BP 10: Postersession II

Topics: Cytoskeletal Filaments (10.1–10.8), Cell Mechanics (10.9–10.33), Cell Adhesion and Migration, Multicellular Systems (10.34–10.58), Neurosciences (10.59–10.61).

Time: Monday 17:30–19:30 Location: Poster C

BP 10.1 Mon 17:30 Poster C

Mechanical Properties of Intermediate Filaments — Johanna Block[1], Hannes Witt[2], Julia Kraxner[1], Charlotta Lorenz[1], •Anna Schepers[1], Andreas Janshoff[2], and Sarah Köster[1] — [1]Institute for X-Ray Physics, Georg-August-Universität, Göttingen, Germany — [2]Institute of Physical Chemistry, Georg-August-Universität, Göttingen, Germany

Different cell types exhibit different mechanical properties which are determined by the cytoskeleton. Microtubules and microfilaments are conserved throughout all metazoan cell types, whereas different intermediate filaments (IFs) are expressed in a cell-type specific manner. Therefore, IFs are believed to play a major role in determining the mechanical properties of the different cell types. Using optical tweezers, combined with microfluidics and fluorescent microscopy, we directly probed the stretching behavior of single IFs. Under physiological buffer conditions and due to varying stretching protocols we found a strong loading rate dependent behavior as well as a tensile memory and a pronounced energy dissipation for the IF vimentin. By theoretical modeling and Monte Carlo simulations we are able to fit our data and link the results to the molecular structure of vimentin.

BP 10.2 Mon 17:30 Poster C

Comparison of the cytoskeleton of squamous cells using fluorescence microscopy — •Mona Plettenberg[1], Maja Strugacevac[1], Constanze Wiek[2], Julia Kristin[2], Marcel Glaas[2], Jörg Schipper[2], and Mathias Getzlaff[1] — [1]Institute of Applied Physics, Heinrich-Heine-Universität Düsseldorf, Universitätsstr. 1, 40225 Düsseldorf, Germany — [2]Düsseldorf University Hospital, Department of Othorinolaringology, Moorenstrasse 5, 40225 Düsseldorf, Germany

Our group's aim is to investigate the mechanical properties of benign and malign squamous cells. The fluorescence microscopy is one of the group's essential experimental techniques to gain new knowledge.

The cell's mechanical properties are mainly determined by the cytoskeleton. Especially the microtubule and actin filaments are key features for the cell's elasticity. In cancerous squamous cells, the cytoskeleton structures are changing. To investigate the differences, we compared the cytoskeleton of four cell lines extracted from tumors of different states in the head-neck area. By staining the cytoskeleton filaments with SiR-Actin and SiR-Tubulin, they could be observed under the fluorescence microscope. For this purpose, we optimized the staining process for our used cell lines.

The higher the tumor state is, the more the cytoskeleton is unorganized and the cells show more motility characteristics. We also could observe a decline of the actin-skeleton as well as of the microtubules. These facts lead us to the assumption that our investigated cells are more elastic in a higher tumor state.

BP 10.3 Mon 17:30 Poster C

FRAP traces of immobile self-assembled complexes from Monte-Carlo simulations — •Justin Grewe[1,2] and Ulrich S. Schwarz[1,2] — [1]Institute for Theoretical Physics, Heidelberg — [2]Bioquant, Heidelberg

Non-muscle myosin II plays an important role in many essential cellular processes, including adhesion, migration and cytokinesis. Because myosin II is a non-processive motor, it cannot generate appreciable levels of force by itself, but needs to work in larger ensembles. In non-muscle cells, it assembles into myosin II minifilaments, which are approximately 300 nm large and contain around 30 myosin II molecules. As shown by experimental FRAP studies, this supramolecular complex is very dynamic, exchanging myosin monomers with a typical half time of 70 seconds. Using Monte-Carlo methods, we study the interplay between assembly and force generation in a spatial model for minifilaments. Our simulated FRAP-traces show the signature of different time scales, in contrast to the standard analysis of experimental FRAP-traces, which uses only one time scale.

BP 10.4 Mon 17:30 Poster C

DNA based molecular force sensors in reconstituted actin networks — •Christina Jayachandran[1], Max Wardetzky[2], Florian Rehfeldt[1], and Christoph F. Schmidt[1] — [1]1Drittes Physikalisches Institut, Fakultät für Physik, Georg-August-Universität, Göttingen — [2]Institut für Numerische und Angewandte Mathematik, Georg-August-Universität, Göttingen

Actin, among the other bio-polymers present in cells, is largely responsible for cellular shape and mechanical stability. The actin cytoskeleton which self-assembles into networks of crosslinked filaments and bundles is responsible for active cellular processes ranging from migration, division and intracellular transport to morphogenesis. Crucial for these processes is the spatial and temporal regulation of the structure and dynamics of the network and of the generation of forces, mostly by myosin motors. To understand basic phenomena in such active networks, we investigate model networks comprised of semi-flexible actin filaments crosslinked by custom designed dsDNA constructs as flexible cross linkers. We also utilize these DNA constructs as force sensors in order to map stress distributions in the networks. We characterized the FRET-based stress sensors with a spectrophotometer. We study the rheological properties of the actin/DNA networks with a bulk rheometer and by high-bandwidth and high-resolution microrheology aiming to understand network failure mechanisms beyond linear response.

BP 10.5 Mon 17:30 Poster C

Stretching Adherent Cells with Light — •Tobias Neckernuss, Daniel Geiger, Jonas Pfeil, Irina Schrezenmeier, and Othmar Marti — Institute of Experimental Physics, Ulm University

The mechanical properties of cells are important parameters in natural science and medicine. Over the years various techniques have been developed to assess parameters like stiffness, creep and relaxation constants of all kinds of cells. Often the investigation relies on the interaction of the cells with a probe like in AFM or micropipette aspiration. However, these techniques always measure properties of the joint system cell and probe.
In 2001 Guck et al. demonstrated a new method to trap and stretch cells in a microfluidic channel with laser light. To the best of our knowledge this technique has only been applied to suspended cells so far. We will present a novel setup to stretch and measure adherent cells - that is the majority of cells in the human body - with a laser. This represents the first non contact opportunity to deform cells perpendicular to the substrate. A demonstration of the capability of the technique to determine overall cellular stiffness is given. Furthermore, we show a selection of models for the viscoelastic response as well as a glimpse of further applications.

BP 10.6 Mon 17:30 Poster C

Dynamic Actin Structures in Frog Egg Extract — •Jianguo Zhao and Christoph F. Schmidt — Drittes Physikalisches Institut - Biophysik, Fakultät für Physik, Georg-August-Universität Göttingen

The actin cytoskeleton in eukaryotic cells undergoes continuous turnover, which is of crucial importance for various functions, e.g. cell motility and division. While components are constantly exchanged, the concentrations and distributions of components, including monomeric and polymeric actin often maintain a steady-state. On the other hand, cytoskeletal structures are also quite adjustable when needed, and different steady states can be accessed in response to regulatory signals. Given the complexity of cells, it is desirable to be able to study such dynamic rearrangements in reconstituted model systems. We employed water-in-oil emulsion droplets composed of Xenopus laevis egg cytoplasmic extract as a model system. In preliminary experiments, we observed local actin network clusters in the presence of Arp2/3 complex. The size of aggregated clusters was dependent on droplet dimensions, concentration of extract, nucleation protein and MgCl2. Small clusters were quite active and transported stress over a relatively long-distance inside the droplet.

BP 10.7 Mon 17:30 Poster C

Failure of biological networks with dynamic cross-links — •Mareike Berger, David Brückner, and Chase Broedersz — Ludwig-Maximilians-Universität, Munich, Germany

The cytoskeleton is a complex network of crosslinked biopolymers, which is crucial for cellular rigidity and cell motility. To achieve such a variety of functions, it is important that these cytoskeletal networks can both withstand stress and adapt to external forces by remodeling. Rheological experiments with reconstituted crosslinked actin filament networks have revealed that these systems exhibit a complex viscoelastic response, which depends sensitively on the external stress imposed on the system: Under stress the network can behave either more fluid-like or more solid-like, depending on the configuration of the system. To investigate this behavior, we introduce a simple model of dynamically cross-linked networks. With this model we can study both these nonlinear viscoelastic properties as well as the failure of these networks under stress.

BP 10.8 Mon 17:30 Poster C

Tug of War and Coordination in Bidirectional Transport by Molecular Motors — •Omar Munoz and Stefan Klumpp — Institut für Nichtlineare Dynamik, Universität Göttingen

Intracellular cargo transport is known to be bidirectional and mediated by molecular motors that bind to the cargoes and cytoskeletal filaments. Theoretical models for bidirectional transport include a tug-of-war between the motors and motor coordination through a mediator. Here, a tug-of-war model is extended to include motor activation and inactivation as a mechanism for biochemical coordination. Stochastic simulations provide an understanding of the dynamics of this system and of the effect of this additional coordination. The proposed coordination model is successful in describing the experimental observations of unexpectedly long unidirectional runs as well as memory of the direction after forced unbinding. These results and the recent experimental findings suggest that models of bidirectional transport should be cargo specific and combine features of both coordination and tug-of-war.

BP 10.9 Mon 17:30 Poster C

Is the size of a cell nucleus an indicator for cancer? — •Lisa Rohde[1], Maja Strugacevac[1], Nina Bartels[1], Constanze Wiek[2], Julia Kristin[2], Marcel Glaas[2], Jörg Schipper[2], and Mathias Getzlaff[1] — [1]Heinrich-Heine-Universität Düsseldorf, Institute of Applied Physics, Düsseldorf, Germany — [2]Düsseldorf University Hospital, Department of Otorhinolaryngology

Identifying characteristics of cancer cells is still one of the main topics of recent research. Due to that our group is investigating properties of head and neck squamous cell carcinoma cells and dysplastic oral keratinocytes by fluorescence microscopy. The live cell imaging gives detailed information about single organelles, which is necessary for comparing the cell differences.

The nucleus is involved in the mitosis, contains the DNA and is therefore responsible for important physiological processes. As the mitosis rate is increased cancer cell nuclei hold much more chromatin than healthy cells do. This potential indicator for cancer motivates the comparison of the size of the different cell nuclei.

The cell nucleus is marked with Hoechst 33342, a blue fluorescent staining kit. The used laser scanning fluorescence microscope allows us three-dimensional cell nuclei observation. Different cancer cell lines and oral keratinocytes were compared to investigate whether the size of cell nuclei is an indicator for cancer.

BP 10.10 Mon 17:30 Poster C

Stress fiber network organization during cell spreading on micropatterned substrates — •Dimitri Probst[1], Julia Jäger[1], Elena Kassianidou[2], Anne-Lou Roguet[3], Sanjay Kumar[2], and Ulrich S. Schwarz[1] — [1]Institute for Theoretical Physics and BioQuant, Heidelberg University, Heidelberg, Germany — [2]Department of Bioengineering, University of California, Berkeley, USA — [3]École Polytechnique, Palaisaeu, France

Cell spreading, adhesion and migration are strongly modulated by both biochemical and physical cues from the environment. The latter is particularly evident for the actomyosin system, whose organization is strongly determined by adhesive geometry, stiffness and topography of the extracellular environment. In order to understand how the actomyosin system dynamically responds to the adhesive geometry of its environment, we have studied cell spreading onto rectangular fibronectin frames with varying gap locations that determine final cell shape. We find that the global spreading dynamics onto a given pattern can be well predicted with a Cellular Potts Model describing the interplay between adhesion and tension, and that the distribution of stress fiber (SF) orientations can be predicted by establishing that discrete SFs form tangentially behind the advancing lamellipodium at spatial intervals of approximately 2.0 μm and temporal intervals of approximately 15 minutes. Because these times are comparable with the overall spreading times, cells have a memory of their spreading history through the organization of the SF network, despite the fact that their final shape is mainly dictated by the pattern geometry.

BP 10.11 Mon 17:30 Poster C

Acoustic wave irridation of cancer cells — •Maximilian Erinski[1], Maja Strugacevac[1], Tobias Löffler[1], Constanze Wiek[2], Julia Kristin[2], Marcel Glaas[2], Jörg Schipper[2], and Mathias Getzlaff[1] — [1]Heinrich-Heine-Universität Düsseldorf, Institute of Applied Physics, Universitätsstr. 1, 40225 Düsseldorf — [2]Düsseldorf University Hospital, Department of Otorhinolayngology, Moorenstr. 5, 40225 Düsseldorf

In previous research our group showed differences in mechanical properties of cancer cells from the head and neck area compared to non-cancer cells. These differences are caused by changes in the actin filaments and microtubules of cancer cells.

Our findings could be used to develop a new selective cancer treatment. Due to different mechanical properties, acoustic wave irradiation destroys cancer cells and does not influence benign cells. The aim is not to induce necrosis leading to inflammation, but to start apoptosis.

In order to observe cell behavior during wave irradiation cells were stained using CellMask Green staining kit and were observed under confocal laser scanning microscope. In this work we used acoustic waves exhibiting frequencies from 0.5 to 10 kHz. The behavior of the cells to different frequencies and input power was investigated and will be presented.

BP 10.12 Mon 17:30 Poster C

Characterization of a piezoelectric actuator for output power and thermal behaviour — •Tobias Löffler[1], Stefan Krüger[1], Maja Strugacevac[1], Julia Kristin[2], Constanze Wiek[2], Marcel Glaas[2], Jörg Schipper[2], and Mathias Getzlaff[1] — [1]Institute of Applied Physics, University of Düsseldorf — [2]Düsseldorf University Hospital, Department of Otorhinolaryngology, Moorenstrasse 5, 40225 Düsseldorf, Germany

Our group is investigating the influence of acoustic waves on squamous cell carcinoma cells of the head-neck area in order to to determine their mechanical properties. A piezoelectric actuator with a sharp tip is used to produce sound waves in the range from 0,5 to 10 kHz. A detailed characterization of the acoustics is necessary for a better understanding of the interaction between the sound waves and the cells.

Temperature measurements at different distances in direction of oscillation and additional as a function of time have been performed in order to determine the temperature-profile in the vicinity of the probe. Additionally, the output energy was characterized. The experimental setup and the probe's characteristics will be presented in detail.

Furthemore, we observed the behaviour of the cancer cells on acustic waves at various frequencies and sound intensities. These results will be presented as well.

BP 10.13 Mon 17:30 Poster C

Time Resolved Measurements of Force Evolution in Platelets Under Flow Condition — •Jana Hanke, Anna Zelena, and Sarah Köster — Institute of X-Ray Physics, University of Göttingen, Göttingen, Germany

Force generation plays an important role for numerous biological processes like contraction, spreading and motility. In vivo, both chemical and physical cues influence this process. For cells like e.g. endothelial cells and blood cells, an important physical factor is external shear flow. Blood platelets, in particular, generate strong forces while constantly being subject to shear. Hence, studying the impact of shear on their contractile behaviour is important for the understanding the mechanics of blood clotting. Here, we present a method combining microfluidics with time-resolved traction force microscopy to mimic blood flow. We study the adhesion and contraction of human blood platelets under low shear rate conditions as found in veins and compare the results to data recorded without flow. We can reveal that the spatial traction force distribution and the total force remains unchanged with increasing shear flow. Similarly, the force dipoles show no difference in the degree of anisotropy between static and flow conditions. Interestingly, however, when studying the preferred orientation of contraction with respect to the flow direction, we observe adaptation of the platelets to the flow. With increasing shear rate, the angle rises from 45° to 90°. Our microfluidic chamber can be easily reproduced and adapted to mimic various different physiological conditions,

enabling the study of other cell types.

BP 10.14 Mon 17:30 Poster C

How filaments density impacts force generation and protrusion rate of lamellipodium in motile cells — •Setareh Dolati and Martin Falcke — Max delbrück center for molecular medicine(MDC), Berlin, Germany.

In Migrating cells, the Arp2/3-complex is thought to be responsible for formation and maintenance of the lamellipodium. However, studies show in addition to Arp2/3 activity formins also contribute to actin filament nucleation and elongation in the lamellipodium of B16-F1 melanoma cells and their activity strongly impacts force generation. Loss of formins reduces actin density, lamellipodium width and protrusion velocity of B16-F1 melanoma cells, while Arp2/3 activity and the actin network assembly rate are not affected by the absence of formins. Knocking out FMNL2 and FMNL3 individually and both together shows a correlation between actin filament area density and protrusion rates. Also, by manipulating Arp2/3 activity in B16-F1 melanoma cells, the same correlation between the protrusion rate and the filament area density in the lamellipodium has been observed.

Here, we mathematically model the lamellipodium as a viscoelastic gel representing an actively polymerizing and cross linked network of actin filaments. Taking the density of filaments as a control parameter, we suggest a mechanism that explains how the formins contribution to the actin area density leads to their corresponding contribution to the protrusion rate in the lamellipodium and how the structure of the actin network and properties like assembly rate of the network affect the dynamics of the lamellipodium.

BP 10.15 Mon 17:30 Poster C

Cellular Forces under Altered Gravity Conditions — •Julia Eckert[1,2,3], Stefano Coppola[2], Thomas Schmidt[2], Lukas M. Eng[1], Robert Lindner[3], and Jack J.W.A. van Loon[3,4] — [1]School of Science, Department of Physics, Technische Universität Dresden, Dresden, Germany — [2]Physics of Life Processes, Leiden Institute of Physics, Leiden University, Leiden, The Netherlands — [3]Life & Physical Science, Instrumentation and Life Support Laboratory (TEC-MMG), ESA/ESTEC, Noordwijk, The Netherlands — [4]VU Medical Center/ACTA, Amsterdam, The Netherlands

During future long-term space missions, the human organism will be exposed to microgravity and other gravitational levels for extended periods of time. Hence, it is of vital importance to develop a basic understanding of mechanobiology and mechanosensing under such conditions.

Here, we introduce a measuring approach based on a micropillar array technology. Different cell types, like bone and fibroblast cells, were placed on polydimethylsiloxane pillars with controlled stiffness allowing to examine cell traction forces. Further, they were exposed to altered gravity in the Large Diameter Centrifuge and in the Random Positioning Machine of the European Space Agency in The Netherlands. We found that cells respond to the new gravitational environment and their behavior depend on g-force into or away from the pillar array, substrate stiffness and their cell type. Our approach is suitable to study biological response to changing gravity conditions at the cellular level.

BP 10.16 Mon 17:30 Poster C

Design and construction of a magnetic trap for microrheological measurements — •Jonas Pfeil, Irina Schrezenmeier, Tobias Neckernuss, Daniel Geiger, Frederike Erb, Fabian Port, and Othmar Marti — Institute of Experimental Physics, Ulm University, Ulm, Deutschland

Today microrheological measurements on living cells using optical tweezers are scientific state of the art for analysis of cell mechanics. The maximum force that can be exerted on cells is limited by the maximum tolerable temperature of the cell. This limits the maximum forces to the nN range, which are too small to deform a whole cell significantly.

In contrast magnetic traps using superparamagnetic beads and high speed optical measurements do not heat the sample. Instead the limiting factors are magnetic flux and the gradient of the magnetic flux, which corresponds to the force on the beads. To achieve high gradient fields strong magnets can be used or the tip of the magnet has to be brought to the vicinity of the sample.

We will present solutions for the construction of a magnetic trap using a sharp tip and a single electromagnet using previously published designs adapted to our setup and our performance needs.

BP 10.17 Mon 17:30 Poster C

The role of endothelial cell mechanics in leukocyte extravasation — •Matthias Brandt[1], Volker Gerke[2], and Timo Betz[1] — [1]Institute of Cell Biology (ZMBE), University of Münster, Von-Esmarch-Straße 56, D-48149 Münster — [2]Institute of Medical Biochemistry (ZMBE), University of Münster, Von-Esmarch-Straße 56, D-48149 Münster

The endothelium forms the inner surface of blood and lymphatic vessels in the human body. For the immune response of an organism, leukocytes need to transmigrate through this endothelial cell (EC) monolayer, which requires coordination and adaptation of the EC and leukocyte mechanics. We aim to investigate the effect of EC stiffness on leukocyte guidance and the role of EC mechanics in this transendothelial migration.

We use an *in vitro* model consisting of HUVEC cells cultivated on a polyacrylamide gel substrate functionalized with basement membrane proteins, and leukocytes flown in by a microfluidic setup. The impact of varying substrate stiffness on EC mechanics and the question to which extend stiffness gradients are reflected by the endothelium itself is examined. Traction force microscopy serves to measure forces applied by the ECs to the substrate and to infer force transmissions at cell-cell junctions. The stiffness of the EC cortex and intracellular forces are measured using an optical tweezer. Using optogenecic activation of Rac1, RhoA and CDC42 signaling will generate localized EC contractility allowing to correlate EC mechanics and leukocyte migration.

BP 10.18 Mon 17:30 Poster C

Flow of a cell inside a microfluidic channel using FEM simulation — •Ralf Schuster[1], Tobias Neckernuss[1], Daniel Geiger[1], Ulrich Simon[2], Kay-Eberhard Gottschalk[1], and Othmar Marti[1] — [1]Institute of Experimental Physics, Ulm University, D-89081 Ulm — [2]Ulmer Zentrum für Wissenschaftliches Rechnen (UZWR), Ulm University, D-89081 Ulm

From the mechanical deformation of cells conclusions, regarding type, state, size or some inherent feature, can be drawn. Variations of structure and shape of cells play an important role for cell migration and proliferation. For instance tumor and normal cells can be distinguished by elasticity, indicated by the amount of deformation under a given stress. Metastasizing cancer cells can have a softer cytoskeleton through changes in the network, leading to a reduced drag resistance when passing through narrow constrictions.

The parabolic flow profile inside a microfluidic channel causes the cells to deform, while passing through it. The deviation from circularity of the cell at steady-state conditions can be taken as a characteristic measure for the deformation (Otto et al. Nature Methods 2015). Two different finite element-modeling approaches will be shown. The composition and the values of the properties of the cell are generated according to other works and experiments, performed at our Institute. Achieving accordance between experiment and simulation will lead to numerical values for the material parameters of cells respectively cell types and will be the basis for further experiments.

BP 10.19 Mon 17:30 Poster C

Intracellular passive and active microrheology in dividing epithelial cells — •Sebastian Hurst and Timo Betz — Institute of Cell Biology, ZMBE, University of Münster, Von-Esmarch-Straße 56, 48149 Münster

While there is a good understanding of chromosome segregation during cell division, surprisingly little is known about how the different organelles are distributed during this fundamental process. It is generally assumed that organelles are not systematic transported to the daughter cells but that their distribution relies on passive diffusion and hence stochastic transport throughout the cell. Although diffusion will provide fast mixing of small molecules, it is not clear if this can explain the even distribution of larger organelles with low copy number, especially in highly polarized cells.

Active, targeted transport of large organelles during cell division is mainly known for asymmetric cell division, and has not been reported in symmetric division. Another attractive mechanism for equal distribution of organelles during cell division is the increase of random mobility. This could be achieved by active, undirected fluctuations e.g. generated through motor protein activity. To test this hypothesis that active fluctuations help distributing organelles we perform optical tweezer based passive and active microrheology measurements with exogenous particles inside dividing MDCK cells. The results are used

to calculate the intracellular viscoelasticity and mechanical activity to pinpoint the influence of active cytosolic mixing during cell division.

BP 10.20 Mon 17:30 Poster C

Design and characterization of mechanically tunable hyaluronic acid based hydrogels — •Martin Schilling and Florian Rehfeldt — Third Institute of Physics - Biophysics, Georg-August-University, Göttingen, Germany

Many aspects of cell behavior are influenced by the mechanical properties of their microenvironment. To mimic the various elastic moduli of different in vivo environments of cells, it is necessary to design and characterize hydrogels for cell culture with tunable elasticity.

Hyaluronic acid (HA), a polysaccharide consisting of disaccharide units, was chosen as base for the hydrogel system as it is biocompatible and not toxic for cells, thus allowing for 3D encapsulation.

However, native HA does not crosslink naturally so its disaccharides have to be chemically modified. Depending on the degree of modification HA can be used for different approaches. High modified HA hydrogels are tunable in a large range of elasticities and due to their degree of modification cannot be recognized by HA receptors of cells that need longer segments of unmodified disaccharides. A lower degree of modification decreases the range of elasticity but allows for cellular recognition of HA. In order to obtain a hydrogel with moderate elasticity and the properties of low modified HA both high and low modified HA are mixed in several different ratios. The gelation kinetics of the resulting hydrogels are investigated by rheology using oscillatory deformation tests. In order to analyze the viscoelastic properties of the cross-linked hydrogels the storage modulus G' and the loss modulus G" were measured.

BP 10.21 Mon 17:30 Poster C

Mechanical and biochemical micromanipulation of individual suspended cells probed with optical tweezers — •Samaneh Rezvani[1], Todd M. Squires[2], and Christoph F. Schmidt[1] — [1]Third Institute of Physics-Biophysics, Faculty of Physics, University of Göttingen, Göttingen, Germany — [2]Department of Chemical Engineering, University of California, Santa Barbara, USA

Cells communicate with their environment through biochemical and mechanical interactions. They can respond to stimuli by undergoing shape- and, in some situations, volume changes. Key determinants of the mechanical response of a cell are the viscoelastic properties of the actomyosin cortex, effective surface tension, and osmotic pressure. It is challenging to measure the mechanical response of cells while changing environmental conditions. We here demonstrate the use of a novel microfluidic device with integrated hydrogel micro-windows to change solution conditions for cells suspended by optical traps. Solution conditions can be rapidly changed in this device without exposing the cells to direct fluid flow. We use biochemical inhibitors and varying osmotic conditions and investigate the time-dependent response of individual cells. Using a dual optical trap makes it possible to probe the viscoelasticity of suspended cells by active and passive microrheology and to quantify force fluctuations generated by the cells at the same time.

BP 10.22 Mon 17:30 Poster C

A 2-D Continuum Model of Cell Migration — •Behnam Amiri and Martin Falcke — Max Delbrück Center for Molecular Medicine(MDC), Berlin, Germany.

Actin-based cell migration is critical for many biological processes including embryonic development and tumor metastasis. At the leading edge of the motile cells, polymerization of actin filaments creates the force necessary for protrusion. Here we present a 2-dimensional continuum model for the lamellipodia dynamics of a motile cell. The model quantitatively describes the pushing forces exerted by newly polymerized filaments in a semi-flexible layer behind the leading edge, and their effect on the retrograde flow of the cytoskeleton and the membrane protrusion. We will demonstrate that the interplay between these components can determine the most prominent aspects of the cell morphodynamics. The developed modeling framework consists of a coupled system of Reaction-Diffusion-Advection PDEs for cytoskeleton components, a stokes flow PDE for velocity profile of the cytoskeleton and a Reaction-Advection PDE for the properties of filaments in the semi-flexible region along the leading edge. All of these equations must be computed in the unsteady moving cell domain and with appropriate boundary conditions at the moving cell boundary. In order to numerically solve this hybrid continuum model, we use a moving boundary finite element scheme for free boundary problems. Our model gives insight into how actin polymerization at the leading edge can affect the overall morphodynamics of the cell.

BP 10.23 Mon 17:30 Poster C

Near Real Time Analysis of Stress Fiber Formation in Stem Cells — •Lara Hauke, Carina Wollnik, and Florian Rehfeldt — University of Göttingen, Third Institute of Physics - Biophysics

Human mesenchymal stem cells (hMSC) can be directed to differentiate into various lineages by different matrix elasticities. While changes in lineage specific protein expression occur over a period of days to weeks, significantly different structures of stress fibers are observable within the first 24 hours of plating [1] quantified by an order parameter S. With our massively parallel live-cell imaging set-up we record cells under physiological conditions (37 °C, 5 %CO2) over a period of 24-48 hours to obtain a statistically sufficiently large data set. We aim for a full representation of filament processes over time and space allowing for statistical analysis. This unbiased classification will be represented by persistence in space and time and potential cross-talk with other cytoskeletal components. For this we developed the *FilamentSensor* [2,3] a freely available tool for near real-time image analysis of stress fibers. We present experimental data where we can distinguish the development of hMSCs on 1 kPa, 10 kPa and 30 kPa elastic substrates with 99 % confidence and are working on single filament tracking and better analysis of orientation fields. References: [1]A. Zemel, et al., Nat. Phys., 2010. [2]www.filament-sensor.de [3]B. Eltzner, et al., PLoS One, 2015.

BP 10.24 Mon 17:30 Poster C

Elastic Response of Epithelial Model Tissues in Deformation Experiments — •Simone Gehrer[1], Sara Kaliman[1], Damir Vurnek[1], Maryam Aliee[1], Shuqing Chen[2], Andreas Maier[2], Diana Dudziak[3], Rudolf Merkel[4], and Ana-Sunčana Smith[1,5] — [1]PULS Group, Institute for Theoretical Physics I, FAU Erlangen — [2]Pattern Recognition Lab, Department of Computer Science 5, FAU Erlangen — [3]Dermatology, Universitätsklinik Erlangen — [4]ICS-7: Biomechanics, Forschungszentrum Jülich — [5]Division of Physical Chemistry, IRB Zagreb

Epithelial tissues act as barriers between different tissue types and form boundaries of the majority of organs. They are often exposed to mechanical stress to which they quickly respond by changing shape and internal organization on short time scales. On longer time scales, stress can be released by proliferation and growth.

To investigate the response of MDCK II tissues grown on PDMS substrates, we expose the cell-colonies to an uniaxial stress (10 – 30%) using a stretching device. The resulting changes are monitored for minutes to days by phase-contrast and confocal microscopy. The reversible changes in the overall shape of the cell confirm that on short time scales the tissue responds as an elastic material. This is furthermore confirmed by analysing the morphology and connectivity of individual cells before and after stress. On longer time scales, we find that the growth rate of the colony is affected by the continuous deformation, while after 24 – 48h the tissue adapts and resumes the morphological and topological characteristics as the control.

BP 10.25 Mon 17:30 Poster C

Cell-Type Specific Mechano-Sensing Altered by Blebbistatin — •Galina Kudryasheva and Florian Rehfeldt — Göttingen University

Cells sense the mechanical properties of their surroundings with contractile acto-myosin stress fibers through focal adhesions and react to such physical stimuli by distinct pattern formation of their cytoskeleton and by altering their bio-chemical pathways. Especially striking is the mechano-guided differentiation of human mesenchymal stem cells (hMSCs). The structure and dynamics of acto-myosin stress fibers is used as an early morphological marker and theoretically modelled using classical mechanics with an active spring model. We use this approach to elucidate the mechanical cell-matrix interactions of hMSCs and several types of differentiated cells. Employing immuno-fluorescence microscopy we visualize stress fibers and analyze the global morphology of the cells cultured on elastic substrates (E_m from 1 kPa to 130 kPa). Applying the theoretical model to our experimentally obtained cell spread area we extract an effective Young's modulus of the cell (E_c). We demonstrate that E_c changes during hMSCs differentiation process and varies for different cell lines. Our experiments show that the mechanical susceptibility is cell type specific and dependent on acto-myosin contractility. Interestingly, addition of the non-muscle myosin II (NMMII) inhibitor blebbistatin at low concentrations (c =

12.5 and 25 uM) softens the cells (reduces the effective Young's modulus E_c) and facilitates cell spreading only on soft substrates through relaxing the cellular acto-myosin cortex.

BP 10.26 Mon 17:30 Poster C

Elastic beads as in vivo tension sensors — •Arne Hofemeier, Bernhard Wallmeyer, and Timo Betz — Institute of Cell Biology, ZMBE, University of Münster

Mechanical tension has recently been recognized as a key element to understand many biological processes such as cell fate determination or collective cell migration during embryogenesis. However, direct experimental access to determine tension in vivo in a non-destructive way remains a major challenge. Here, we present a novel experimental approach that allows direct measurement of stress inside in vitro and in vivo tissue. By injecting fluorescent polyacrylamide (PAA) beads of known size and elasticity in the tissue, we are able to measure the deformation of their surface and obtain the resulting displacement vector. Solving the inverse elastic problem yields an approximation of the stress field inside the tissue. Furthermore, we show two applications of this novel technique. Firstly, PAA beads are injected into mouse muscles to examine forces exerted during muscle contraction on muscle stem cells, a cell type known to respond to changes of mechanical properties. Secondly, PAA beads are injected into zebrafish embryos to investigate the role of tissue stress in collective cell migration during embryogenesis.

BP 10.27 Mon 17:30 Poster C

Fluid flow in curvilinear microchannels for stem cell purification- understanding the deformability-induced lift force — •Ewa Guzniczak[1], Melanie Jimenez[2], and Helen Bridle[1] — [1]Heriot-Watt University, School of Engineering and Physical Science, Department of Biological Chemistry, Biophysics and Bioengineering Edinburgh Campus, Edinburgh EH14 4AS — [2]University of Glasgow, School of Engineering, Biomedical Engineering Division, Glasgow G12 8QQ

Traditionally, fluid flow in microscale confined channels has been associated with a negligible inertia since fluid flow occurs at low Reynold's numbers. However previous work (Di Carlo 2009) has shown physical phenomena occurring at commonly neglected intermediate flow regimes, namely secondary flow and inertial migration of particles, determined by channel geometry, particle size and flow rate. The interplay between fluid flow pattern and particles, if fine-tuned, leads to particles ordering and separation, and the effect has been exploited in a range of applications. However, biological particles due to their deformable nature add complexity to the focusing mechanism and it is challenging to predict their behaviour. We exploit inertial focusing in curvilinear microchannels to purify manufactured red blood cells, which are the end-products of stem cell differentiation. Separation is based on their physical properties, namely size and deformability. Thus, we are also exploring how deformability-induced lift force affects and contributes to particles separation in the spiral microchannel.

BP 10.28 Mon 17:30 Poster C

Measurements and Simulations with the CellMOUSE device — •Jonas Pfeil, Tobias Neckernuss, Daniel Geiger, Ralf Schuster, and Othmar Marti — Institute of Experimental Physics, Ulm University

We recently developed a tool to characterize suspended cells passing an optical sensor, the so called CellMOUSE device. With this high speed optical setup we are able to determine different parameters like shape, size and morphology of the passing particles. These are important markers to distinguish different cells.
We will show measurements of various samples using the CellMOUSE device to show the range of possible applications. Besides investigations of well known samples for validation of the measurement principle, we also observe and distinguish cells of different origins in mixtures. Due to the real time nature of the experiment, we are able to manipulate single cells according to the measurement result. The technique can be also applied to other samples like bacteria or particles of different sizes.
To complete the study, we developed a simulation system for CellMOUSE to determine the figures of merit a priori.

BP 10.29 Mon 17:30 Poster C

Cells Modeled as Osmotically Pressurized Elastic Shells — •Behzad Golshaei, Renata Garces, Samaneh Rezvani, and Christoph F Schmidt — Drittes Physikalisches Institut - Biophysik, Fakultät für Physik, Georg-August-Universität Göttingen

Animal cells, as well as bacteria, are mechanically protected by a viscoelastic envelope consisting of lipid membranes and polymer networks. External mechanical stimulation leads to responses such as deformations or flows. In order to understand the mechanical behavior of cells, we model cells as pressurized elastic shells using finite element modeling. We study how geometrical parameters (cortex thickness and cell diameter), thermodynamic effects (osmotic pressure difference), and material properties (Young*s modulus) affect the response of a cell to indentation. We focus on the time scales where cellular systems show elastic behavior in order to compare our model with experimental results. Results from two types of experimental set-ups have been used to parameterize linear elasticity equations. The first set of experiments used an optical trap to indent mammalian cells, and in the second set, bacteria were indented by beads of varying diameter using AFM.

BP 10.30 Mon 17:30 Poster C

Mechanical Coupling of Human Embryonic Stem Cell Derived Cardiomyocytes — •Heidi Somsel[1], Wolfram-Hubertus Zimmermann[2], and Christoph F. Schmidt[1] — [1]Drittes Physikalisches Institut - Biophysik, Fakultät für Physik, Georg-August-Universität Göttingen — [2]Institut für Pharmakologie und Toxikologie, Universitätsmedizin Göttingen, Georg-August-Universität Göttingen

In the United States, someone suffers a myocardial infarction every 40 seconds[1]. A major long-term effect of these infarctions is scar tissue with a stiffness (40 kPa) that is larger than the surrounding myocardium (15 kPa). These scars strongly interfere with heart function.

Mechanical coupling between CMs is believed to play an important role in stabilizing the global contraction of the heart[3]. In this study, we aim to understand mechanical coupling and synchronization between neighboring pairs of CMs. Human embryonic stem cell (hESC) derived CMs were plated on PDMS substrates in geometries with physiological aspect ratios. The Young's moduli of the underlying substrate were varied from those of the healthy heart (15 kPa) to infarcted tissue (45 kPa) to model the reaction of CMs in response to these different myocardial regimes. We found synchronization in frequency and phase between neighboring cells. 1] Benjamin, E., et al.(2017). 2] Riegler, J., et al.(2015). 3] Nitsan, I., et al.(2016).

BP 10.31 Mon 17:30 Poster C

Probing C. Elegans Micromechanics in vivo — •Peter Weist, Renata Garces, Eugenia Butkevich, and Christoph F. Schmidt — Drittes Physikalisches Institut - Biophysik, Fakultät für Physik, Georg-August-Universität Göttingen

To perform undulatory locomotion, C. elegans generate forces acting not only on the surrounding environment but also against its own-body bending resistance. The decoupling of body passive-active responses during the bending is crucial to quantify the forces generated by the worms muscles. To date, a direct measurement of the stresses involved in the worms deformation is lacking. In this contribution, we present an experimental set-up that monitors the global response of individual worms to bending and pulling forces in a simple geometry. Living worms are kept straight by clamping their extremities onto agar plates. We pull and move the center of the worm with a custom-made cantilever of known spring constants (values around 1 N/m). We measure the loading forces and displacement profiles. Describing the worm body as a purely elastic material, we are able to determine bending and stretching contributions to the global stiffness and to derive material parameters. Furthermore, to separate the passive response of the body from the muscle activity, we vary the contraction-relaxation state of the muscles using pharmacological treatments. We provide a synthesis of the typical range of magnitudes of the worm's material parameters for different muscles states. The characterization technique for the mechanics of wild-type worms we propose can be used as a standard test for muscle functioning, including genetically modified species.

BP 10.32 Mon 17:30 Poster C

Elasto-Tweezers: A novel platform for high-precision cell elasticity measurements — •Sebastian Knust[1], Andy Sischka[2], Hendrik Milting[3], Bastien Venzac[4], Séverine Le Gac[4], Elwin Vrouwe[5], and Dario Anselmetti[1] — [1]Experimental Biophysics and Applied Nanoscience, Faculty of Physics, Bielefeld University, Bielefeld, Germany — [2]Ionovation GmbH, Osnabrück, Germany — [3]Heart and Diabetes Center NRW, Ruhr University of Bochum, Bad Oeynhausen, Germany — [4]Amber, MESA$^+$ Institute for Nanotechnology, University of Twente, Enschede, The Netherlands — [5]Micronit Microtechnologies B.V., Enschede, The Netherlands

The correct mechano-elastic properties of human cells are essential for their health and function. However, certain diseases like some cancers and cardiomyopathies alter those properties. High-throughput and high-resolution measurements of cell elasticities can therefore be used to provide insights into the pathomechanisms of these diseases.

We are able to directly measure both the forces applied to the cell with piconewton resolution and the cell deformation with submicrometre resolution by using a dual-beam optical tweezers setup with video-based force detection and coupling of functionalised beads to the cell surface. This allows all elasticity measurements with superior resolution compared to other techniques like optical stretchers.

To achieve high-throughput measurements, this novel setup will be combined with custom-designed microfluidical cartridges to facilitate automated and reliable formation of cell-bead complexes to perform completely automated measurements of up to 600 cells per hour.

BP 10.33 Mon 17:30 Poster C

Cortical Actin Contractility of Single Suspended Cells — •Enrico Warmt, Steffen Grosser, Erik Morawetz, and Josef Käs — Universität Leipzig, Soft Matter Physics Division, Linnéstr. 5, 04103 Leipzig

Up to now cellular contractility was seen basically as a force dipole requiring adhesion sites and actin stress fibers, mainly necessary during cell migration. In this study, we investigate suspended cells regarding active contractility, lacking stress fibers and adhesion points. Epithelial cells assemble a strong acto-myosin cortex providing pretension forming round cell shape, and exhibiting more contractile behavior during long optical stretcher observation. In contrast, mesenchymal cells, show more elongated cell shapes and less cortical contractility. Cell contractility needs a short mechanical impulse to induce acto-myosin contraction of the cell cortex, even below initial cell elongation. We will focus on how these findings correlate to different migratory and jamming behavior in healthy and mesenchymal cell clusters.

BP 10.34 Mon 17:30 Poster C

Dynamic patterns of the plant growth regulator auxin — •João Ramos and Karen Alim — Max Planck Institute for Dynamics and Self-Organization

Auxin is a phytohormone whose patterns are responsible for plant morphogenesis and triggering cell fate decisions. Patterns of auxin concentration and flow change dynamically throughout plant development with the help of membrane bound efflux (PIN) and influx carriers (AUX/LAX). Nevertheless, the mechanisms behind auxin transport are still not fully understood, in particular, current models fall short on explaining fountain-like auxin flow patterns during lateral root formation. Recently, observations show that PIN localisation is influenced by mechanical stress/strain, which coupled with the auxin-induced local decrease of cell wall stiffness, has the potential to unlock our understanding of auxin transport phenomena. Moreover, experimental efforts in observing morphodynamics and auxin carriers during lateral formation were recently boosted with the advent of light sheet microscopy, in effect turning lateral root formation into a new prime model system for auxin transport. Here, we study a vertex model for cell wall mechanics, coupled with a compartment model of auxin transport from a cell to its immediate neighbours both passively and carrier mediated. More specifically, the effect of cell wall stress on PIN cycling, auxin-induced wall softening and AUX/LAX expression positive feedback on auxin levels, are taken into account. This model will later be coupled to a tissue growth model, in order to study how auxin patterns change dynamically during lateral root formation.

BP 10.35 Mon 17:30 Poster C

Inferring the rules of single cell behavior from video recordings of collective tumor cell systems — •Claus Metzner, Julian Übelacker, Nico Wunderling, Christoph Mark, Franziska Hoersch, Christina Hillig, and Ben Fabry — Biophysics Group, Friedrich-Alexander Universität, Erlangen, Germany

Collective effects in multicellular systems emerge from the behavior of the individual cells and their mutual interactions. Identifying the rules of this cell behavior is difficult, due to their stochastic nature. Moreover, different microscopic rules can be consistent with the same macroscopic effects. We therefore present a machine learning method that extracts a stochastic model of single cell behavior from video recordings of multicellular systems. The method is based on a Maximum Likelihood approach that analyzes the motion of individual cells relative to their immediate neighbors. In particular, we extract the average speed and directional persistence of individual cells, as well as a pair-wise, distance-dependent interaction potential between nearby cells. First, we demonstrate the feasibility of the method by extracting the rules from simulated data with known model parameters. Next, we apply the method to multicellular systems consisting of a single cell type (MDA-MB-230, or HT1080), seeded on a flat cell culture dish. Finally, we investigate mixed systems of immune cells (Natural Killer (NK) cells, T-cells) and tumor cells (K562 lymphoma and MeWo melanoma cell lines) in a collagen gel and extract the maximum distance from which the immune cells can detect their targets.

BP 10.36 Mon 17:30 Poster C

3D collective migration in cancer spheroids and during invasion — •Swetha Raghuraman and Timo Betz — Institute of Cell Biology, ZMBE, University of Münster, Von-Esmarch-Straße 56,48149 Münster

Cancer cells move collectively in order to migrate and overcome space constrictions and geometric obstacles. This movement is characterized by cell-cell adhesion differences, the extracellular matrix or cell-substrate interactions, as well as intercellular cross-talks during invasion, morphogenesis and wound healing. The mechanisms and the physics behind coordinated behavior of cells have been studied recently at the 2D level, and in-vivo tissue homeostasis. However, due to the challenges involved in reproducing and imaging tumor spheroids, collective motion of 3D cancer invasion remains a complex task. With the use of Light Sheet Microscopy, we have been able to record cancer spheroids with fluorescently marked nuclei over several days at sub-cellular resolution. 3D particle tracking of several thousand cells allows well defined velocity correlations and density fluctuation measurements within the spheroid, and at the cell invading a collagen matrix. By combining these parameters we will test the hypothesis whether cancer cell migration in 3D is physically similar to active jamming, as recently suggested in 2D situations.

BP 10.37 Mon 17:30 Poster C

Light-Switchable Adhesion of Soil-Dwelling Microalgae — •Christian Titus Kreis[1], Christine Linne[1], Marine Le Blay[1], Alice Gragnier[1], Marcin Michal Makowski[1], Maike Lorenz[2], and Oliver Bäumchen[1] — [1]Max Planck Institute for Dynamics and Self-Organization (MPIDS), Am Faßberg 17, D-37077 Göttingen, Germany — [2]SAG Culture Collection of Algae, Nikolausberger Weg 18, D-37073 Göttingen, Germany

Freshwater microalgae live in heterogeneous, aqueous habitats, such as soil, aquatic sediments, puddles, and lakes. Besides having fundamental ecological functions and enormous technological potential in photobioreactors, microalgae form biofilms on surfaces in wet environments, which may affect the functionality of any anthropogenic structures. Despite the relevance of controlling microalgal adhesion, the biological mechanisms and intermolecular forces that govern microalgal adhesion to surfaces are poorly understood. We discovered in micropipette-based *in vivo* force spectroscopy that the adhesion of the unicellular microalgae *Chlamydomonas reinhardtii* to surfaces can be reversibly switched on and off by tailoring the light conditions [1]. Here, we present results on the underlying molecular mechanism of light-switchable flagella-mediated adhesion. Additionally, we performed experiments with other unicellular microalgae indicating that actively controlled flagella adhesiveness might be a more generic trait of soil-dwelling microalgae.

[1] Kreis et al., *Nature Physics*, 2017, doi:10.1038/nphys4258.

BP 10.38 Mon 17:30 Poster C

Dynamics of actin stress fiber patterns in laterally confined cells — •Andreas Müller and Tilo Pompe — Universität Leipzig, Institute of Biochemistry, Johannisalle 21-23, 04103 Leipzig, Germany

Cell shape and function are inseparably linked. Cell shape can be regulated intracellularly by structural proteins or extracellularly by adaption to the surroundings. In this way, the extracellular geometry can be used to manipulate cell function.

We use glass substrates and soft polyacrylamide hydrogels that are micro-structured with stripe-like patterns to study the adaptation of cells to adhesion geometry. Isolated HUVECS are studied for several hours in order to correlate the their morphology, the reorganization of their actin cytoskeletons, and the dynamics of cell traction forces in response to lateral constraint. Current work focusses on live-cell imaging to reveal stress fiber dynamics and concurrent traction forces. We found that aligned stress fibers in polarized cellssmove inward, perpendicular to their orientation and the direction of main traction forces. In addition, the directionality and magnitude of traction forc-es are

strongly correlated to cell shape and actin cytoskeleton pattern with an overall dependence on the degree of confinement.

Overall, our setup allows us to quantitatively analyze in a time-resolved manner the cell's morphological and mechanical adaption to spatial confinement in correlation to the actin cytoskeletal components as the main contributors to the force homeostasis. By that, we aim to contribute to elucidate the mechanisms behind the mutual relationship between cell shape and function.

BP 10.39 Mon 17:30 Poster C

Bacterial adhesion on nanostructured silicon surfaces — •Friederike Nolle[1], Johannes Mischo[1], Christian Spengler[1], Nicolas Thewes[1], Markus Bischoff[2], and Karin Jacobs[1] — [1]Department of Experimental Physics, Saarland University, Saarbruecken — [2]Institute for Medical Microbiology and Hygiene, Saarland University, Homburg/Saar

To prevent the inflammation of a medical implant, its material specifications are of crucial importance. An ideal surface would hinder bacterial biofilm formation and/or kill adhering pathogens without harming surrounding somatic cells. Surface modifications of single attributes have to be controlled and possible changes in adhesion of bacteria to these surfaces have to be observed. This study focuses on the nanoroughness of silicon surfaces, obtained by wet chemical etching, and its influence on bacterial adhesion (*Staphylococcus aureus*). The adhesion of bacteria is mediated by biopolymers, the properties of which we are able to characterize by AFM force spectroscopy, where the probe is a single bacterium. With our setup an insight into the adhesion force of *Staphylococcus aureus* was gained and also changes of the bacterial viability on the rough surfaces compared to smooth silicon surfaces were examined. In addition, the impact of hydrophobicity of rough silicon surfaces on adhesion was considered by silanizing the hydrophilic silicon.

BP 10.40 Mon 17:30 Poster C

Phase field modeling of moving cells - shedding light on the motility onset — Cody Reeves[1,2], Benjamin Winkler[3], Igor Aranson[2,4], and •Falko Ziebert[5,3] — [1]Engineering Sciences and Applied Mathematics, Northwestern University, Evanston, USA — [2]Materials Science Division, Argonne National Laboratory, USA — [3]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Germany — [4]Department of Biomedical Engineering, Pennsylvania State University, University Park, USA — [5]Institute for Theoretical Physics, Ruprecht-Karls-University Heidelberg, Germany

Substrate-based crawling motility of eukaryotic cells is essential for many biological functions, both in developing and mature organisms. Although a comprehensive understanding remains elusive, progress has been achieved recently in its modelling on the whole-cell level. We survey the recent advances made by employing the phase field approach, a powerful method to implement moving, deformable boundaries. The developed approach in addition is modular in the sense that, depending on the problem at hand, different model components (e.g. adhesion dynamics, substrate deformation and membrane feedback) can be included or disregarded without changing the formalism. We exemplify the approach by showing that our framework captures the spontaneous rotational states prior to the cell motility onset and cell polarization, recently found for keratocytes by two groups (S. Lou et al. JCB 2015; F. Raynaud et al. Nature Phys. 2016), and interpret them as nonlinear shape deformation waves.

BP 10.41 Mon 17:30 Poster C

3D-environments shape T-cell motility and cell-cell contacts during HIV-1 infection — Andrea Imle[1], •Nikolas Schnellbächer[2,3], Peter Kumberger[3], Jana Fehr[3], Paola Carillo-Bustamante[3], Frederik Graw[3], Ulrich Schwarz[2,3], and Oliver Fackler[1] — [1]Department of Infectious Diseases, Integrative Virology, University Hospital Heidelberg — [2]Institute for Theoretical Physics, Heidelberg University — [3]BioQuant, Heidelberg University

The spread of HIV-1 can progress either through cell-free infection or through direct cell-cell contacts between immune cells. The latter mode is assumed to be more efficient, but it remains elusive which strategy is favored under different conditions and how tissue structure might change the contribution of each mode of infection to viral spread. To address this problem, we study HIV-1 infection dynamics of primary T-lymphocytes in tissue-like 3D environments (collagen matrices of different densities). Based on single cell tracking data, we developed a quantitative analysis to study how different 3D environments influence cell migration and shape the kinetics of cell-cell contacts. This information is then used to parameterize a Cellular Potts Model (CPM). Applying this CPM in combination with population dynamics models to the infection dynamics data, we infer kinetic parameters of HIV-1 spread under different environmental conditions. Together, our work provides mechanistic and quantitative insight to understand how 3D environments shape HIV-1 spread.

BP 10.42 Mon 17:30 Poster C

Tissue competition: The role of cross adhesion — •Tobias Büscher and Jens Elgeti — Theoretical Soft Matter and Biophysics, Institute of Complex Systems and Institute for Advanced Simulation, Forschungszentrum Jülich, D-52425 Jülich, Germany

Cells grow and divide, which implies a change in volume. In physical terms, the conjugate force to a change in volume is a pressure. Thus, in order to grow, cells must exert mechanical pressure on the neighbouring tissue. In turn, mechanical stress influences growth. Indeed, experiments on the growth of a cancer cell line display a reduction in proliferation due to mechanical pressure [1,2,3]. This effect leads to a mechanical contribution when tissues compete for space. The tissue with higher homeostatic pressure, i.e. the pressure at which cell division and death balance, overwhelms the weaker one [4,5]. We expand these works to include different adhesion properties. We find that the cross adhesion between the two tissues plays a crucial role in the dynamics of the competition. Besides one overwhelming the other, we observe a variety of states in which the two tissues coexist, ranging from spherical inclusions to a bi-continous structure. Interestingly, cancer cells typically express less adhesion proteins.

[1] Montel *et al*, 2011, *PRL* **107**, 188102
[2] Delanrue *et al*, 2013, *PRL***110**, 138103
[3] Podewitz *et al*, 2016, *EPL* **109**, 58005
[4] Basan *et al*, 2011, *Phys. Biol.* **8**, 026014
[5] Podewitz *et al*, 2016 *New J. Physics* **18**, 083020

BP 10.43 Mon 17:30 Poster C

Role of mechanics in morphogenesis control — •Jason Khadka, Jean-Daniel Julien, and Karen Alim — Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany

A major question in developmental biology is to understand how reproducible shapes arises from the collective behaviour of individual cells. What is the role of feedback of mechanical forces on cell growth? In plants, cell shapes are controlled by individual cell wall stiffness, which itself is controlled by tissue-wide mechanical stresses via the dynamics of cortical microtubules. The prime model to investigate the impact of this mechanical feedback on cell growth is the tip of a plant shoot termed shoot apical meristem. This stem-cell niche is the source of all above-ground plant organs, where mechanics is well defined by its near dome-like structure. We built a quasi-three dimensional vertex model for plant tissue growth. Using the model, we investigate the role of mechanics for robust tissue shape formation by studying morphological changes of shoot shape that arise from limiting cellular ability to read mechanical signal. Further, we employ our model to analyse the importance of cell division in maintenance of shoot shape by investigating tissue morphologies with different underlying cell division patterns.

BP 10.44 Mon 17:30 Poster C

Visualization of intracellular calcium levels in *Dictyostelium discoideum* with a genetically encoded reporter — •Manuel Frey, Sven Flemming, Serena Cucinotta, and Carsten Beta — Biological Physics, Universität Potsdam

Ca^{2+} is an important second messenger in eukaryotic cells and is crucial for several signaling pathways related to cellular functions such as chemotaxis and cell motility. In order to visualize Ca^{2+} in the social amoeba *Dictyostelium discoideum*, we expressed a genetically encoded GFP based Ca^{2+} reporter at the plasma membrane. This enabled us to monitor spatiotemporal changes in the intracellular Ca^{2+} levels. As expected, we could detect global increases in calcium levels after chemotactic stimulation with cyclic AMP. Mechanical stimulation of cells with a micropipette led to a local calcium response. Furthermore, we could detect short, focal increases of Ca^{2+} at the basal plasma membrane, which coincided with the appearance of F-actin foci at the same location. In cells exposed to continuous shear flow, we observed periodic oscillations of the intracellular Ca^{2+} levels. Interestingly, once excited these oscillations continued for several minutes even after the shear flow was stopped. In contrast, application of a short pulse of shear flow induced only single responses. Our results show that local-

ized increases in Ca^{2+} can be visualized with our new reporter in live cell imaging experiments and revealed interesting oscillatory behavior under shear flow. Currently, we work on the co-expression of other reporters, which will provide more information on the biological function of this behavior and the related signaling pathways.

BP 10.45 Mon 17:30 Poster C

Evolution of simple multicellular life cycles in a dynamic environment — •Yuriy Pichugin and Hye Jin Park — Max Planck Institute for Evolutionary Biology, August-Thienemann-Str. 2 24306 Plön

Reproduction is a defining feature of living systems. To reproduce multicellular organism must fragment into smaller parts. To investigate evolutionarily optimal strategies of fragmentation under the dynamic environment, we use the model in which groups arise from the division of cells that do not separate but stay together until the moment of group fragmentation. The environmental conditions change in our model by alternating between two seasons, and different group sizes have a different birth rate of cells depending on the season. We outline which fragmentation strategies are evolutionarily optimal at given environmental conditions.

BP 10.46 Mon 17:30 Poster C

Sorting of malaria-infected red blood cells based on adhesion in shear flow — •Anil Kumar Dasanna and Ulrich Schwarz — BioQuant & Institute of Theoretical Physics, Heidelberg University, Heidelberg

Malaria is an infectious disease caused by the unicellular parasite Plasmodium falciparum. Once inside the human body, the parasite hides from the immune system inside the red blood cells, where it multiplies over a period of 48 hours, before it ruptures the host cell and infects new red blood cells. Infected red blood cells can be cleared by the spleen based on their altered mechanics. In order to avoid this, the parasite induces an adhesive system on the surface of the red blood cells, which is built up progressively over the 48 hours of the intracellular stage. Recently white blood cells have been shown to be sorted out using ligand patterns arranged with a small inclination angle with the shear flow direction. Using adhesive dynamics simulations for round cells, we show that this method can be also extended to sort out different stages of malaria-infected red blood cells. We predict an optimal range for key parameters, such as inclination angle and shear rate. Round shapes are only appropriate for the late stage of the infection and in order to understand sorting in the earlier stages, we also have implemented a deformable red blood cell model.

BP 10.47 Mon 17:30 Poster C

Amoeboid cells as a candidate for drug delivery — •Valentino Lepro, Oliver Nagel, Setareh Sharifi, and Carsten Beta — Institut für Physik und Astronomie, Universität Potsdam

The increasing interest towards new frontiers of drug delivery and micro-actuators raises the need to develop systems able to transport micron-sized objects in a directed fashion. A promising strategy that recently emerged is to exploit living cells as smart, steerable, and biochemically powered carriers. Inspired by amoeboid cells such as leukocytes migrating in our bodies, this project explores the potential of chemotactic eukaryotic cells as micro-carriers, using Dictyostelium discoideum as a model organism. Such chemotactically guided transport by amoeboid cells proved to be robust and reliable. However, due to the complex and not fully understood nature of amoeboid motion and cell-substrate interaction, the details of this process are not well understood and it remains difficult to regulate. Here, we present a more quantitative analysis indicating that cells loaded with a microparticle tend to displace more efficiently than unloaded ones, resulting in a particle-size dependent diffusion coefficient of loaded cells. Moreover, isolated cell-particle pairs may behaved like non-linear oscillators suggesting that the cell-particle interaction acts as a stimulus that enhances cell motility. In particular, the different adhesion geometries induced by the additional confinement could favor cytoskeleton polarization, which in turn promotes motility. Furthermore, we used gelatin gels as a simplistic model of a 3D tissue structure, to mimic a more natural environment for cell-based microtransport.

BP 10.48 Mon 17:30 Poster C

Morphology to encode information — •Mirna Kramar and Karen Alim — Max Planck Institute for Dynamics and Self-Organizaton, Göttingen

The challenges of living in a complex environment require organisms to develop reliable sensory and information processing mechanisms. For an organism that explores its environment by foraging, remembering sources of food or harm is essential for survival. We study *Physarum polycephalum* as a model organism at the verge between simple and complex life. The body of *P. polycephalum* is a network of cytoplasm-filled tubes lacking any organizing centre. This unicellular, multinucleate organism relies on shuttle streaming of its cytoplasm caused by peristaltic contractions of the actomyosin lining the tubes. As a response to stimuli, *P. polycephalum* reorganises its network to exploit a food source or avoid harm. The mechanism by which *P. polycephalum* memorises information about stimuli is not yet explained. Potentially there are three interrelated ways of information encoding, acting on different timescales: the peristaltic contractions (short term), the morphology of the network (intermediate) and the deposition of extracellular slime (long term memory). In particular, we here focus on the mechanism of information encoding in the network morphology, achieved by reinforcing of important connections and pruning of unimportant ones. To study this kind of memory, we use time series of images of the foraging organism, as well as simulations of network dynamics.

BP 10.49 Mon 17:30 Poster C

Cellular Potts Models for Neural Tissue Simulations — •Jakob Rosenbauer and Alexander Schug — Forschungszentrum Jülich, 52428 Jülich, Germany

Experimental capability in biology has been leaping forward in the last decades. Methods such as light-sheet microscopy have given more and more insights into the dynamics of tissue. Computational models are of rising importance for biological questions. The cellular Potts model (cpm) is a computational model derived from the Potts model. The development of tissue can be modelled with single cell resolution, up to a very high number of cells. A parallel version was developed, facilitating large three dimensional simulations of tissue dynamics on large cluster networks, which can be applied to a large variety of biological questions. Through a high scalability this model allows for modelling of much larger specimen than possible to date. The patterning of the neural plate in zebrafish embryonal development was modelled using the parallel cpm. The tissue dynamics during epiboly were modelled by the cpm. In that developmental stage the neural plate starts its patterning into different regions via a signalling molecule. Different modes of transport of that molecule, diffusion and so called cytonemes, were compared.

BP 10.50 Mon 17:30 Poster C

Does peristaltic pumping account for mass transport in *Physarum polycephalum*? — •Felix Bäuerle and Karen Alim — Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany

Physarum polycephalum, the infamous "intelligent" slime mold, has proven time and time again that it can solve complex problems. For example, it is able to find the shortest path through a maze, connect food sources in an efficient fashion or choose a balanced diet. In all of these efforts the adaptation of the morphology to a changing environment is the key. In detail cytoplasmic flows transport cytosolic fluid from pruning regions to growing ones. At the same time a peristaltic wave of contractions spans the whole body plan. Can this traveling wave generate enough pressure to account for the relatively fast reorganisation speed in *P. polycephalum*? While the contractions are known to account for the shuttle streaming, no investigations have been done so far on the net flow. We are presenting calculations of flow stemming from the contraction patterns in stimulated plasmodia and relate these to the morphology reorganisation.

BP 10.51 Mon 17:30 Poster C

Single cell migration and transitions to different substrates on micro patterns — •Christoph Schreiber, Felix J. Segerer, and Joachim O. Rädler — Faculty of Physics and Center for NanoScience, LMU München

When cells migrate in the body, for example during cancer metastasis, cells are facing different extra cellular matrix (ECM) proteins that can influence the cell migration behavior. To study the effects of different ECM proteins, standardized experimental conditions and suitable metrics to characterize cell motility are needed. We use micro-contact printed stripes or rings to get race tracks for cells with defined protein coatings. The tracks constrict cells to move only in 1D, which simplifies the analysis of the movement.

We find bimodal migration behavior with states of directional migration (run states) and reorientation (rest states).[1] We extract characteristic persistence times, which, in combination with the velocity of cells in the run state, provide a set of parameters quantifying cell motion. To be able to study transitions of single cells to different ECM proteins like fibronectin and collagen IV we developed a new patterning technique based on two stamping processes. Thus, transition rates and velocities on different protein coatings can be analyzed. Together this results in a fingerprint-like set of parameters characterizing cell migration that can be used to distinguish cell lines as well as to quantify the effects of motility affecting drugs.

[1] Schreiber et al. Sci. Rep. 6, 26858 (2016)

BP 10.52 Mon 17:30 Poster C

Scanning Ion Conductance Microscopy on osteoblasts with regard to their adhesion on surfaces — •Christian Völkner[1], Regina Lange[1], MohammadReza Bahrami[1], Martina Grüning[2], Henrike Rebl[2], Ingo Barke[1], Barbara Nebe[2], and Sylvia Speller[1] — [1]University of Rostock, Institute of Physics, 18059 Rostock, Germany — [2]University Medical Center Rostock, Dept. of Cell Biology, 18057 Rostock, Germany

Our aim is to elucidate mechanisms of initial cell adhesion and migration of osteoblasts (MG63) on material surfaces. To this end we prepare substrates with different properties such as surface charges, polarisability, electric potential and electromagnetic field landscapes. Furthermore we implement an electro-stimulation chamber to apply fields in the quasistatic regime [1]. Our main approach is Scanning Ion Conductance Microscope (SICM), in which a nanopipette is used as a probe and the ion current serves as localized interaction signal. In contrast to other scanning probe methods like Atomic Force Microscopy it allows one to obtain the nanomorphology of the surface of living cells reducing forces between cell and nanoprobe and respective cell responses [2]. Especially, substructures of the migration fronts of adhering osteoblasts are being addressed.

[1] N. W. S. Kam, E. Jan, N. A. Kotov, Nano Lett. 9, 273 (2009)

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Examining Anticipation in Physarum polycephalum — •Nico Schramma, Felix Bäuerle, and Karen Alim — Max Planck Institute for Dynamics and Self-Organisation, Göttingen, Germany

Memory and anticipation are complex mechanisms that have developed in higher species to predict and adapt to changing conditions. Even the unicellular slime mold *Physarum polycephalum* has been shown to anticipate periodic events. As a plasmodial vascular network, *P. polycephalum* changes its morphology in order to forage, and pumps cytoplasma through the organism using oscillatory contractions of tubes organized in a peristaltic wave. Saigusa et. al. showed that lateral restricted foraging *P. polycephalum* networks decrease their speed when stimulated periodically by unfavorable conditions. Interestingly, even after omission of the stimulus *P. polycephalum* still anticipates the withhold stimulus. However, the mechanism of this sophisticated behavior is not yet understood and cannot be extracted from their low resolution data. Here we show that periodic blue light stimulation of *P. polycephalum* networks entraines frequency modulations of tube contractions, which persist after the omission of further stimuli. Kymograph analysis of microscope pictures shows that the entrained frequency changes overall with a period similar to the periodic stimulation, with overall frequency minima coinciding with the blue light stimulus. Our analysis therefore suggests that the anticipation behaviour of *P. polycephalum* is a function of the entrainment of frequency modulations.

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Limitations of Murray's law in a dynamic network — •Noah Ziethen, Felix Bäuerle, Nico Schramma, and Karen Alim — Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany

The morphology of biological networks is often regarded as the result of optimization under a given demand. Optimization for minimal dissipation under cost for the maintenance of a tubular network leads to a relation between the radii of tubes meeting at a network node, denoted Murray's law. So far, the theoretical prediction of Murray's law has been found to agree surprisingly well with what seems to be any kind of vascular networks ranging from plants and animals. Contrary to the uni-directional flows in vascular networks the slime mould Physarum polycephalum exhibits oscillatory shuttle flow, providing an excellent test case to investigate the limitations and underpinnings of Murray's law.

Here, we image and analyze the dynamic network morphology of P. polycephalum over time. Quantification of Murray's law does not yield accordance with the theoretical predictions. A widely spread distribution of branching ratios was observed in which the mean value did not agree with Murray's law. Nevertheless, a decreasing trend of the branching ratio was observed. The time evolution of the decrease correlated with the phenomenon of pruning. The relation between the local branching ratio and the different regions of the slime mould showed a slightly different distributions in branching ratios for pruning and non-pruning regions.

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Organ-on-a-chip meets traction force microscopy: *In situ* characterization of forces in 3D μ-tissues — •Stefanie Fuchs, Oliver Schneider, Christopher Probst, and Peter Loskill — Department of Cell and Tissue Engineering, Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB, Stuttgart, Germany

Organ-on-a-Chip (OoC) systems are microfluidic devices which enable the cultivation of 3D tissues in a precisely controllable, physiological microenvironment. In combination with human induced pluripotent stem cells these systems have the potential to revolutionize the drug development process. Therefore, it is essential to accurately characterize the integrated tissues. An important characteristic of many tissues is the force exerted by the cells. This information is useful to characterize for instance the growth of cells and the contraction state of (cardiac) muscle cells. Traction force microscopy (TFM) is a commonly used tool to spatially resolve these forces.

Here, we present a TFM system directly embeddable into OoC systems, which consists of an elastic layer with integrated fluorescent nanobeads on the surface. Based on the elastic modulus of the substrate, the force on the surface can be derived from the bead displacement. We highlight that our system directly integrates a gauging mechanism for the determination of the substrate's mechanical properties, allowing the accurate determination of forces by considering each individual sample composition. The presented system enables precise *in situ* measurements of forces exerted by different tissue types in an OoC with a simple fluorescence microscope.

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Fluid and Jammed Behaviour in Cell Spheroids — •Steffen Grosser, Linda Oswald, Jürgen Lippoldt, and Josef A. Käs — Peter-Debye-Institut für Physik weicher Materie, Universität Leipzig

Cell Spheroids are many-particle "droplets" of soft matter with a constant volume fraction of one, which however can display fluid or "jammed"/glassy behaviour, as we can show with bulk rheology and single-cell tracking. Full three-dimensional digital segmentation of spheroids into single cell volumes reveal that for epithelial vs. cancerous spheroids (MCF-10A vs MDA-MB-436), this change in fluidity is reflected in the cell arrangements (cell shape). This could affect histopathology, where malignancy and dedifferentiation are detected via cell shape changes.

BP 10.57 Mon 17:30 Poster C

The influence of Rac1 on motility into 3D extracellular matrices andmechanical properties — •Tom Kunschmann, Stefanie Puder, and Claudia Tanja Mierke — Biological Physics Division, Peter Debye Institute for Soft Matter Physics, University of Leipzig, Germany

The formation of membrane ruffles and lamellipodia promotes the motility of adherent cells. In 2D cell motility assays, these protrusions are important for sensing of the microenvironment and initiation of substrate adhesions. The influence of structures such as lamellipodia or invadopodia for providing cellular mechanical properties and 3D motility of cells is still not yet clear. Hence, we showed that Rac1 affects cellular mechanical properties and facilitates the invasion in 3D microenvironments. We analyzed whether fibroblast cell lines genetically deficient for Rac1 possess altered mechanical properties such as cellular deformability and altered motility into 3D ECM. Thus, we analyzed Rac1 wild type and knockout cells for alterations in cellular deformability using an optical cell stretcher. We found that Rac1 knockout cell lines were pronouncedly more deformable compared to Rac1 wild type cells. The increased mechanical deformability of Rac1 knockout cells is suggested to be responsible for their reduced motility in dense 3D ECM. Thus, we investigated whether increased deformabil-

ity of Rac1 knockout cells suppresses cellular motility into 3D collagen fiber matrices. Rac1 wild type cells displayed increased motility in 3D compared to Rac1 knockout cells. These results were validated by using Rac1 Inhibitor EHT1864 which revealed similar results.

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Parameter-free high-resolution traction force microscopy — •Yunfei Huang, Gerhard Gompper, and Benedikt Sabass — Institute of Complex Systems 2, Forschungszentrum Juelich , 52425 Juelich, Germany

In Traction Force Microscopy, elastic displacements caused by mechanical interaction of cells with their environment are employed to calculate cellular traction forces. Calculation of traction from displacement is a linear problem. However, as a result of insufficient measurement density and a long-range interaction kernel, the calculated traction values strongly depend on the chosen method for solving the problem. Here, we systematically test the performance of state-of-the-art methods from sparse learning, computer vision, and Bayesian inference for traction force microscopy. Classical approaches include L2- and L1-regularization or spatial filters that depend on an ad-hoc choice of parameters. We also study three further parameter-dependent approaches, namely Elastic Net (EN) regularization, Proximal Gradient Lasso (PGL), and Proximal Gradient Elastic Net (PGEN). Next, we pioneer the use of parameter-free methods such as Bayesian Compressive Sensing (BCS), Bayesian Lasso (BL), and Bayesian Elastic Net (BEN). We introduced novel computational methods for traction force microscopy that eliminate the need for user-defined filter-parameters and also exhibit excellent performance with regard to resolution and accuracy. These methods can enable an objective detection and quantitative measurement of forces at minute cellular adhesion sites.

BP 10.59 Mon 17:30 Poster C

Interkinetic nuclear migration as a stochastic process in the zebrafish retina — Afnan Azizi[1], •Anne Herrmann[2], Salvador J. R. P. Buse[1], Yinan Wan[3], Philipp J. Keller[3], Raymond E. Goldstein[2], and William A. Harris[1] — [1]Department of Physiology, Development and Neuroscience, University of Cambridge, Cambridge, United Kingdom — [2]Department of Applied Mathematics and Theoretical Physics, University of Cambridge, Cambridge, United Kingdom — [3]Howard Hughes Medical Institute, Janelia Research Campus, Ashburn, VA, USA

Interkinetic nuclear migration (IKNM), a movement of nuclei between the apical and basal surfaces of proliferating cells in developing epithelia, was first observed more than 80 years ago. Since, IKNM has been studied in multiple organisms but despite these efforts many questions about the role and mechanism of this process remain unsolved. In earlier studies, only single or sparsely labelled nuclei in an otherwise unlabelled tissue were imaged. Here, we present data from light sheet microscopy on wholly labelled retinas, where the movement of all nuclei in a tissue section can be followed with high temporal resolution. This approach enables us to study the movements of individual nuclei as well as their collective behaviour in a systematic fashion. Our data, in combination with mathematical models, support the hypothesis of IKNM as a stochastic process. These results present IKNM as a possible precursor for the observed stochasticity in progenitor differentiation and have important implications for understanding the organisation of developing vertebrate tissues.

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Neuronal model for startling coupled with a collective behavior model — •Andrej Warkentin[1] and Pawel Romanczuk[1,2] — [1]Bernstein Center for Computational Neuroscience, Humboldt Universität zu Berlin — [2]Institute for Theoretical Biology, Department of Biology, Humboldt Universität zu Berlin

Many aspects of fish school behavior can be explained qualitatively by self-propelled agent models with social interaction forces that are based on either metric or topological neighborhoods. Recently, startling of fish has been analyzed in its dependence of the network structure [1] but a neurophysiological model and its influence on the collective behavior is missing. Here, we coupled a model for collective behavior with a neuronal model that receives looming visual stimulus input to initiate a startle response, inspired by the neurobiologically well-studied Mauthner cell system. First, we analyzed the basic properties of the startle behavior of a single fish as a reaction to one or multiple looming stimuli. On the group level, we looked at startling frequency and cascades as well as group cohesion, polarization and mobility depending on neuronal and collective behavior parameters via simulations of the combined model. Our results indicate that the startling frequency strongly depends on the dynamics of the group structure, e.g. when the group approaches a boundary of the arena. In summary, we took first steps towards a biologically plausible model for startle response initiation in the context of collective motion.

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Decision-Making across the Lifespan: Neurocognitive Models of Ageing and Dementia — •Gunther Klobe — Department of Clinical Neurosciences, University of Cambridge, UK

In the study of healthy ageing and neurodegenerative diseases, there are marked variations between individuals in terms of behaviour and decision-making. I examine these individual differences, using neurally inspired models of decision-making based on the accumulation of evidence for each possible response in simple perceptual reaction time tasks.

By analysing behavioural data using such models (Linear Ballistic Accumulator, Drift-Diffusion Model), one gains insight into individual differences that are not apparent from a simple comparison of mean reaction times and error rates because the latter approach ignores crucial information hidden in the cross-trial distribution of reaction times within a single subject.

My initial work examines the effects of ageing on decision-making processes using behavioural data from a large cross-sectional study, known as CamCAN (Cambridge Centre for Ageing and Neuroscience). In due course I will perform a similar analysis on data from clinical studies with dementia patients.

In both populations the decision-making model parameters can then be correlated with existing structural brain imaging data and thus become interpretable in terms of neural architecture and physiology, hopefully improving our understanding of the links between brain structure and task performance.