BP 15: Poster IIb

Bioimaging, Biomaterials and Biopolymers

Time: Tuesday 18:00–20:30 Location: Poster F

BP 15.1 Tue 18:00 Poster F

A Next-Generation qPlus-Sensor-Based AFM Setup: Resolving Archaeal S-Layer Protein Structures in Air and Liquid — Theresa Seeholzer, Daniela Tarau, Lea Hollendonner, Andrea Auer, Reinhard Rachel, Dina Grohmann, Franz J. Giessibl, and •Alfred J. Weymouth — Universität Regensburg, Regensburg, Deutschland

Surface-layer (S-layer) proteins form the outermost envelope in many bacteria and most archaea and arrange in two-dimensional quasicrystalline structures via self-assembly. We investigated S-layer proteins extracted from the archaeon Pyrobaculum aerophilium with a qPlus sensor-based atomic force microscope (AFM) in both liquid and ambient conditions and compared it to transmission electron microscopy (TEM) images under vacuum conditions. For AFM scanning, a next-generation liquid cell and a new protocol for creating long and sharp sapphire tips was introduced. Initial AFM images showed only layers of residual detergent molecules (sodium dodecyl sulfate, SDS), which are used to isolate the S-layer proteins from the cells. SDS was not visible in the TEM images, requiring more thorough sample preparation for AFM measurements. These improvements allowed us to resolve the crystal-like structure of the S-layer samples with frequency-modulation AFM in both air and liquid.

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BP 15.2 Tue 18:00 Poster F

High-resolution chemical imaging of model system Bacillus *subtilis* using mid-IR photo-induced force microscopy (PiF-IR) — •Selema Buzhala[1,2], Robin Schneider[1], Maryam Ali[2], Astrid Tannert[1,3], Sebastian Unger[1,2], Rainer Heintzmann[1,2], Ute Neugebauer[1,2,3], and Daniela Täuber[1,2] — [1]Leibniz Institute of Photonic Technology, Jena — [2]Friedrich Schiller University Jena — [3]Jena University Hospital, Center for Sepsis Control and Care, Jena, Germany

Mid-infrared photo-induced force microscopy (PiF-IR) offers high spectral resolution in combination with surface sensitivity and a spatial resolution in the range of a few nanometers. In a recent study, we demonstrated its ability to reveal local variations in the secondary protein structure of F-Actin on a scale of 5 nm [1]. Here we apply PiF-IR to individual cells of the well-known Bacillus *subtilis* treated with an antibacterial drug and to untreated controls. Cropped scans at high spatial resolution visualize variations in the sugar and peptide contents of the bacterial cell walls. Additional chemical information is provided from the analysis of hyperspectral images using home-written software. [1] J. Joseph, L. Spantzel, M. Ali, D.M. Joseph, S. Unger, K. Reglinski, C. Krafft, A.-D. Müller, C. Eggeling, R. Heintzmann, M. Börsch, A.T. Press, D. Täuber. Nanoscale chemical characterization of secondary protein structure of F-Actin using mid-infrared photoinduced force microscopy (PiF-IR). Spectrochimica Acta part A: Molecular and Biomolecular Spectroscopy, 306, 123612, 2024.

BP 15.3 Tue 18:00 Poster F

Robust and fast sorting of droplets in microfluidic devices by droplet size and droplet content based on bright field and fluorescent information — •Jonas Pfeil[1,2], Patricia Schwilling[1], and Othmar Marti[1] — [1]Universität Ulm, Ulm, Deutschland — [2]Sensific GmbH, Biberach, Deutschland

Droplet-based microfluidics is a promising tool to manipulate biological systems in small sample volumes down to single-cell level. Active sorting of droplets allows to enrich target configurations with high selectivity and selectivity.

We present methods and tools required to enrich droplets based on size and content in multiplexed bright-field and fluorescent microscopic imaging at sorting rates of 60 Hz. The PDMS-based microfluidic device uses a two electrode design with an high voltage AC field to sort droplets via dielectrophoretic forces.

BP 15.4 Tue 18:00 Poster F

Scanning small angle x-ray scattering of hydrated cells in flow environment — •Boram Yu[1], Mangalika Sinha[1], Rita Mendes da silva[1,2], Peter Luley[1], Manfred Burghammer[2], and Sarah Köster[1] — [1]Institute for X-Ray Physics, University of Göttingen, Germany — [2]European Synchrotron Radiation Facility (ESRF), Grenoble, France

Imaging biological cells using x-rays is a complementary approach to electron and fluorescence microscopy due to their high penetration depth and the possibility for label-free imaging. One such technique is scanning small angle x-ray scattering (SAXS), which provides both real space overview images with moderate resolution and reciprocal space information with high resolution, making it useful for obtaining structural information of ordered intracellular structures. However, imaging cells in an aqueous state, i.e., in a physiological environment, is challenging due to low electron density contrast, pronounced radiation damage, and radiation-induced gas formation. To overcome these challenges, we built a dedicated flow sample chamber, offering minimized thickness of the liquid layer in the beam path while continuously exchanging liquid during scanning. Using this technique, we conducted a study on fixed-hydrated mammalian cells with cytokeratin bundle networks. Despite the weak contrast and short exposure time, we were able to obtain distinguishable differences in strongly ordered cell components. It implies that scanning SAXS combined with the flow sample chamber offers structural information from fixed-hydrated cells in liquid flow.

BP 15.5 Tue 18:00 Poster F

Structure and mechanics of actomyosin contractility in hiPSC cardiomyocytes — •Mangalika Sinha[1], Boram Yu[1], Rita Mendes da Silva[1,3], Isabelle Refke[1,2], Manfred Burghammer[3], Ulrike Rölleke[1], and Sarah Köster[1] — [1]Institute for X-Ray Physics, University of Göttingen, Germany — [2]University Medical Center, Göttingen, Germany — [3]European Synchrotron Radiation Facility (ESRF), Grenoble, France

Cardiomyocytes derived from human induced pluripotent stem cells (hiPSC-CMs) are an interesting model system for studying heart activity and cardiovascular diseases in human. These cells contain sarcomeres, composed of actin-myosin, which is responsible for the contractility of cardiac muscles. Moreover, the contraction of these cardiac muscle cells depends on the geometry of these sarcomeres. In this study, we use complementary techniques, small angle x-ray scat- tering (SAXS) and traction force microscopy (TFM), to understand the relation between well-aligned sarcomeres and the contractile force generation of the actin-myosin complexes present in the muscle cells.Our SAXS results enable us to quantify the orientation of the sarcomeric structures. It correlates well with the fluorescence microscopy images of the actin filaments. The TFM data provide insights into contractile force generation. These findings play an important role in understanding the contractile nature of the sarcomeres and their behavior in healthy and diseased human heart.

BP 15.6 Tue 18:00 Poster F

Insights from live non-linear microscopy imaging: comparative analysis of temperature-induced mitochondrial morphology shifts using standard versus machine-learning method — •Marta Bukumira[1], Aleksandra Vitkovac[2], Tanja Pajić[2], Marina Stanić[3], Mihailo Rabasović[1], and Nataša V. Todorović[4] — [1]University of Belgrade, Institute of Physics, Belgrade, Serbia — [2]University of Belgrade, Faculty of Biology, Belgrade, Serbia — [3]University of Belgrade, Institute for Multidisciplinary Research, Belgrade, Serbia — [4]University of Belgrade, Institute for Biological Research "Siniša Stanković", Belgrade, Serbia

Using two-photon excited fluorescence (TPEF) modality of our home built nonlinear laser scanning microscope, we investigated, as a proof of principle, mitochondrial morphology adaptations in an eukaryotic cell in vivo, as a response to cooler ambient temperature during growth. The cells were stained with the vital mitochondrial dye Rhodamine 123 in order for mitochondria to exhibit TPEF. We compared cultures grown at two cooler and one control temperature. Acquired images show superior level of clarity and an optimal signal-to-noise ratio, allowing for the morphology differentiations of intricate subcellular structures influenced by subtle temperature variations. Two approaches for extracting parameters from TPEF images were juxtaposed: standard

method of particle analysis in ImageJ and nonstandard method in Ilastik, a machine learning-based software. The latter demonstrated greater suitability for this type of analysis, showing increased efficiency in terms of time and reduced susceptibility to errors.

BP 15.7 Tue 18:00 Poster F

Functionalization of carbon nanoparticles for a cellular application — •Carla Sprengel, Lennard Fastabend, Cathrin Nollmann, and Thomas Heinzel — Condensed Matter Physics Laboratory, Heinrich Heine University, Düsseldorf, Germany

Nanoparticles as carriers in drug delivery systems are gaining in interest in the field of cancer therapies. Transporting drugs directly into targeted cells could enhance the efficiency and reduce side-effects in therapy. The carbon nanodots presented here show promise as potential carriers because of their low cytotoxicity and cellular uptake via endocytosis. Furthermore, the particles can be localized on a cellular level due to their fluorescence properties. Since an effective functionalization of our particles is crucial for the application in drug-delivery systems, we tested our particles as carriers by binding a polymer to them. Here we present the successful functionalization of our carbon nanoparticles and a cellular uptake into the lysosomes of MCF-7 cells.

BP 15.8 Tue 18:00 Poster F

Multifunctional Photoluminescent Quantum dots as Amplifiers for 1O2 Generation and Synergistic Enhanced Photodynamic Therapy — •Zahid Ullah Khan[1], Latif Ullah Khan[2], Hermi Felinto de Brito[1], and Paolo Di Mascio[1] — [1]Institute of Chemistry, University of São Paulo (USP), 05508-000, São Paulo-SP, Brazil — [2]Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME) P.O. Box 7, Allan 19252, Jordan.

The development of multi-functional nano-platform with integrated diagnostic and therapeutic features is highly desired for precise treatment. Here, we report the synthesis of CdSe/ZnS core-shell QDs by new method, which exhibited wide-range color-tunability (490-570 nm). The color tuning was achieved as result of interfacial alloying (predominantly exchange of Se2- by S2- anion) without changing the size of NCs. The QDs demonstrated efficient singlet molecular oxygen (1O2) quantum yields of 14, 12, and 18% for yellow-emitting CdSe/ZnS QDs (I), green-emitting CdSe/ZnS QDs (II), and blue-emitting CdSe/ZnS QDs (III), respectively. The 1O2 was produced by QDs via triplet-triplet energy transfer to dioxygen. The QDs were studied in macrophage cells that internalized the NCs via energy-dependent endocytosis predominantly macropinocytosis and other lipid raft-mediated endocytic pathways and manifested considerable amount in the intracellular regions without causing cytotoxicity3. In summary, the study will open new possibilities of band edge engineering and pathway-specific delivery of QDs-based theranostic into a site of interest for simultaneous bioimaging and photodynamic therapy.

BP 15.9 Tue 18:00 Poster F

In vivo Actin staining approaches validated using structured illumination and expansion microscopy — •Shangjun Cheng[1,2,3], Sara Gjeci[1,3], Aleksandar Rusevski[1,3], Patrick Then[1,4], Hans-Dieter Arndt[1], Rainer Heintzmann[1,2], Daniela Täuber[1,2], and Adrian T. Press[1,3] — [1]Friedrich Schiller University Jena — [2]Leibniz Institute of Photonic Technology, Jena — [3]Jena University Hospital, Jena — [4]Microverse Imaging Center, Jena, Germany

Actin assembly and disassembly is essential for any type of cell mobility. Variations in Actin content in liver tissue have been found to be an indicator for animal survival in a recent study utilizing a mouse model for systemic infection [1]. In vivo imaging of Actin, thus, provides access to enhanced understanding of cellular behavior in various areas of research including the response to infection and therapy. We use structured illumination and expansion microscopy to evaluate several approaches for in vivo Actin staining. [1] P. Martinac, A.T. Press, A. Medyukhina, K.-J. Benecke, J. Shi, D. Täuber, S. Hoeppener, Z. Cseresnyes, I.G. Scheblykin, M.H. Gräler, I. Rubio, M.-T. Figge, U.S. Schubert. M. Bauer: Inhibition of phosphoinositide 3-kinase-y improves liver function in sepsis by preventing RhoA-mediated cholestasis in 9th International Congress "Sepsis and Multiorgan Dysfunction", Infection, 47, S6-S7, 2019.

BP 15.10 Tue 18:00 Poster F

Combining fluorescence lifetime imaging and expansion microscopy for investigation of Actin staining approaches — •Elza Sunil[1], Shangjun Cheng[1,2,3], Subham Adak[1], Sara Gjeci[1,3], Aleksandar Rusevski[1,3], Hans-Dieter Arndt[1], Adrian T. Press[1,3], Daniela Täuber[1,2], and Rainer Heintzmann[1,2] — [1]Friedrich Schiller University Jena — [2]Leibniz Institute of Photonic Technology, Jena — [3]Jena University Hospital, Jena, Germany

Cytoskelettal Actin plays an important role in cell stability and mobility. In a previous study, an increased amount of aggregated F-Actin has been found in liver tissue from infected animals in a mouse model for systemic infection [1]. We combine fluorescence lifetime imaging and expansion microscopy to evaluate different Actin staining approaches aiming at enhancing our understanding of Actin aggregation in the context of infection and therapy. [1] P. Martinac, A.T. Press, A. Medyukhina, K.-J. Benecke, J. Shi, D. Täuber, S. Hoeppener, Z. Cseresnyes, I.G. Scheblykin, M.H. Gräler, I. Rubio, M.-T. Figge, U.S. Schubert. M. Bauer: Inhibition of phosphoinositide 3-kinase-y improves liver function in sepsis by preventing RhoA-mediated cholestasis in 9th International Congress "Sepsis and Multiorgan Dysfunction", Infection, 47, S6-S7, 2019.

BP 15.11 Tue 18:00 Poster F

Synchronisation of confocal laser scanning and single photon counting in a homebuilt Fluorescence lifetime imaging microscopy (FLIM) setup — •Subham Adak[1,2,3], Elza Sunil[1,2], Monalisa Goswami[1,2], Daniela Täuber[1,2], and Rainer Heintzmann[1,2,3] — [1]Leibniz Institute of Photonic Technology, Jena — [2]Institute of Chemical Physics, Friedrich Schiller University Jena — [3]Abbe Center of Photonics, Jena, Germany

Fluorescence Lifetime Imaging Microscopy (FLIM) is an attractive microscopy method in the life sciences, yielding information on the sample otherwise unavailable through intensity-based techniques [1]. In our homebuilt FLIM setup we combine a confocal laser scanning system from LaVison BioTec with a single photon counting system from picoQuant. The triggers for confocal scanning and for single photon acquisition are carefully synchronized. We tested (i) the accuracy of the determined lifetimes, and (ii) the time and spatial resolution of the instrument using fluorescent beads of different diameters. [1] A. Le Marois, S. Labouesse, K. Suhling, and R. Heintzmann, (2017), Noise-Corrected Principal Component Analysis of fluorescence lifetime imaging data. J. Biophoton., 10: 1124-1133.

BP 15.12 Tue 18:00 Poster F

Oxygen Measurements of single Red Blood Cells by Lightmicrospy — •Sarah Tabea Hermes, Agatha Belen Pinto Pino, Thomas John, and Christian Wagner — Campus E2.6 66123 Saarbrücken

The red blood cells in our body have a very high affinity for absorbing oxygen. In the lungs, they are loaded with oxygen and release it again in the body. The release of oxygen changes the light spectrum of the hemoglobin, thereby slightly altering its color. At selected wavelengths, this difference is significant and can be utilized to detect the O_2 content of individual cells using light microscopy. We are discussing various methods to prepare red blood cells in vitro without O_2. The objective is to investigate the oxygen release or uptake of individual cells under microfluidic conditions.

BP 15.13 Tue 18:00 Poster F

Monitoring the developmental dynamics of cysts with light sheet microscopy — •Ivana Jeremic, Paula Gironés Payá, Florian Rehfeldt, and Matthias Weiss — University of Bayreuth, Bayreuth, Germany

Proper epithelial morphogenesis is crucial for organ development and functioning. Understanding the mechanisms that guide morphogenesis is essential, not only for decoding the fundamental biology of organs but also for a better comprehension of the processes involved at the onset and progression of diseases. A key aspect of morphogenesis, e.g. in the kidney, is the formation of cell clusters that surround a hollow lumen. Development of the lumen depends on the interaction of epithelial cells with the extracellular matrix (ECM). So far, two primary mechanisms for lumen creation have been identified: cavitation and hollowing. During cavitation, cells in the center of spheroids undergo apoptosis, hence creating a hollow space. In contrast, during hollowing small endocytic vesicles are created that later fuse to produce a central lumen. Which of these two mechanisms is predominant depends on the interplay of various mechanical and chemical cues. In our project, we explore the influence of substrate composition and stiffness on the development of Caco-2 cell cysts. Monitoring of cyst development is facilitated by a custom-made light sheet microscope, designed for live-

cell imaging of samples with a few hundred micrometers in diameter. Our preliminary data suggest that the mechanical properties of the surrounding matrix is key for the formation of a single lumen or multiple lumina in a given cell cluster.

BP 15.14 Tue 18:00 Poster F

Quantum optics meets microscopy - An ultra-sensitive resonator microscope for nano- and life sciences — •Florian Steiner, Rute Fernandes, Maerpreet Arora, and Thomas Hümmer — Ludwig-Maximilians-University Munich, Department of Physics, Munich, Germany

Isolated nanoscale systems provide only weak interaction with light due to their small size and therefore are often indirectly investigated via fluorescence microscopy. This limits insights into individual nanosystems and slows down research in the fields of nanotechnology, material science, drug design, and pharmaceutical diagnostics.

We can overcome these limitations by using of optical microresonators, a technology pioneered in quantum optics [1]. In these resonators, light strongly interacts with a sample and thereby enhances weak absorption for several orders of magnitude. The small mode waist in micro-cavities enables a scanning microscopy approach, i.e. ultra-sensitive spatially resolved absorption measurements near the diffraction limit, can be performed [2]. By optimizing the mechanical stability and by developing integrated electronics, extinction cross section of 1 nm2 can be imaged in real time. Different illumination energies allow sample characterization via their spectral profile.

The potential of the new microscope will be illustrated by examples including label free imaging of ultrathin human tissue sections [3].

1. D. Hunger et al., New J. Phys. 12, 065038 (2010) 2. M. Mader et al., Nat. Commun. 6, 7249 (2015) 3. J. Noe et al., Imaging & Microscopy 4 (2022)

BP 15.15 Tue 18:00 Poster F

MINFLUX allows measuring the Measuring Mean Back Relaxation in cells using fluorescent probes — •Tobias Deisel, Till Münker, Bart Vos, and Timo Betz — Third Institute of Physics, Georg-August Universität Göttingen, Göttingen, Germany

Living systems like cells exhibit dynamics far from thermodynamic equilibrium. In order to study such non-equilibrium systems, we need to use analytical methods beyond the classical methods developed in statistical physics. We have recently introduced the Mean Back Relaxation (MBR), which exploits a three-point probability function and is solely derived from passive measurements. A main hurdle in using the MBR is the requirement of particle trajectories with high temporal and spatial precision, that are sufficiently long to detect activity. In normal fluorescence microscopy, it is not possible to achieve this because of probe bleaching. To overcome this, we measure the MBR using MINFLUX nanoscopy, which is able to track fluorescent particles at a spatial-temporal resolution in the order of nanometers at a frequency in the order of a few kHz. This makes it an interesting tool to record detailed trajectories needed to evaluate the MBR, and paves the way to exploit the MBR even in single molecule imaging.

BP 15.16 Tue 18:00 Poster F

Motility of Salmonella Typhimurium above and within mucus — •Kevin Diestelhorst[1], Fereshteh Ghazisaeedi[2], Anton Klimek[3], Sebastian Braetz[2], Karsten Tedin[2], Marie Weinhart[1,4], Roland Netz[3], Marcus Fulde[2], and Stephan Block[1] — [1]Institute of Chemistry and Biochemistry, Freie Universität Berlin — [2]Institute of Microbiology and Epizootics, Freie Universität Berlin — [3]Department of Physics, Freie Universität Berlin — [4]Institute of Physical Chemistry and Electrochemistry, Leibnitz Universität Hannover

How do infectious agents like bacteria overcome protecting biohydrogels, such as the glycoalix or mucus? To address this question, the motion of GFP-labeled Salmonella Typhimurium in bulk solution and within hydrogels was recorded by fluorescence microscopy. A method is presented, which enables to correct the strong fragmentation of raw bacterial trajectories (caused by broad bacterial size distributions). In line with previous studies, random as well as ballistic bacterial motility is observed, the extent of which depends on the expression of key proteins. Analyzing random and deterministic features of the ballistic trajectories indicates that flagella-generated propulsion force is on the order of 100 fN per bacterium. To extend these investigations to 3D motion of bacteria across mucus, epithelial cells were cultured, leading to the formation of a native mucus layer on their apical side. The dynamics of bacterial penetration through mucus was followed by continuously recording fast 3D stacks of the cell culture. The experiments indicated that the invasion proceeded via tunnel-like structures.

BP 15.17 Tue 18:00 Poster F

Adapting your super-resolution microscope setup to the sample requirements — •Florian Schock[1,2] and Christoph Cremer[2,3] — [1]Institute for Physics, University of Mainz — [2]Kirchhoff Institute for Physics, University of Heidelberg — [3]Max Planck Institute for Polymer Research, Mainz

Several decades after the first development of super-resolution microscopy (SRM), methods to circumvent the Abbe limit of optical resolution, commercial devices have become almost standard equipment on the academical level. The introduction of commercial devices has many advantages for a wide range of users, but also means that the adaptive potential of devices developed in specialized microscopy groups is lost. Here we would like to give a brief overview of some of the possibilities and considerations necessary to serve different applications ranging from biology to materials science. In particular, we would like to point out that SRM is about methods. For example, circumventing the Abbe limit is possible even for small numerical apertures. An example of this is the SRM application in ophthalmology.

BP 15.18 Tue 18:00 Poster F

Electro-optic imaging for a lightsheet based fluorescence lifetime imaging microscope (FLIM) — •Nils Bode[1], Adam Bowman[2], Dara Dowlatshahi[3], Rose Knight[3], Soichi Wakatsuki[3], and Mark Kasevich[2] — [1]Physics Department, Friedrich-Alexander-Universität Erlangen-Nürnberg, Staudtstraße 1, 91058 Erlangen, Germany — [2]Physics Department, Stanford University, 382 Via Pueblo Mall, Stanford, CA 94305, USA — [3]School of Medicine, Stanford University, 318 Campus Drive West, Clark Center, Stanford, CA 94305, USA

Electro-optic imaging enables fast fluorescence lifetime microscopy with throughputs that are $10^3 - 10^5$ times higher than those of typically used single photon counters. This enables the investigation of biological processes, like spatially resolved neuron activity and action potential propagation, that are beyond earlier systems capability. The presented electro-optic imaging setup utilizes a Pockels cell in combination with polarization splitting optics to acquire two distinct temporal gates per frame, whose ratio allows for lifetime calculation. For this work an electro-optical setup was built around a classical lightsheet microscope. This combination enables fast fluorescent lifetime imaging of volumetric samples. We used *Arabidopsis thaliana* seedlings, both labeled and label-free, as biological sample systems and performed spatial and lifetime calibration with fluorescent beads.

BP 15.19 Tue 18:00 Poster F

Visualizing Molecular Dynamics with High-Speed Tip-Scanning Atomic Force Microscopy — •Jörg BArner, Andre Körnig, Thomas Henze, and Heiko Haschke — JPK BioAFM Business, Bruker Nano GmbH, Am Studio 2D, 12489 Berlin, Germany

Biological systems exhibit very high structural and functional dynamics on molecular scales. Understanding the principles of the kinetics behind structural changes at that scale is of critical importance when studying samples ranging from single membrane proteins to complex macromolecular systems, in order to accurately develop novel therapeutic applications. We have used high-speed tip-scanning atomic force microscopy (AFM) with a kilohertz line-rate to visualize molecular dynamics by enabling temporal resolution on the sub-100-milisecond scale. The use of a tip-scanning AFM, as compared to a sample-scanning system, enables high-resolution correlation experiments with advanced optical techniques. We will give two examples in which high-speed tip-scanning AFM was applied for studying of structural transitions and biomolecular dynamics in samples, containing triangular DNA origamis and photosensitive azobenzene-containing surfactants.

BP 15.20 Tue 18:00 Poster F

Virtual 3D Histology using Synchrotron Radiation: Present Status of GINIX, Outlook to PETRA IV — •Markus Osterhoff and Tim Salditt — Institut für Röntgenphysik, Uni Göttingen, Göttingen

We present the current state of the art of Synchrotron based phase-contrast tomography in a multi-scale setup.

In waveguide-filtered cone-beam geometry, high resolution scans (voxel sizes reaching 100 nm) reveal minute details of the specimen,

at the scale of organelles. Conversely, the parallel beam geometry facilitates rapid acquisition, capturing a larger field of view, thereby integrating sub-cellular data within a broader physiological context. Thus, tomography scans with voxel sizes of 650 nm achieve a 2D in-plane resolution comparable to microscopic histology. However, as a non-invasive, fully three-dimensional technique, it eliminates the need for physical slicing of samples, resulting in isotropic 3D resolution.

We could image human lung tissue severely affected by Covid-19, and evidence diffuse alveolar damage with its prominent hyaline membrane formation. Extending conventional histopathological examination by a third dimension allows to analyse the delicate pathological changes of the vascular system of severe Covid-19 progressions.

In the future, with GINIX II we are aiming to improve biomedical x-ray tomography at better spatial resolution under physiological conditions. Notably, automated measurements and real-time analysis of raw detector images ensures balance between speed and accuracy for clinical diagnostics and research applications.

BP 15.21 Tue 18:00 Poster F

Infrared optical and thermal properties of snail shells — •Natanja Elliger[1], Bruno Gompf[1], Heinz-R. Köhler[2], and Martin Dressel[1] — [1]1. Physikalisches Institut, Universität Stuttgart, 70569 Stuttgart, Germany — [2]Physiologische Ökologie der Tiere, Institut für Evolution und Ökologie, Universität Tübingen, 72076 Tübingen, Germany

Land snails of arid habitats endure intense sunlight for months without overheating although their body is surrounded by a closed shell with its aperture sealed, minimising possible evaporative cooling. The thermoregulation process that enables land snails to withstand high temperatures is yet unknown. In a systematic investigation, we study the relationship between the optical and infrared optical properties and the thermodynamic properties to the underlying nano-/microstructures of the shells. We employ FTIR reflection measurements as well as absorption (photoacoustic) measurements in the Mid-IR to VIS spectral range on snails from different habitats. Additionally, we perform scatterometry in the NIR to VIS spectral range to investigate the diffuse reflection and possible Lambertian behaviour. With the combination of these techniques, we hope to gain a thorough understanding of how snails keep their houses up to 10°C colder than the stones nearby.

BP 15.22 Tue 18:00 Poster F

Rate-independent hysteretic energy dissipation in collagen fibrils — •Martin Dehnert, Paul Zech, Alexandra Bendixen, Andreas Otto, and Robert Magerle — Fakultät für Naturwissenschaften, Technische Universität Chemnitz, Germany

Nanoindentation cycles measured with an atomic force microscope on hydrated collagen fibrils exhibit a rate-independent hysteresis with return point memory. This previously unknown energy dissipation mechanism describes in unified form elastoplastic indentation, capillary adhesion, and surface leveling at indentation velocities smaller than $1\,\mu$m/s, where viscous friction is negligible. A generic hysteresis model, based on force–distance (FD) data measured during one large approach-retract cycle, predicts the force (output) and the dissipated energy for arbitrary indentation trajectories (input). While both quantities are rate-independent, they do depend nonlinearly on the indentation history and on the indentation amplitude. We present different types of cyclic FD measurements performed on native collagen fibrils in humid air. The energy dissipation is mainly caused by plastic deformation during tip indentation and it can be quantified with the plasticity index. The latter can be used for high-resolution mapping of connective tissues.

BP 15.23 Tue 18:00 Poster F

Haptic Perception of Nanomechanical Surface Properties — •Paul Zech, Martin Dehnert, Alexandra Bendixen, Andreas Otto, and Robert Magerle — Fakultät für Naturwissenschaften, TU Chemnitz

In the realm of analyzing and presenting scientific data, scientists heavily rely on their visual perception. Graphical representations of data, either as diagrams or tables, appear to be the standard approach. Here, we present a method for exploring nanomechanical properties on the human scale through haptic perception. This methodology opens up the possibility of utilizing multiple human senses simultaneously when analyzing data. We use a haptic device to translate the tip–sample interaction forces measured with an atomic force microscope (AFM) on the nanometer scale into forces perceivable by humans. In doing so, we introduce a generic rate-independent hysteresis model that describes sequences of mechanical phenomena occurring in AFM-based nanoindentation experiments, including plastic indentation, elastic response, capillary adhesion, and surface leveling. This model accurately describes the complex nanomechanical behavior of collagen fibrils in native tendon, and it is also applicable to other soft materials. As an example for human tissues, we demonstrate the interactive haptic exploration of gelatin droplets at different relative humidities. This allows to vary the mechanical properties of gelatin over a large range, from a stiff solid to a very soft gel.

BP 15.24 Tue 18:00 Poster F

Influence of water content on nanomechanical properties of native tendon tissue — •Mario Zerson, Martin Dehnert, Paul Zech, and Robert Magerle — Fakultät für Naturwissenschaften, TU Chemnitz

Water is an essential component of natural tissues, providing elasticity to collagen fibrils and their interfibrillar matrix. Atomic force microscopy (AFM) in humid air enables high-resolution imaging of the nanomechanical properties of collagen fibrils in native tendons. Accurate control of humidity and temperature is essential for reproducible measurements of nanomechanical properties in AFM-based nanoindentation experiments. Here we report on the influence of relative humidity on the nanomechanical properties of native tendon tissue obtained from the calcaneus (Achilles) tendon of chickens. The sample is exposed to a flow of humid air with controlled relative humidity and force–distance data are measured. We use the same tip on the same collagen fibrils for different levels of relative humidity. This eliminates variation due to differences in tip shape and different tissue samples. Our data show the variation of effective indentation modulus and plasticity index as a function of relative humidity in the range of 40 to 95%. We compare these results with analogous experiments on gelatin films.

BP 15.25 Tue 18:00 Poster F

Triacylglycerides influence water content and nanomechanical properties of collagen fibrils — Martin Dehnert, •Tiberius Klose, Yang Pan, Dietrich R. T. Zahn, and Robert Magerle — Fakultät für Naturwissenschaften, TU Chemnitz

Lipids are an essential component of connective tissue, which includes tendons, ligaments and cartilage. They act as lubricants in joints and tendons, with a major component being triacylglycerides. In cases of excess adiposity and other diseases, excess cholesterol is found in tendons, where it forms granular domains (xanthoma). However, the presence and effect of lipids in natural (healthy) collagen fibrils is poorly understood. Here, we show that collagen fibrils extracted from chicken calcaneal (Achilles) tendon contain triacylglycerides that influence the nanomechanical properties and water uptake of the fibrils. After extracting the lipids with organic solvents, we measure an increased swelling behavior and an increased indentation modulus in collagen fibrils using atomic force microscopy. With Raman spectroscopy, we identify triacylglycerides as the major lipid component. Our results demonstrate that triglycerides are an essential component of the natural collagen fibril structure, where they act as plasticizers and mediate the fibril's water content and mechanical properties. This methodology could be used to investigate the influence of lipids on the biomechanical properties of connective tissues during development, ageing, and diseases. In particular, the effect of nutrition, which has a major influence on lipid balance, could be studied.

BP 15.26 Tue 18:00 Poster F

Simulating synthetic, DNA-based systems across different scales — •Aaron Gadzekpo[1], Xenia Tschurikow[1], Mai Tran[2], Rakesh Chatterjee[3,4], Vasily Zaburdaev[3,4], Kerstin Göpfrich[2], and Lennart Hilbert[1] — [1]Karlsruhe Institute of Technology — [2]Max Planck Institute for Medical Research — [3]Max Planck Zentrum für Physik und Medizin — [4]Friedrich-Alexander Universität Erlangen-Nürnberg

Molecular dynamics (MD) simulations at different scales can aid in the design and characterisation of synthetic biological systems. Combining coarse-grained MD-simulations with experiments allowed us to explain how the shape of droplets formed by self-interacting DNA-nanomotifs responds to adding increasing concentrations of amphiphilic nanomotifs. Currently, we are investigating how DNA-strands can serve as condensation surfaces for droplet formation at subsaturated nanomotif concentrations. To accurately simulate microscopic aspects of our DNA-based systems, such as transient hybridisation that underlies nanomotif interactions, we employ simulations at resolutions of one to a few nucleotides. Capturing macroscopic behaviour, such as phase

separation, requires simulating larger systems sizes and time scales, for which we develop models averaging many nucleotides. We present ongoing research aimed at integrating simulations at different scales for model-guided design of synthetic, DNA-based systems.

BP 15.27 Tue 18:00 Poster F

How Crowding and Confinement change the Phase Behavior of Intrinsically Disordered Nuclear Proteins — •Janka Bauer[1], Dorothee Dormann[2,3], and Arash Nikoubashman[1,4,5] — [1]Institute of Physics, JGU Mainz, Germany — [2]Biocenter, Institute of Molecular Physiology, JGU Mainz, Germany — [3]Institute of Molecular Biology, Mainz, Germany — [4]Leibniz-Institut für Polymerforschung, Dresden, Germany — [5]Institut für Theoretische Physik, Technische Universität Dresden, Germany

The liquid-liquid phase separation of intrinsically disordered proteins plays an integral part for the formation of membraneless organelles in cells, which in turn have key functional and regulatory roles. Many studies on LLPS focus on in vitro experiments and bulk simulations in solution, but real-life systems are highly influenced by crowding within a cell as well as the confinement by the cell membrane. To mimic more closely conditions prevalent in cellular environments, we perform coarse-grained molecular simulations [1] of the low-complexity domains of heterogeneous nuclear ribonucleoprotein A1 (hnRNPA1) and Fused in Sarcoma (FUS) in spherical confinement, where we systematically vary the fraction of the crowding agent polyethylene glycol (PEG). We further elucidate how the elasticity of a PEG network influences and even limits size and mobility of the protein condensates.

BP 15.28 Tue 18:00 Poster F

Structural motif stability of bacteriophage MS2 RNA packaging signals upon changes in their flanking sequence — •Veronika Bukina[1,2] and Anže Božič[1] — [1]Jožef Stefan Institute, Ljubljana, Slovenia — [2]University of Ljubljana, Slovenia

The RNA motifs can be responsible for specific important functions. For instance, in bacteriophage MS2, they serve as packaging signals (PSs), which play a crucial role in binding viral coat proteins during capsid assembly. This work aims to analyze motif structural stability on the example of the well-studied MS2 virus. As a consequence of current experimental studies, which reveal the multiple putative PS sites across the MS2 RNA genome, we focus on 14 RNA motifs of the virus, including the most widely known TR hairpin. The study of motif stability involves manipulating the flanking sequences surrounding them and comparing various measures calculated from their secondary structure, such as structure probability, ensemble defect, and Shannon entropy. To verify the tertiary structures of these RNA segments, the oxDNA software is employed. Our results show the stability of certain motifs regardless of the presence or absence of sequences around them, even when the nucleotide content of flanking sequences is randomized. Conversely, other unstable motifs are stabilized by genome or flanking sequences that tell us about the importance of the particular structure as well as of the genome sequence. The outcome of this work is beyond viral PS structural stability, extending to applications in RNA binding protein (RBP) studies and more.