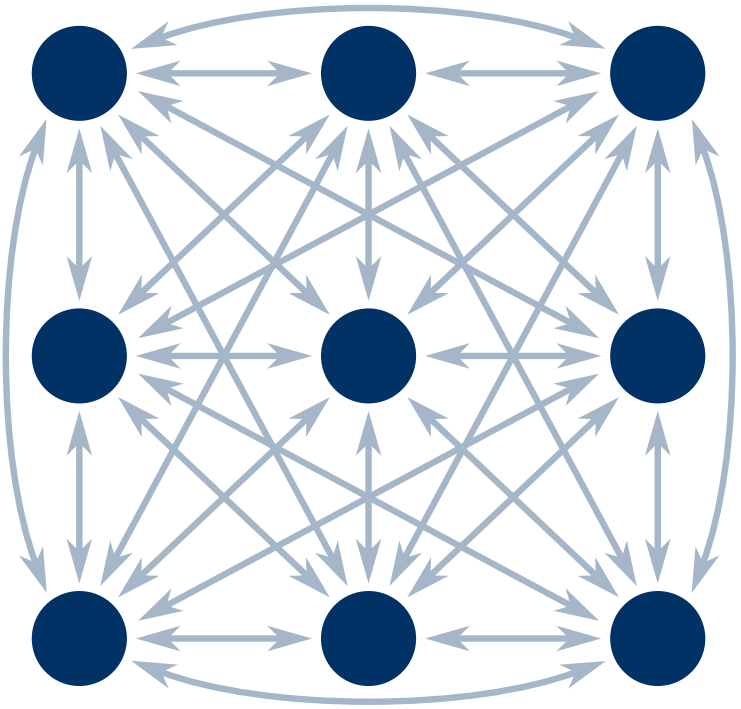


Analyzing the Stability and Capacity Limits of Hopfield Networks

Dominik Kaufmann

14:00 - 14:15

How does our brain remember things, even when we only perceive them partially? Hopfield networks offer a fascinating mathematical model that mimics this human ability. In my presentation, I will give an introduction to the workings of these recurrent neural networks, which function as associative memory systems. I will show the connection between energy minimisation and pattern recognition. A key focus will be on analysing the storage capacity and stability of the network under different conditions, for example, how much information can be stored in a Hopfield network before it starts to collapse, or how similar patterns can be before the network can no longer distinguish between two memories. I will also investigate extended models with additional slow links and how parameters such as correlation, time constants and update strategies affect the behaviour of the network.

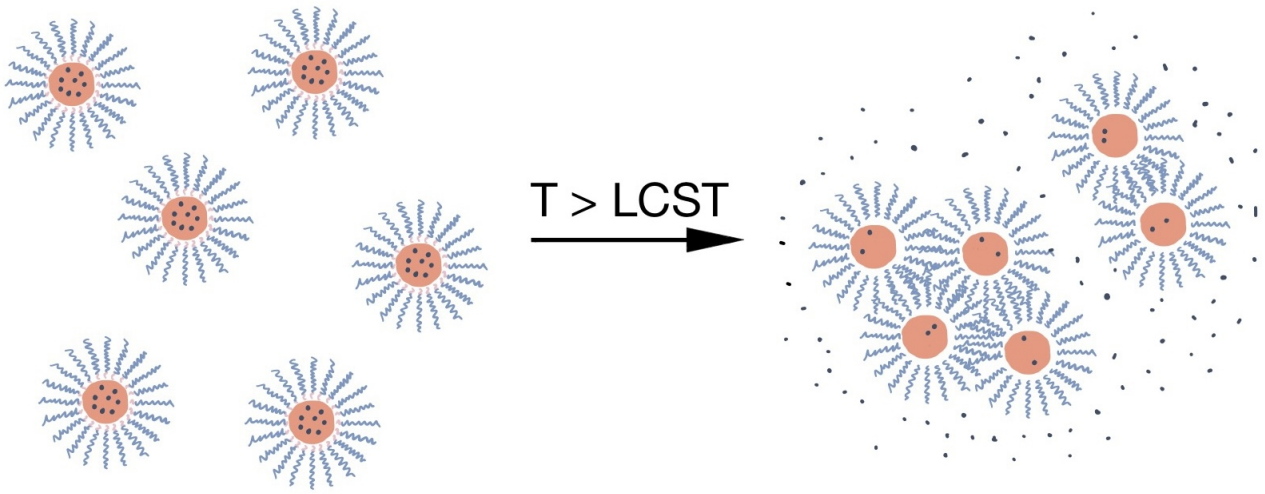


Thermoresponsive Polymers

Josefine Dünhöft

14:15 - 14:30

This block-course focused on the development of thermoresponsive PBA-b-PDEGA block copolymers for potential drug delivery applications. A library of copolymers with varied block lengths was synthesized via photoinitiated RAFT polymerization, enabling precise control over molecular weight and dispersity. These smart polymers exhibit a lower critical solution temperature (LCST), transitioning from hydrophilic to hydrophobic above this point, which induces micelle disassembly and enables temperature-triggered drug release. Doxorubicin (DOX), a model chemotherapeutic agent, was successfully encapsulated within selected PBA-b-PDEGA compositions. Overall, the course emphasized synthesis, characterization, self-assembly behavior, and thermoresponsive properties, highlighting the potential of these materials as intelligent drug delivery systems.



Voltage Tuneability of Varactor Diods onSTO Substrate

Sarah Stalder

14:30 - 14:45

Quantum computing relies on the manipulation and measurement of so-called qubits, which are the fundamental calculating units in quantum computing. For accurate readout, the resulting signals must be amplified with a high signal-to-noise ratio. However, current approaches to amplify said signals, face limitations with either the adjustment to the amplified signal frequency, the operating temperature, or the magnetic field compatibility. A new approach for amplification is planar varactor diodes, fabricated by vapor deposition of gold on strontium titanate. This approach shows promising results in passive measurements at 4 K, offering a potentially scalable and cryo-compatible solution for quantum signal amplification.

Poster List

P1: Lipid Nanoparticles For Gene Delivery, Sarah Vogel

P2: Examination of Single and Double Quantum Dots on a SemiQon Device at 80 mK, Lea Studer

P3: Quasi-Classical Trajectory Simulations of the He-H_2^+ Complex, Natalie Walser

P4: Cell Material Interaction and Tissue Engineering, Meret Benninger

P5: Surface Modification and Biocompatibility of Titanium Discs for Implant Applications, Louis Schulz

P6: From purification to structure - an insight into the workflow of cryo-EM, Judith Leu

P7: NIPAm-DMAEMA Microgels: Effect of Composition and Surfactant on Stimuli-response, Eduard Basler

P8: Tuning surfaces with diazonium salts, Valeria Gempeler

P9: Raman Spectroscopy of SrTiO3 Nano Membrane, Linus Wesp

P10: Lateral flow essay with gold nanoparticles, Xaver Hohmann

P11: Monitoring the Assembly of a Functionalized Surface Using QCM, Dominik Kaufmann

P12: Structural Characterization of the Cell Death Effector Protein MLKL, Josefine Dünhöft

P13: Lanthanide-Doped Group-IV Metal Nanocrystals, Sarah Stalder