BP 8: Poster Session Ia

Cytoskeleton, Membranes and Vesicles, Cell Mechanics. Additional posters on Cell Mechanics in Poster Session Ib.

Time: Monday 18:00–20:30 Location: Poster C

BP 8.1 Mon 18:00 Poster C

Microtubule dynamics in the presence of an actin network — •Saheli Dey, Tiago Mimoso, and Sarah Köster — Georg-August-Universität Göttingen

The eukaryotic cytoskeleton is a composite network of biopolymers of variable flexibilities. It drives many important biological processes such as cell division and motility. In response to external and internal stimuli, the cytoskeleton rapidly rearranges itself. This property is achieved with the aid of microtubules and actin filaments, which are the dynamic components of the cytoskeleton. Since these biopolymers co-exist in a cell, our focus lies on understanding microtubule dynamics in a composite network system. Using a bottom-up approach, we investigate whether actin filaments influence microtubule dynamics. Total internal reflection fluorescence (TIRF) microscopy serves as an essential tool to capture the dynamics of the microtubules in our experiments. Based on our analysis from kymographs, we quantify the polymerization and depolymerization rates of microtubules. Furthermore, rescue and catastrophe frequencies indicate the influence of actin filaments on the stability of microtubules. Till now studies have shown interaction between these two cytoskeletal filaments in the presence of motor proteins or cross-linkers. Complementary to those results, our study provides insight into direct filament-filament interactions and will answer the question of whether actin filament networks stabilize dynamic microtubules against depolymerization.

BP 8.2 Mon 18:00 Poster C

Imaging F-Actin arrangement via homo-FRET using 2D polarization fluorescence microscopy — Lukas Spantzel[1,2], Chen Sun[3], Lena Jesse[1,2], Yunhao Mei[1,4], Yutong Wang[1,4], Shangjun Cheng[1,2,4], Mohammad Soltaninezhad[1,4], Michael Börsch[1,2], Rainer Heintzmann[1,4], Ivan G. Scheblykin[3], Adrian T. Press[1,2], and •Daniela Täuber[1,4] — [1]Friedrich Schiller University, Jena — [2]University Hospital Jena — [3]Lund University, Sweden — [4]Leibniz Institute of Photonic Technology, Jena, Germany

Polymicrobial infection affects the organization of F-Actin in the cytoskeleton and the cortex causing cell death. We use 2-dimensional polarization fluorescence imaging (2DPOLIM) to visualize the aggregation of phalloidin-dye labeled F-Actin via Förster Resonance Energy Transfer (homo-FRET). The homo-FRET efficiency observed from fibrillar structures in mouse embryonal fibroblasts agrees well with that of single fibrillar F-Actin synthesized from non-muscle Actin. Higher values are observed from other structures inside the cells, representing a more dense aggregation of the F-Actin in those regions.

BP 8.3 Mon 18:00 Poster C

Influence of the cytoskeletal surrounding on microtubules in cells — •Anna Blob[1], Roman David Ventzke[1,2], Thomas Giacomo Nies[2], Axel Munk[2], Laura Schaedel[3], and Sarah Köster[1] — [1]Institute for X-Ray Physics, University of Göttingen — [2]Institute for Mathematical Stochastics, University of Göttingen — [3]Center for Biophysics, Saarland University

The cytoskeleton in eucaryotic cells determines essential cellular functions and properties. It is an intricate network of three different filamentous proteins, microtubules, actin filaments and intermediate filaments, each of which has unique features. Microtubules are important for intracellular transport and withstand compressive forces while exhibiting characteristic bending and buckling in cells. Interactions between cytoskeletal filaments have been found, such as the templating of microtubules by vimentin intermediate filaments in cells. Yet, the scope and consequences of such cytoskeletal interdepence are not fully understood. Here, we investigate how the orientation and bending of microtubules in cells is influenced by actin and vimentin intermediate filaments. We compare microtubule networks in vimentin-knockout and wildtype mouse fibroblasts on micropatterns and disturb the actin network chemically. We find that microtubules are radially oriented regardless of the presence of vimentin or actin. The local curvature of microtubules is not influenced either, even if the cells are under mechanical compression. Our study suggests that the organization and mechanical behavior of microtubules in cells may be more independent of the surrounding cytoskeleton than expected.

BP 8.4 Mon 18:00 Poster C

Keratin and actin networks in epithelial cells under uniaxial strain — •Ruben Haag[1], Ruth Meyer[1], Peter Luley[1], Nicole Schwarz[2], and Sarah Köster[1] — [1]Institute for X-Ray Physics, University of Göttingen — [2]Institute of Molecular and Cellular Anatomy, RWTH Aachen University

The cytoskeleton is mainly made up of microtubules, actin and intermediate filaments (IFs). The composition of the IF-network is cell-type specific and influences the viscoelastic properties of cells. In some epithelial cell types, the keratin IFs forms a rim close to the F-actin cortex. It is hypothesized that this so-called "IF-cortex" is linked to radial keratin spokes, forming a "rim-and-spokes"-structure. This hypothesis leads to the question of how the IF and actin cortices complement each other. Furthermore, it was previously observed that keratin IF, unlike actin filaments, survive being stretched to high strains. We now ask the question of whether this unique force-extension behavior of keratin is also relevant in whole cells, and of how both the IF and the actin cortices interact. In order to investigate the extension behavior of whole cells, we design a uniaxial cell-stretcher compatible with fluorescence and atomic force microscopy, enabling us to stretch cells up to high strains of 80%. Subsequently, we analyze the cells both in 2D and in 3D at different strains. To achieve this goal, we first deconvolve the images, then segment the individual cells and finally analyze the cell shape and the keratin-actin colocalization.

BP 8.5 Mon 18:00 Poster C

Active microrheology on in vitro cytoskeletal networks — •Shanay Zafari, Pratima Sawant, and Sarah Köster — Institute for X-Ray Physics, University of Göttingen, Germany

The cytoskeleton plays a crucial role in maintaining cell shape and overall structural integrity. It consists of three types of filaments including actin filaments (AFs) and intermediate filaments (IFs). Notably, IFs stand out for their exceptional extensibility and remarkable resistance against rupture at high strains, while AFs break at low strains. Composite networks of these two different kinds of filaments may lead to emergent mechanical properties. Here, we examine the mechanical properties of actin and vimentin networks separately by performing active microrheology with optical tweezers. We quantify the viscoelastic properties of the networks by fitting the force-strain curves with a power-law decay function. Our results indicate different viscoelastic behavior for pure actin and pure vimentin networks. This sets the stage for a comprehensive study of combined networks in order to understand the role of intermediate filaments in composite cytoskeletal networks at high strain.

BP 8.6 Mon 18:00 Poster C

Response of confined vimentin intermediate filament networks to applied strain — •Pratima Sawant, Shanay Zafari, and Sarah Köster — Institute for X-Ray Physics, University of Göttingen, Germany

Eukaryotic cells undergo high strains during division, motility, wound healing and numerous other cellular processes. The mechanical integrity of cells under these conditions is maintained by the cytoskeleton, mainly comprising actin filaments, intermediate filaments (IFs), and microtubules. Among these three filament types, IFs are the most extensible ones. However, the role of IFs in modulating the mechanical response of cells under strain still remains unclear. In vitro studies on single vimentin IFs show that they exhibit tensile memory and can dissipate more than 70% of the input energy. Since these filaments form networks in cells, it is crucial to extend this analysis to study network behaviour. Here, we present a microfluidic device that is compatible with fluorescence microscopy. We image reconstituted networks of vimentin encapsulated in microfluidic droplets. Flowing these droplets through constricted channels ensures the application of a global strain. Furthermore, the networks are suspended within the droplets and not attached to a substrate in this set-up. Thus, this approach enables us to probe the mechanical properties of vimentin IF networks in a

confined environment with the ability to manipulate the degree and nature of strain and buffer conditions.

BP 8.7 Mon 18:00 Poster C

Unveiling microtubule fracture dynamics: A comprehensive examination of the influence of lattice defects on the breakage process of microtubules — •Amir Zablotsky and Karin John — Université Grenoble Alpes / CNRS, LIPhy, Grenoble, France

Microtubules (MTs), crucial to many cellular functions, are tube-like structures formed by a quasi-crystalline arrangement of $\alpha\beta-$tubulin heterodimers.

Two parameters that are major determinants for MT stability and dynamics are the lattice binding energy and anisotropy (defined as the ratio between the longitudinal and lateral binding energies).

Despite considerable effort on comprehending the dynamics of the MT tip, in particular the so called dynamic instability, the dynamics within the "bulk" MT lattice have received little attention.

Recent experimental findings revealed that MTs often present dimer and monomer sized vacancies along their shaft, resulting in structural defects that compromise their shaft integrity and may interfere with the dynamic instability at the tip.

Here we employ kinetic Monte Carlo simulations, as well as analytical approaches, to study the defects dynamics in the MT shaft and their effects on MT breakage in the absence of free tubulin dimers.

Our findings highlight the significant role of initial defects in the fracture propagation dynamics. Furthermore, comparison with experiments allows us to identify lattice binding energies and anisotropies that accurately reproduce experimental observations of fracture times and lengths.

BP 8.8 Mon 18:00 Poster C

The structure and mechanics of the actin cortex in different adhesion states — •Christoph Anton[1], Lucina Kainka[1], Sandra Iden[2,3], and Franziska Lautenschläger[1,3] — [1]Department of Physics, Saarland University, Saarbrücken, Germany — [2]Center of Human and Molecular Biology (ZHMB), Saarland University, Homburg, Germany — [3]Center for Biophysics, Saarland University, Saarbrücken, Germany

Transitions between different cellular adhesion states are essential for many biological processes e.g. metastasis. These transitions involve drastic changes of the actin cortex, a submembraneous network of actin filaments. Our aim is to characterize the properties of the actin cortex in single adherent cells and cells within a monolayer. We use scanning electron microscopy and atomic force microscopy to quantify the structure and mechanics of the actin cortex. We investigate how the structural and mechanical properties are related to each other and how they are influenced by the amount of filamentous actin and the amount of actin bundles within the cortex. Furthermore, we investigate the role of specific proteins (e.g. the cell-cell adhesion protein E-cadherin) by using different inhibitors and chemical compounds. Generally, it is our aim to control state transitions by controlling the actin cortex via compounds that affect the amount of filamentous actin and the actin bundles.

BP 8.9 Mon 18:00 Poster C

Membrane Stiffness and Formation of Microtentacles — •Yannic Veit[1], Lucina Kainka[1], Christoph Anton[1], and Franziska Lautenschläger[1,2] — [1]Department of Experimental Physics, Saarland University, Saarbrücken, Germany — [2]Center for Biophysics, Saarbrücken, Germany

Microtentacles (McTNs) are microtubule-based membrane protrusions. They are found in circulating tumour cells (CTCs) and are assumed to promote reattachment of the CTCs to the vessel walls and facilitate the extravasation from the blood stream.

We previously found that McTNs grow from actin-rich sites (actin patches). There is a force balance between the microtubules and the cell barrier, which consists of the actin cortex and the cell membrane. During the formation of microtentacles, that barrier exerts a counterforce depending on its stiffness on the microtubules. This led us to a question: Does decreased actin patch area decrease membrane stiffness and influence McTN formation?

To disentagle the influence of the two components of the barrier, we tackled actin directly by depolymerisation using latrunculin A, and the membrane stiffness itself by depleting it of cholesterol with methyl-beta-cyclodextrin. The membrane stiffness was quantified via tether rupturing using atomic force microscopy.

We found that decreasing the actin patch area decreases the membrane stiffness while depleting the membranes of cholesterol increases the stiffness. We found that an increase in membrane stiffness inhibits microtentacle formation.

BP 8.10 Mon 18:00 Poster C

Quantitative description of cellular adhesion forces and corresponding focal adhesions — •Kathi Michèle Kaiser[1], Carsten Baltes[1], Ben Wieland[2], Gubesh Gunaratnam[2], and Franziska Lautenschläger[1,3] — [1]Department of Experimental Physics, Saarland University, Saarbrücken, Germany — [2]Institute for Medical Microbiology and Hygiene, Saarland University, Homburg, Germany — [3]Center of Biophysics, Saarland University, Saarbrücken, Germany

The adhesion force of a cell has a huge impact on various processes linked to adhesion, for example in metastasis. Controlling the adhesion force means controlling the balance between adhesive and non-adhesive forces which could help to prevent the formation of metastasis.

The adhesion of cells to the extracellular matrix is mediated by integrin receptors, which link the cytoskeleton of the cell to the extracellular environment. On the cytoplasmic side these receptors are connected to actin filament bundles via an assembly of proteins forming the focal adhesions (FA).

My aim is to find a correlation between the number and size of the FAs and the adhesion force of a cell. Different compounds, which alter the dynamics of actin, were used to change the properties of the FAs. With a TIRF microscope the FAs could be imaged. To measure the adhesion force of single cells a fluid force microscope was used. These measurements enabled us to quantitatively describe and correlate the adhesion forces corresponding to the properties of the FAs. Once we understand this correlation, we will be able to understand an altered adhesion in a pathogenic context or to actively influence adhesion.

BP 8.11 Mon 18:00 Poster C

Mechanical properties of microtubule in actin network — •Komal Bhattacharyya, Sarah Köster, and Stefan Klumpp — University of Göttingen, Göttingen, Germany

The cytoskeleton provides structural support and facilitates dynamic cellular processes such as growth and migration. Actin and microtubules are key components of the cytoskeleton. Actin, characterized by its semi-flexible nature, contrasts with the stiff, rod-like structure of microtubules. The synergy between these two elements plays a pivotal role in numerous biological phenomena. For instance, microtubules exhibit enhanced resistance to compressive forces when integrated into an actin network. In our research, we use Cytosim[1] to simulate the networks formed by actin and microtubules. Specifically, we analyze the buckling behavior of microtubules under varying compressive forces. The objective is to unravel the specific interactions between actin and microtubules that contribute to the observed mechanical responses within composite networks.

[1] Francois Nedelec and Dietrich Foethke 2007 New J. Phys. 9 427

BP 8.12 Mon 18:00 Poster C

Interactions between synaptic vesicles and cytoskeletal filaments — •Tiago Mimoso[1], Rajdeep Chowdhury[2], Saheli Dey[1], Christian Hoffmann[3], Dragomir Milovanovic[3], Silvio Rizzoli[2], and Sarah Köster[1] — [1]Institute for X-Ray Physics, University of Göttingen, Germany — [2]Institute for Neuro- and Sensory Physiology, University Medical Center Göttingen, Germany — [3]Laboratory of Molecular Neuroscience, DZNE, Germany

Signal transmission of neurons occurs both electrically and chemically. The chemical signal is transported by synaptic vesicles (SVs) via the synaptic cleft to an adjacent neuron. Thus, these SVs are found in the synapse, within the so-called synaptic bouton. Here, the SVs are surrounded by cytoskeletal filaments, including dynamic microtubules (MTs) that undergo rapid assembly and disassembly. Some studies suggest interactions between SVs and the cytoskeletal filaments. Therefore, we now ask the question of what influence the presence of SVs has on microtubules. We employ a reconstituted in vitro system, by attaching the SVs to the surface and imaging the dynamic microtubules by total internal reflection fluorescence microscopy to obtain the growth rate, disassembly rate, catastrophe frequency and rescue frequency. We present an approach for attaching SVs to a surface using protein G and a primary antibody targeting a membrane protein in SVs. The MT are attached using biotin-neutravidin complex. This method grants control over the SVs and MT positioning, enabling a comprehensive study of their dynamic interactions.

BP 8.13 Mon 18:00 Poster C

Influence of perfluorocarbon on the structural changes of lipid monolayers and on protein adsorption — •Jaqueline Savelkouls, Christian Albers, Gordon Scholz, Eric Schneider, and Michael Paulus — Maria-Goeppert-Mayer-Straße 2, 44227 Dortmund

Perfluorocarbons (FCs) have high medical potential, serving as therapies in ophthalmology and respiratory diseases by replacing liquid FC ventilation and unsafe lung surfactant (LS) substitutes in the future [1]. We analysed the influence of the FC F-Decalin on the structural changes of model membranes of LS like anionic DPPA and zwitterionic DPPC monolayers at different initial surface pressures as well as on the adsorption of the surface-active proteins human serum albumin and lysozyme at beamline ID10 with a photon energy of 22 keV at the European Synchrotron Radiation Source (Grenoble, France). All samples were measured in situ at ambient temperature and pressure using a combined grazing incidence X-ray diffraction and X-ray reflectivity study. In summary, surface-active proteins adsorb to the lipid membrane either with and without a FC atmosphere. F-Decalin itself adsorbs to the interface between the head and tail groups of the lipid monolayer as well as to the hydrophobic regions of the lipid and protein. This leads to a compression of the lipid and protein layer. F-Decalin reduces the size of the crystalline domains, the surface tension of the monolayers and induces a fluidisation of the lipid monolayer. This effect is observed for monolayers with initially high surface tensions. [1] M. P. Krafft, DOI: 10.1002/pola.21937

BP 8.14 Mon 18:00 Poster C

Investigating the Fusion Efficiency of Respiratory Virus-Like Particles with Model Cell Membranes — •Mahsa Mohammadian[1], Chetan S Poojari[2], Ralf Seemann[1], Jochen Hub[2], and Jean-Baptiste Fleury[1] — [1]Department of Experimental Physics and Center for Biophysics, Saarland University, Germany — [2]Theoretical Physics and Center for Biophysics, Saarland University, Germany

Viral infections are initiated when a virus attaches to a host cell membrane, and then penetrates the cell through a process called membrane fusion. The fusion process depends on specific fusion proteins located on the viral particle surface, which contain a short, relatively hydrophobic segment called "fusion peptide" that binds to the host membrane. To investigate the fusion efficiency of various fusion peptides, we create non-infectious virus-like particles (VLPs) decorated with different fusion peptides and fuse them with an artificial cell membrane. For this purpose, 3D microfluidic devices are used to create either supported or free-standing lipid bilayers and the fusion process is then studied using fluorescence microscopy. Furthermore, molecular dynamics (MD) simulations are employed to provide structural and energetic insights into the effect of fusion peptides on stalk-formation. Our study provides structural insights into the interactions between virus particles and cell membranes, which can facilitate the development of new therapeutic strategies and more effective viral vectors for therapeutic applications.

BP 8.15 Mon 18:00 Poster C

Structure and Electrostatics in Monolayers of Raft-Forming Lipid Mixtures Containing GM1 — •Miriam Grava[1], Valeria Rondelli[2], and Emanuel Schneck[1] — [1]Technische Universität Darmstadt, Germany — [2]Università degli Studi di Milano, Italy

Lipid rafts are membrane domains with specific lipid composition and high sterol content, that can host certain membrane protein. Important examples are lipid domains enriched in glycosphingolipids such as ganglioside GM1 with negatively chargeable sialic acids, whose protonation state can depend on lipid packing and on the type and concentration of counterions.

Here, we use mixed lipid monolayers to mimic GM1-containing rafts in the mammalian nervous system and investigate them with synchrotron-based x-ray scattering and x-ray fluorescence, to elucidate their structural and electrostatic characteristics under various biologically relevant conditions.

The experiments reveal electron density profiles, in-plane lipid ordering, and the surface charge density. The absence of a pronounced charge inversion in the presence of divalen cations indicates that a considerable fraction of ions bridges two negatively charged GM1 molecules.

BP 8.16 Mon 18:00 Poster C

Cavitation in lipid systems: Insights from molecular dynamics — •Marin Šako and Matej Kanduč — Jožef Stefan Institute, Ljubljana, Slovenia

Liquids under tension are found in many systems in nature as well as in technology. Examples include lithotripsy and sonoporation of cell membranes, octopus suckers, catapulting mechanisms of fern spores, and the hydraulic system in plants. Such systems under these metastable conditions are vulnerable to cavitation. Lipid membranes, as part of cell membranes, are found in almost every biological system. The study of cavity formation in lipid membranes under tension plays an important role in the research of biological systems. In this context, lipid-lipid adhesion energy, as well as adhesion energy between lipids and other surfaces, is a crucial physical property as it tells us a lot about the strength of interaction between lipids and other matter.

In this poster I present our work on adhesion of lipid systems obtained from molecular dynamics simulations. More specifically, I will examine the lipid-lipid adhesion energy as well as lipid-surface adhesion energy and how it depends on the surface properties. Additionally, I will discuss how the adhesion energy and surface properties affect cavitation in lipid bilayers and lipid-substrate systems.

BP 8.17 Mon 18:00 Poster C

The Mechanics of Pancake-like Adhered Vesicles — •Gianna C. Wolfisberg[1], Hendrik T. Spanke[1], Jaime Agudo-Canalejo[2], Eric R. Dufresne[1,3], Robert W. Style[1], and Aleksander A. Rebane[1,4] — [1]Department of Materials, ETH Zürich, Switzerland — [2]Max Planck Institute for Dynamics and Self-Organization (MPIDS), Germany — [3]Department of Physics, Cornell University, USA — [4]Programs in Chemistry and in Physics, New York University Abu Dhabi, United Arab Emirates

Eukaryotic cells contain various lipid membrane-bounded organelles that possess unique biochemical identities. However, it remains often unclear how the organelle shapes are generated and what role the shapes play in function. An important example is the Golgi Apparatus, which has a highly conserved architecture comprising a stack of pancake-like sub-compartments (cisternae) that are adhered to each other and whose function is to process, sort, and transport freshly synthesized proteins via mechanisms that remain mysterious. Here, we develop an in vitro approach to study the mechanics of cisternae by creating flattened vesicle shapes of high surface-to-volume ratio achieved through adhesion and osmotic deflation. We compare our experimental shapes with the spontaneous curvature model. We find simple relations of aspect ratio and size that govern the mechanical properties of adhered pancake-like vesicles. We apply these simple relations to Golgi cisternae and find that the estimated adhesion strength between cisternae in cells is insufficient to create these flat shapes, suggesting that the shape is maintained by the cell using other mechanisms.

BP 8.18 Mon 18:00 Poster C

Flow Dynamics in the Capillary Network of Different Blood Cell Types — •khadija larhrissi[1], Christian Wagner[1], Felix Milan Maurer[1], Selina Wrublewsky[2], Yazdan Rashidi[1], Alexis Darras[1], and Matthias Laschke[2] — [1]Department of Experimental Physics, University Campus, Saarland University, 66123 Saarbrucken, Germany — [2]Institute for Clinical and Experimental Surgery, Saarland University, 66421 Homburg, Germany

Red blood cells (RBCs) constitute the majority of cells in the blood and play a key role in transporting oxygen to tissues and organs. On the other hand, leukocytes, also known as white blood cells, make up approximately 1% of the total blood volume in most mammals. The flow of these cells ensures the body's defence against various viral and bacterial infections. The White blood cells (WBCs) exhibit two modes of motion: a fast flow mode where they move with the surrounding fluid, and a slower rolling mode where they partly adhere to the wall, whereas Red Blood Cells (RBCs) simply flow with the surrounding fluid.

In this study, our objective is to examine the influence of geometry and distribution on the flow of white blood cells (WBCs) and to explore how the rigidity of red blood cells (RBCs) alters flow dynamics. To achieve this, we used Golden Syrian Hamsters as a model system to quantify the flow of cells by fluorescence microscopy and compare their behavior in different networks of vessels. Additionally, since some WBCs are larger in size than the capillaries they pass through, we will examine the impact of this size difference on their flow.

BP 8.19 Mon 18:00 Poster C

Exploring Cell Shapes and Dynamics Through Discrete Differential Geometry — •Mauricio Rojas-Vega, Andela Šarić, and Christopher Wojtan — Institute of Science and Technology,

Klosterneuburg, Austria

Our study utilizes the Canham-Helfrich bending energy model to validate anticipated cellular phenomena within membrane structures, identifying three primary equilibrium shapes. Introducing an external cargo attracted to the membrane confirms established interactions, resulting in observed budding and wrapping. These findings solidify our model's robustness in encapsulating known cellular behaviors.

Additionally, our research explores controlled membrane manipulations, enhancing the model's representation of fluid-like behavior. Future work aims to incorporate non-reciprocal interactions for exploring non-equilibrium cell shapes and validating the inside-out model.

This research consolidates understanding of established cellular interactions, offering avenues to explore non-equilibrium cellular phenomena, thereby advancing our comprehension of cellular dynamics.

BP 8.20 Mon 18:00 Poster C

The Role of Perilipin 5 for the Contact Sites between Lipid Droplets and Bilayer: Protein Tether, or Lipid Bridge? — •Shima Asfia, Mahsa Mohammadian, Ralf Seemann, and Jean-Baptiste Fleury — Department of Experimental Physics and Center for Biophysics, Saarland University, Germany

Lipid droplets (LDs) play a pivotal role in cellular energy storage and supplying components for the structure of organelle membranes. As the biology of lipid droplets relies on close coordination and communication with other cellular organelles, it is important to take a look at this interaction. In particular, the role of the protein Perilipin 5 (PLIN5), which is known as a mediator in regulating LDs dynamics and metabolism in cells is of interest. To investigate the impact of PLIN5 on the formation of contact sites between LDs and a bilayer, LDs (triolein oil droplets) surrounded by a phospholipid monolayer with and without PLIN5 are brought in contact with single unilamellar vesicles (SUV)s with a composition close to the ER membrane. To detect different contact interactions of SUVs with the monolayer coating the LDs, the SUVs were double fluorescent labeled with a phospholipid Rhodamine dye in the bilayer and Cy5 dye in the core. Protein tethers can be assumed when the SUVs stay in contact with LDs via protein attachment; in this case, spots with both fluorescent dyes are observed on the surface of the LDs. Lipid bridges can be assumed when SUVs fuse to the LD monolayer, and a colored *Rhodamine ring* appears on the surface of LDs revealing that only the phospholipid dye of the SUVs merged with LDs monolayer.

BP 8.21 Mon 18:00 Poster C

Modulating self-organizing protein patterns by controlling the number of membrane linkers and the membrane charge — •Katharina Esch[1,2], Mergime Hasani[1,2], and Katja Zieske[1,2] — [1]Biophysics and Optogenetics, Max Planck Institute for the Science of Light, Erlangen, Germany — [2]Department of Physics, Friedrich-Alexander Universität Erlangen Nürnberg, Erlangen, Germany

In nature, patterns occur on many different scales and are an expression of nature's ability to self-organize. Understanding the mechanisms regulating such patterns is an intriguing challenge in biophysics. The Min protein system is one of the best-studied examples of protein self-organization, and Min proteins self-organize into spiral waves on a model lipid membrane. In this study, we investigate the effects of biophysical membrane parameters on Min protein waves using purified proteins and a model lipid membrane. First, we demonstrate that an increase in protein-membrane interaction induces patterns of different geometry. Specifically, we observe not only wave-like patterns but also snowflake-like and flower-like patterns in dependence on the number of membrane linkers. Second, we demonstrate that these snowflake-like patterns not only occur on E. coli membranes but also on a minimal membrane composition of DOPC and PG. Finally, membrane charge modulates the complexity of protein patterns. Our results demonstrate that the regulation of membrane charge and linkers is an intriguing mechanism to regulate cellular pattern formation on the mesoscale.

BP 8.22 Mon 18:00 Poster C

Formation of supported artificial Membranes of Lipid Raft Models by Physical Vapor Deposition — •Nancy Gomez-Vierling[1], Daniel Saavedra[1], Marco Soto-Arriaza[2], Marcelo A. Cisternas[3], Nicolás Moraga[1], Tomás P. Corrales[4], and Ulrich G. Volkmann[1] — [1]Instituto de Física and CIEN-UC, Pontificia Universidad Católica de Chile (UC), Santiago, Chile — [2]Facultad de Medicina y Ciencia, Universidad San Sebastián, Santiago, Chile — [3]Escuela de Ingeniería Industrial, Universidad de Valparaíso, Santiago, Chile — [4]Departamento de Física, Universidad Técnica Federico Santa María, Valparaíso, Chile

The study focuses on advancing the development of rapid and cost-effective biosensors through the exploration of artificial membranes. The researchers, particularly from SurfLab UC, aim to create a Supported Lipid Bilayer (SLB) mimicking the Lipid Rafts model in cellular membranes. They employ the vapor-phase deposition method to determine optimal temperatures for evaporation rates of cholesterol, DOPC, and sphingomyelin molecules within a high vacuum chamber. The research delves into understanding the phases formed by these molecules at different temperatures. The obtained critical information guides the deposition of these molecules onto a silicon substrate, alongside DPPC molecules, to form self-assembling artificial bilayers resembling lipid rafts. The significance of this research lies in providing solvent-free alternatives for designing, fabricating, and storing phospholipid bilayer-based devices, including sensors and biomimetic devices. Acknowledgements: ANID Ph.D. Fellowships (NGV, DS, NM).

BP 8.23 Mon 18:00 Poster C

Superstructure in lipopolymer monolayers at the air/water interface — •Issam Assi, Heiko Ahrens, and Christiane A. Helm — Institute of Physics, University of Greifswald, 17489 Greifswald, Germany

Lipopolymers with covalently bound poly(ethylene oxide) (EO_N)head groups have been introduced to stabilize bilayer membranes. Langmuir monolayers of the lipopolymer DSPE-EO_N at the air/water interface show in the isotherm a transition from the liquid expanded to the liquid condensed phase, which is confirmed by in-situ Grazing Incidence X-ray Diffraction (GID). A laterally inhomogeneous film of condensed ordered alkyl chains embedded in a matrix of solvated polymers is formed. Small Angle GID shows that these lipid domains are ordered with a lattice constant of about 12 nm. Hexagonally ordered lipid domains were observed in situ with GID, which changed on further compression to a lamellar phase (nanostripes). The films stayed homogeneous on the micrometer scale as observed with Brewster Angle Microscopy. On transferred monolayers, these supramolecular phases were observed with AFM. The enthalpy of the phase transition was determined from isotherms at different temperatures for several EO degrees of polymerization (N between 6 and 112). The lattice constants of the hexagonally ordered lipid domains and the nanodomains changed very little.

BP 8.24 Mon 18:00 Poster C

Nobody is perfect: inspecting the defects of lipid membrane stacks by STED microscopy and X-ray diffraction — •Sarah Becker, Jette Alfken, and Tim Salditt — Institute for X-Ray Physics, University of Göttingen, Göttingen, Germany

Solid-supported lipid membranes are an important model system for biological membranes. A commonly used method to study the structure of lipid bilayers is x-ray reflectometry which yields averaged information such as the number of membranes deposited, the bilayer thickness, and the density profile. However, information regarding single defects in membranes is not accessible by this ensemble averaging technique based on diffraction. Now, we have applied different fluorescence microscopy techniques such as epifluorescence, confocal and STED microscopy, in order to examine local defects in oligo lipid membrane stacks. The high resolution STED images extend the multiscale structural characterization of membrane stacks by brightfield microscopy and x-ray reflectometry, which we also have applied. The study shows that the idealized assumption of perfect stacks without defects is not warranted and that (partial) dewetting effects can easily be encountered when preparing bilayers by spin coating.

BP 8.25 Mon 18:00 Poster C

Studying extracellular vesicle-mediated cell communication in flow networks for drug delivery system development — •Jan Jedryszek, Fatemeh Mirzapour, and Karen Alim — School of Natural Sciences, Technical University of Munich, Germany

Extracellular vesicles (EVs) are membrane-bound particles produced by cells and released into the bloodstream, functioning as vital information carriers within the body. They transfer molecules like proteins and RNA, significantly influencing intercellular communication and physiological processes. Functioning similarly to data packets in a network, EVs are key in cell-to-cell signaling. EVs from immune cells, such as dendritic cells and B cells, are pivotal in transferring molecules for adaptive immune responses against pathogens and tumors.

Our research focuses on elucidating this mechanism of long-range

cellular communication and leveraging these insights to enhance drug delivery methods. We are investigating both natural EV*s and synthetic vesicles, the latter of which are loaded with surface proteins and CRISPR-Cas12 gene editing tools, infused into a vasculature-on-a-chip system developed in our lab. By analyzing binding and fusion rates in a flow network, we intend to deepen our understanding of the natural role of extracellular vesicles in intercellular communication within the body and advance drug delivery techniques.

BP 8.26 Mon 18:00 Poster C

Properties of Long-Chain Lipid Enriched Regions in Biological Membranes: Insights from MD Simulations — •Annemarie Quas, Clara Rickhoff, and Andreas Heuer — Institut für Physikalische Chemie, Universität Münster, Corrensstraße 28/30, 48149 Münster

In the yeast plasma membrane, domains rich in long-chain sphingolipids are observed[1]. Our study employs molecular dynamics (MD) simulations to explore the influence of these lipids on membrane properties. We utilize both coarse-grained and all-atom models, employing a simplified lipid composition with varying concentrations of long-chain lipids in the outer leaflet. Initially, the sphingolipids are represented by long-chain phosphatidylinositols. The equilibration steps are performed with the coarse-grained model. Subsequently, back-mapping techniques are utilized to obtain the corresponding all-atom system. This enables extended simulation times and a comparison between all-atom and coarse-grained results. We assess the impact on diverse parameters such as order parameter, membrane thickness, and interdigitation to unravel the relationship between long-chain lipid concentrations and membrane properties. Our findings aim to enhance result interpretation and to provide approaches for new experiments.

[1] Aresta-Branco *et al.*, *J. Biol. Chem.* **2011**, 7, 5043-5054

BP 8.27 Mon 18:00 Poster C

Fungal hydrophobins as building blocks for rigid, water-impermeable pure protein bilayers and vesicles — Friederike Nolle, Kirstin Kochems, Karin Jacobs, and •Hendrik Hähl — Experimental Physics & Center for Biophysics, Saarland University, Saarbrücken, Germany

Hydrophobins are a class of small, strongly amphiphilic and extremely stable proteins formed mainly by filamentous fungi. Similar to surfactant molecules like phospholipids they self-assemble in monolayer films at water interfaces. Contacting two films, stable membranes resembling lipid bilayers are obtained, and subsequently also vesicles can be formed. These hydrophobin bilayers exhibit a similar thickness to lipid bilayers allowing for an incorporation of simple ion channels [1].

Due to their natural biocompatibility, higher stability in comparison to lipid bilayers and versatility gained through bioengineering, the application potential for hydrophobin bilayers and vesicles is vast. Many properties of this new type of membrane are, however, still to be characterized. We report here on mechanical testing via atomic force microscopy on pore-spanning films and determination of the water permeability in a droplet interface bilayer setup. We find that the layers exhibit a finite elasticity and high stability, withstand by far larger osmotic pressures than lipid bilayers, and are nearly impermeable to water [2]. Yet, by disturbing the molecular packing in the bilayer, the permeability can be tuned.

[1] H. Hähl et al., Adv Mater **29**, 1602888 (2017).
[2] F. Nolle et al., Langmuir **39**, 13790 (2023).

BP 8.28 Mon 18:00 Poster C

Molecular Dynamics Simulations as a tool to investigate the impact of imidazole-based cholesterol in lipid bilayers — •Clara Rickhoff, Azadeh Alavizargar, and Andreas Heuer — Institut für Physikalische Chemie, Universität Münster, Münster, Germany

Cholesterol is an important component of plasma membranes in mammalian cells having a significant impact on their fluidity and structure. Experiments aiming at a deeper understanding of the effect of cholesterol are facing the difficulty of tracking this non-fluorescent component of lipid bilayers. In order to overcome this problem, different imidazole-based cholesterols were developed. These modifications allow to add different functionalities to the cholesterol analog without changing the backbone of cholesterol which is embedded in the membrane. [Matos et al, Commun Biol, 2021, 4, 720] In this work Molecular Dynamics simulations of the non-charged imidazole-based cholesterol analog were conducted. This molecule was previously synthesized in the Glorius group (University of Münster). Our simulations aim to investigate the impact of this cholesterol analog on the structure of lipid bilayers and on the stability of lipid rafts. The results of this study allow a more precise assessment of how accurate this analog mimics cholesterol in terms of order parameter, tilt angle and position within the bilayer also in comparison with the positively charged imidazolium-based cholesterol analog.

BP 8.29 Mon 18:00 Poster C

Elevating Understanding of Membranes: How Spectroscopic Techniques can draw from Super-Resolution Microscopy Principles — •Simone Ezendam[1], Jonatan Alvelid[1], Andrea Volpato[2], and Ilaria Testa[1] — [1]Department of Applied Physics and Science for Life Laboratory, KTH Royal Institute of Technology, Stockholm, Sweden — [2]Department of Women's and Children's Health and Science for Life Laboratory, Karolinska Institut, Stockholm, Sweden

Membranes and vesicles play pivotal roles in cellular processes, operating across various scales and intricately interacting with proteins. Super-resolution microscopy has transformed our understanding of membrane dynamics by providing higher resolution compared to traditional optical methods. However, gaining insights into the fast timescales governing translational and rotational diffusion necessitates spectroscopic techniques such as fluorescence correlation spectroscopy (FCS) and fluorescence anisotropy (FA). Because these techniques rely on fluorescence, they can leverage the same principles enabling super-resolution microscopy. An established example is STED-FCS. Recently, our lab introduced STARSS[1], extending time-resolved FA to large proteins. Expanding on these concepts, here, we propose the application of STED in FA for studying membranes.

[1] Volpato et al. Extending fluorescence anisotropy to large complexes using reversibly switchable proteins. Nat Biotechnol (2023). DOI: 10.1038/s41587-022-01489-7

BP 8.30 Mon 18:00 Poster C

The effect of aversive external conditions on the migration of small plasmodia of Physarum polycephalum — •Diana Lenski, Lucas Tröger, and Karen Alim — School of Natural Sciences, Technical University of Munich, Germany

Environmental conditions determine the behavior of living organisms: physical activities as well as internal processes can vary significantly in response to certain interventions in an organism's environment. In a favorable environment, the migration behavior of small plasmodia of the unicellular slime mold, *Physarum polycephalum*, shows a self-avoiding run-and-tumble movement. However, it is not yet clear if and how *P. polycephalum* adapts its migration behavior to aversive external conditions. In this study, we perform migration experiments under various aversive stimuli, in particular differently composed substrates - containing salts or altered pH - and substrates exposed to blue light. Statistical analysis of the cell trajectories and simulations based on data inferred parameters will lead to a deeper understanding of the central migration parameters that are adapted with respect to the environment in order to achieve a most efficient migration.

BP 8.31 Mon 18:00 Poster C

Unravelling the collective behavior of protrusions for directed migration — •Lucas Tröger and Karen Alim — School of Natural Sciences, Technical University of Munich, Germany

Unlike bacteria, eukaryotic cells are large enough to sense a chemical gradient across their cell body. However, chemotaxis of an entire cell requires a mechanism for coordinating competing protrusions. The slime mold *P. polycephalum* is a giant unicellular organism built in the form of a fluid-filled tubular network. Its strong and large-scale cytoplasmic flows make it an ideal model organism to study the role of fluid flows in coordinating the collective behavior of competing protrusions during morphological changes during chemotaxis. We perform experiments, analyze trajectories and protrusion dynamics, and simulate fluid flows to elucidate the mechanism that coordinates the chemotaxis of this macroscopic cell.

BP 8.32 Mon 18:00 Poster C

Clutch Model for focal adhesions predicts perfect self-stablisation — •Anton Burnet[1,2] and Benedikt Sabass[1,2] — [1]Department of Veterinary Sciences, LMU München — [2]Department of Physics, LMU München

Cell-matrix adhesions connect the cytoskeleton to the extracellular environment and are essential for maintaining the integrity of tissue and

whole organisms. Remarkably, cell adhesions can adapt their size and composition to an applied force such that their size increases proportionally to the load. Recently, this group suggested a molecular mechanism that can explain adhesion growth under load for planar cell adhesions. The mechanism is based on conformation changes of adhesion molecules that are dynamically exchanged with a reservoir. Tangential loading drives the occupation of some states out of equilibrium, which for thermodynamic reasons, leads to the association of further molecules with the cluster, which is referred to as self-stabilisation. A variation of the latter model had been considered which linearly coupled the recruitment rate of the reservoir with the occupation number of the unfolded bound states. Simulation results found that a bifurcation occurs for a critical coupling value, where the system transitions from limited self-stabilisation to a perfect self-stabilisation regime where the system no longer undergoes rupture upon an ever increasing force. Moreover, a second regime was found where the system size exhibits exponential growth. In this work, we focus on quantitively understanding these results, starting with simpler coarse-grained models to shed light onto the qualitative behaviour observed from simulations.

BP 8.33 Mon 18:00 Poster C

Stochastic catch-bond model of cell-cell adhesion mechanics and turnover — •Antonella Di Concilio Moschen[1,2] and Benedikt Sabass[1,2] — [1]Department of Veterinary Sciences, LMU München — [2]Department of Physics, LMU München

Catenins are proteins that mediate the binding between transmembrane molecules called cadherins and intracellular actin filaments in cell-cell adherens junctions. Mechanical forces generated by cytoskeleton are directly transmitted via αE-catenin to the membrane-localized E-cadherin/β-catenin complex.

It has been proposed based on *in vitro* experiments that this mechanotransduction mechanism is well described by a two-state catch bond between αE-catenin and F-actin. We aim to understand how the catch bond affects the mechanics and structural dynamics *in vivo*. Specifically we focus on differences between two distinct states of the adherens junctions called zonula-adherens and punctate-adherens junctions. By implementing a Gillespie algorithm to the system's master equation, we construct a framework to quantitatively compare predictions from the above-mentioned two-state catch-bond model with results from FRET and FRAP experiments.

BP 8.34 Mon 18:00 Poster C

Studying cell-particle-interactions using blinking holographic optical tweezers — •David Gitschier, Wolfgang Gross, Manuel Eisentraut, Konrad Berghoff, and Holger Kress — Department of Physics, University of Bayreuth, Bayreuth, Germany

The corona pandemic underlined the importance of a healthy immune system. An indispensable part thereof are the interactions with infected cells and bacteria as well as their subsequent uptake. However, a complete mechanical characterization of this dynamic process still lacks. Here we show how to measure mechanical properties of immune cells during interaction with particles using the versatile technique of blinking holographic optical tweezers. This method enables us to obtain the binding kinetics and viscoelastic parameters of the cellular response. The latter are consistent with power law rheology. Using this, we determine the temporal evolution of the contact radius between particle and cell leading to the timescale of the binding kinetics. Regarding the material softness, addition of cytochalasin D resulted in an increase of the cellular compliance and fluidization of the cortex. Moreover, we visualize the influence of the cortical actin structure by fluorescence microscopy with Lifeact-GFP-transfected cells. Therefore the actin dynamics after initial cell-particle-contact are accessible. Our approach helps elucidating the biomechanical processes underlying this important part of innate immunity. Additionally it allows us to address important, yet unanswered questions like how different microplastic particles interact with cells.

BP 8.35 Mon 18:00 Poster C

Measuring viscoelastic properties in active, living systems through passive observations — •Till M. Muenker[1], Gabriel Knotz[2], Matthias Krüger[2], and Timo Betz[1] — [1]Third Institute of Physics, Universität Göttingen, Göttingen, Germany — [2]Institute of Theoretical Physics, Universität Göttingen, Göttingen, Germany

Accurately quantifying the viscoelastic material properties within active systems, such as cells, poses a challenging task. Due to the non-equilibrium nature of such systems, many powerful tools from statistical physics like the MSD fail to predict material properties from passive observation of a tracer particle. Instead, active methods such as optical- and magnetic tweezers are used where typically external forces are applied to measure the material response. Here, we introduce a new statistical method, termed mean back relaxation (MBR). By quantifying the mean displacement of a probe particle after having transitioned a specific distance in the immediate time history, this new quantity allows to detect breaking of detailed balance in confined systems. Firstly, we test this method in a well-controlled experimental model system where we are able to detect the level of non-equilibrium. Next, we turn to the most complex, but also highly relevant system, living cells. Strikingly, applying this novel approach not only allows us to measure the level of activity but also gives access to the viscoelastic material properties of a range of different cell types. This approach could drastically facilitate the quantification of intracellular mechanics, thus opening the door for many researchers who do not have access to elaborate experimental setups.

BP 8.36 Mon 18:00 Poster C

Analysis of traction stress of iPSC derived heart muscle cells — •Bastian Malte Winter[1], Fatemeh Abbasi[2], Karthika Annamalai[3], Karl Toischer[4], and Timo Betz[5] — [1]Drittes Physikalisches Institut, Göttingen, Deutschland — [2]Drittes Physikalisches Institut, Göttingen, Deutschland — [3]Department of Cardiology and Pneumology, Göttingen, Deutschland — [4]Department of Cardiology and Pneumology, Göttingen, Deutschland — [5]Drittes Physikalisches Institut, Göttingen, Deutschland

During the maturation of animal tissue, their heart, and in particular their myocardium typically undergoes a change of stiffness. Furthermore, it is known that conditions like hypertrophy can also change the stiffness of the myocardium. Generally, changes in stiffness have an effect on force generation of single cells but to which extent this can be also applied to single cardiomyocytes is not well studied. Our goal is to investigate the effect of different substrate stiffnesses on the environment on force generation of single iPSC derived cardiomyocytes. For that, we seed cardiomyocytes on Polyacrylamide-gel (PAA-gel) of different stiffnesses and use Traction Force Microscopy to locate the forces generated by single cardiomyocytes in magnitude and direction. We show that generally an increase in stiffness also results in an increase in force production of single cardiomyocytes.

BP 8.37 Mon 18:00 Poster C

Intracellular Mechanical Fingerprinting: Identifying the proteins controlling the intracellular active mechanics — •Noémie Veyret, Dorian Marx, Till Münker, and Timo Betz — Third institute of Physics, University of Göttingen, Germany

Over the past few years, the study of cell mechanical properties has allowed new insights on the understanding of biological processes and life complexity. According to previous work, intracellular mechanical properties can be narrowed down to a fingerprinting of only 6 parameters. Through the use of active and passive microrheology measurements via optical tweezers, frequency dependent viscoelastic properties and intracellular activity were found to vary for different cell types. The aim of this project is to find a correlation between changes in protein expressions and mechanical fingerprint of cells. To do so optical tweezers measurements will be performed during the differentiation process of induced Pluripotent Stem Cells (iPSC) into cell types derived from the three germ layers, namely neurons (ectoderm), skeletal muscles (mesoderm) and lung epithelia (endoderm). This measurement allows the characterization of the mechanics during the iPSC differentiation process. In parallel, the cell proteome will be studied using mass spectroscopy. Combining both, we hope to find the connection between proteins and their mechanical role, the intracellular "mechanome".

BP 8.38 Mon 18:00 Poster C

Microfluidic single cell study on protoplast fusion — •Ioannis Gkekas[1], Philipp J. Artmann[1], Dario Anselmetti[1], Thorsten Seidel[2], and Martina Viefhues[1] — [1]Experimental Biophysics, Bielefeld University — [2]Dynamic Cell Imaging, Bielefeld University

Plant cells are omnipotent and breeding of new varieties can be achieved by protoplast fusion. Such fusions can be achieved by treatment with poly(ethylene glycol) (PEG) or by applying an electric field. Microfluidic devices allow for controlled conditions and targeted manipulation of small batches of cells down to single cell analysis. To provide controlled conditions for protoplast fusions and achieve high reproducibility, we developed a microfluidic device to reliably trap few of *Arabidopsis thaliana* protoplasts and induced a cell fusion by controlled addition of PEG. Our results indicate that the following fusion

parameters had significant impact on the fusion efficiency and duration: PEG concentration, osmolarity of solution, and flow velocity. PEG concentration below 10% led to only partial fusion. Osmolarity of the PEG fusion solution was found to strongly impact the fusion process; complete fusion of two source cells sufficiently took part in slightly hyper osmotic solutions, whereas iso-osmotic solutions led to only partial fusion at 20% PEG concentration. We observed accelerated fusion for higher fluid velocities. Up to this study, it was common sense that fusion is one directional, i.e. once two cells were fused into one cell they stay fused. Here, we present for the first time reversible fusion of protoplasts. Our microfluidic device paves the way to a deeper understanding on the kinetics and processes of cell fusion.

BP 8.39 Mon 18:00 Poster C

Calcium-dependent flagellar adhessiveness of *Chlamydomonas* — •Marcel Schalling[1], Rodrigo Catalan[1], Marzieh Karimi[2], and Oliver Bäumchen[1] — [1]University of Bayreuth, Experimental Physics V, 95447 Bayreuth, Germany — [2]Max Planck Institute for Dynamics and Self-Organization, Am Faßberg 17, 37077 Göttingen, Germany

Calcium (Ca^{2+}) signalling influences several flagellar processes in flagellated microbes, namely maintenance of the flagella and the regulation of their waveform and beat frequency. The unicellular biflagellated microalga *Chlamydomonas reinhardtii* has been particularly used as a model organism to understand such processes. Interestingly, recent evidence shows that intracellular Ca^{2+} influences the adhesion of *C. reinhardtii* of their flagella to abiotic surfaces [1]. Additionally, *C. reinhardtii* exhibits light-switchable flagellar adhesion [2], such that they adhere to surfaces under blue light and detach under red light. Using single-cell micropipette force spectroscopy [3] in the presence of different concentrations of calcium in the medium, we study the effect of calcium on flagellar adhesiveness in different light conditions. Thereby, we aim at shedding light on the signal transduction pathway underlying light-switchable flagella adhesion.

[1] C. Fort *et al.*, *Journal of Cell Science* (2021)
[2] C. Kreis *et al.*, *Nature Physics* (2018)
[3] M. Backholm and O. Bäumchen, *Nature Protocols* (2019)

BP 8.40 Mon 18:00 Poster C

Nuclear mechanics across scales: from global deformation to local measurements — •Bart Vos[1], Yamini Vadapalli[2], Till Muenker[1], Ivan Avilov[2], Peter Lenart[2], and Timo Betz[1] — [1]Third Institute of Physics, University of Göttingen, Göttingen, Germany — [2]Max Planck Institute for Biophysical Chemistry, Göttingen, Germany

Mechanics play a crucial role in a wide range of cellular processes, from differentiation to division and metastatic invasion. Additionally, mechanical signaling plays an important role in protein expression. Although the mechanical properties of the cytoskeleton, providing shape, motility and mechanical stability to the cell, have been extensively studied, remarkably little is known about the mechanical environment within the nucleus of a cell and the exact mechanisms of force transduction between the cytoplasm to the nucleus.

To address these questions, we apply external deformations to oocytes of different species to observe how cellular deformations can be transmitted to the nucleus, leading to nuclear deformations. We combine this with optical tweezers-based microrheology in the cellular nucleus, allowing a direct comparison between intracellular and intranuclear mechanics. We observe viscoelastic behavior of the nucleoplasm that is profoundly different from the cytoskeleton. In addition, we observe that the nuclear envelope plays an important role by providing stability to the nucleus.

BP 8.41 Mon 18:00 Poster C

Unravelling the action spectrum of light-switchable flagellar adhesion of *Chlamydomonas* — •Rodrigo Catalan[1,2], Antoine Girot[1,2], Alexandros Fragkopoulos[1,2], Olga Baidukova[3], Darius Rauch[3], Peter Hegemann[3], and Oliver Bäumchen[1,2] — [1]Max Planck Institute for Dynamics and Self-Organization (MPIDS), Am Fassberg 17, 37077 Göttingen , Germany — [2]University of Bayreuth, Experimental Physics V, 95447 Bayreuth, Germany — [3]Humboldt University of Berlin, Institute of Biology, Invalidenstrasse 42, 10115 Berlin, Germany.

Most of the phenotypic repertoire of photoactive microorganisms is regulated by light-sensitive proteins called photoreceptors, which enable the organisms to adapt to alterations of their environment. The unicellular biflagellated microalga *Chlamydomonas reinhardtii* has been used as a model organism to study light-mediated phenotypes, such as phototaxis, the sexual life cycle, and the circadian rhythm. Recently, we discovered that *C. reinhardtii* can reversibly switch on and off the adhesiveness of their flagella in blue and red light, respectively [Kreis *et al.*, Nature Physics, 2018]. Using single-cell micropipette force measurements, we show that the action spectrum of flagellar adhesion forces in wild-type (WT) *C. reinhardtii* cells resembles the spectral sensitivity of cryptochrome (Cry) photoreceptors. Further comparison of the flagellar adhesion forces between WT and mutant *C. reinhardtii* cells lacking one or two known photoreceptors reveals that the deletion of both animal- and plant Cry completely disrupts the adhesion phenotype.

BP 8.42 Mon 18:00 Poster C

Modelling the impact of myosin IIA/IIB isoforms on cell migration — •Nils Winkler, Oliver M. Drozdowski, Falko Ziebert, and Ulrich S. Schwarz — Institute for Theoretical Physics and BioQuant, Heidelberg University, 69120 Heidelberg, Germany

Cell motility is one of the hallmarks of life. In mammalian cells, it is based on flow in the actin cytoskeleton, which in turn is driven by both actin polymerization and non-muscle myosin II motors. However, it is unclear how the different isoforms of this motor contribute to cell polarization and migration. Here we propose a one-dimensional active gel model with different myosin species to elucidate the role of non-muscle myosin IIA and IIB. Building on an established coarse-graining procedure [1], we start from binding kinetics and derive a model which can qualitatively explain experimentally found isoform concentration distributions. The model incorporates volume exclusion and cross-diffusion effects caused by the binding properties. Through numerical analysis we explore different migratory modes and the possibility of oscillatory motion driven by concentration differences both in length and velocity.

[1]: Drozdowski, Ziebert and Schwarz, Comms. Phys. 6, 158 (2023)

BP 8.43 Mon 18:00 Poster C

Mechanical fingerprint of the intracellular space — Muenker Till M., Vos Bart E., and •Betz Timo — University of Göttingen, Göttingen, Germany

Many important cellular functions such as organelle positioning and internal cargo transport are dependent on the viscoelastic intracellular mechanical properties of cells. A range of different mechanical models has been proposed to describe these properties. Whilst simple models such as Maxwell or Kelvin-Voigt models don't seem sufficient to capture the full complexity of cells, more elaborate models like generalized Kelvin-Voigt models require a huge number of parameters. This hinders the comparison and interpretation of experimental findings. Further, from a physics perspective, cells are systems out of thermodynamic equilibrium, permanently consuming metabolic energy to carry out mechanical work. The level of "non-equilibrium" can be proposed as an indicator for cell type, cell state or even diseases. To determine both, the viscoelastic properties and the cellular activity, we use optical tweezers based active and passive microrheology in a diverse group of 9 different cell-types. Surprisingly, despite differences in origin and function, the complex moduli of all cell types can be described using a 4 parameter based fractional Kelvin-Voigt model. Additionally, the frequency dependent activity can be described with a simple power law. This approach allows to reduce those complex and frequency dependent properties down to a fingerprint of 6 parameter. Further principal component analysis shows that only 2 of them may be sufficient to characterize the mechanical intracellular state.

BP 8.44 Mon 18:00 Poster C

Cell movement on the fast lane: how patterns can drive cell migration — •Annika A. Vogler, Sebastian W. Krauss, Florian Rehfeldt, and Matthias Weiss — Experimental Physics I, University of Bayreuth, 95447 Bayreuth, Germany

Cell migration is a fundamental process that is key in many physiological events, such as wound healing, embryonic development, or cancer metastasis. In living organisms cells often have to navigate through intricate and obstructed environments. Microstructured surfaces provide a versatile platform for mimicking such environments, and they allow for studying migration dynamics under controlled conditions.

Here, we have investigated the migration of MDA-MB-231 cells on microstructured surfaces, focusing on periodic stripe patterns of varying dimensions. Our results reveal a correlation between stripe width/periodicity and cell migration speed. Moreover, cells display

a unique behavior at the boundaries of the micropattern: Once they reach the edge, they tend to get stuck at these loci, akin to a migrate-to-capture dynamics that eventually leads to trapping in a confined state. Furthermore, the directionality and periodicity of the stripe pattern leads in general to an anisotropic movement, even though pattern features are roughly one magnitude smaller than cells. This finding highlights the ability of cells to sense even very small structures and to adapt their migration accordingly.