AKB 100 Poster Session I

Zeit: Samstag 16:45–18:45 Raum: Poster TU D

AKB 100.1 Sa 16:45 Poster TU D

Activation and characterization of a photoswitchabel GFP variant using two-photon absorption — •Marc Schneider[1], Sara Barozzi[2], Ilaria Testa[1], Mario Faretta[2], and Alberto Diaspro[1] — [1]INFM Genua, Via Dodecaneso 33, I-16146 Genoa, Italy — [2]European Institute of Oncology, Dept of Exp. Oncology, Via Ripamonti 435, I-20141 Milan, Italy

We report about a photoactivatable variant of the Aequorea Victoria green fluorescent protein (PA-GFP). As reported by Patterson and *Lippincott − Schwartz*[1] this special form of the molecule increases its fluorescence intensity when excited by 488 nm after irradiation with high intensity light with $\lambda = 413nm$. We will present data on the two-photon induced photoactivation of the PA-GFP molecule as well as two-photon excitation. Therefore experiments were performed using partially purified protein immobilised on microspheres. The molecular switches were irradiated with laser light in a range of wavelength of a Ti:Sapphire laser system coupled to an inverted microscope. The optimum frequency for activation was chosen to investigate fixed cells. A comparison between the conventional activation with a single photon at $\lambda = 405nm$ and two-photons demonstrates the much smaller activation volumes in the cell.
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(1) Patterson, G. H.; Lippincott-Schwarz, J. Science 2002, 297, 1873.

AKB 100.2 Sa 16:45 Poster TU D

Thermal Fluctuations of Individual Semiflexible Polymers in Confined Geometry — •Sarah F. Köster[1,2], Stephan Herminghaus[1,2], Myung C. Choi[3], Cyrus R. Safinya[3] und Thomas Pfohl[1,2] — [1]Department of Applied Physics, University of Ulm, Albert-Einstein-Allee 11, 89081 Ulm, Germany — [2]Max Planck Institute for Flow Research, Bunsenstraße 10, 37073 Göttingen, Germany — [3]Materials Research Laboratory, University of California, Santa Barbara, CA 93106, USA

Thermal fluctuations of individual actin filaments in confining microchannels fabricated by soft photolithography are studied by means of fluorescence microscopy. The channel dimensions are in the same order of magnitude as the mesh size of the actin cytoskeleton within the eukaryotic cell and thus mimic the native environment of the individual filament. We observe a strong dependence of the tangent correlation upon both the channel geometry and the filament length. Compared to freely fluctuating filaments, long filaments confined in narrow channels exhibit an enhanced tangent correlation revealing a local minimum and an oscillatory behavior. We also observe a clear deviation from existing theoretical models on small length scales, assumedly due to an intrinsic stiffness of the semiflexible chain. These unique characteristics may be qualitatively described by an analytical expression considering the bending energy as well as the confining energy assumed as a parabolic potential. We find the scaling law for the deflection length which has been reported before experimentally confirmed.

AKB 100.3 Sa 16:45 Poster TU D

Interactions of the Extracellular Matrix Protein Collagen I and the Actin Cytoskeleton — •Sarah F. Köster[1,2], Jennie B. Leach[2], Joyce W. Wong[2] und Thomas Pfohl[1] — [1]Max Planck Institute for Flow Research, Bunsenstraße 10, 37073 Göttingen, Germany — [2]Department of Biomedical Engineering, Boston University, 44 Cummington Street, Boston, MA 02215, USA

Both the extracellular matrix (ECM) where collagen is the most important building block and the actin cytoskeleton impact the mechanical properties of mammalian tissue. The study of these fibrous proteins and all the more their interaction is thus a very interesting field whenever looking at living beings. We use a microfluidic diffusive mixing device to create a defined pH gradient in a microchannel which in turn initiates the polymerization and concurrent alignment of soluble collagen into fibrils under hydrodynamic flow. We are thus able to investigate collagen fibrillogeneisis by means of polarization microscopy and x-ray diffraction. Furthermore, substrates prepared by using this technique are used as scaffolds for cell growth. Since the collagen structure has precise alignment in native blood vessels, study of the impact of highly anisotropic (aligned) collagen on vascular smooth muscle cells (VSMC) provides much-needed insights towards structure-property-function relationships between the ECM and the cytoskeleton. Anisotropic collagen induces alignment of the cytoskeleton and may facilitate the study of the cytoskeleton by means fluorescence microscopy and in addition by x-ray diffraction.

AKB 100.4 Sa 16:45 Poster TU D

Single Molecule FRET Experiments with the RNA Helicase YxiN — •Bettina Theissen and Dagmar Klostermeier — Experimentalphysik IV, Universität Bayreuth

RNA helicases unwind double helical RNA structures in an ATP-dependant manner. Their function is essential for all cellular processes that require structural reorganisation of RNA, for example transcription, translation or ribosome biogenesis. While little is known about the mechanism of unwinding, an opening and closing movement of a cleft between two domains during the catalytic cycle has been proposed. Such a movement leads to changes of intramolecular distances. Since fluorescence resonance energy transfer (FRET) can be used to measure distances between two fluorophores, it is a suitable tool for studying these conformational changes.

YxiN is a RNA-helicase from *Bacillus subtilis* that is involved in ribosome biogenesis. For FRET experiments the donor fluorophore alexa 488 and the acceptor fluorophore tetramethylrhodamine have been coupled site-specifically to genetically engineered cysteines on both sides of the cleft. With this doubly labelled protein we perform single molecule FRET experiments to directly observe conformational changes during unwinding of the RNA. These will lead to a detailed understanding of the catalytic mechanism of RNA-helicases.

AKB 100.5 Sa 16:45 Poster TU D

Analyse des Einflusses schwacher, statischer oder niederfrequent wechselnder Magnetfelder auf Fibroblasten — •Juliane Issle und Uwe Hartmann — Fachrichtung Experimentalphysik, Universität des Saarlandes, Im Stadtwald, 66123 Saarbrücken

Wie sich Magnetfelder auf biologische Materie auswirken ist noch nicht vollständig geklärt. Um speziell Effekte auf Menschen zu untersuchen, wurden Experimente an humanen Fibroblasten durchgeführt. Die verwendeten Magnetfeldstärken lagen im Bereich 800 μT bei 50 Hz-Wechselfeldern und 0,8 T bei statischen Feldern. Ebenso wurden Zellen in einer Abschirmkammer kultiviert, in der die maximale Magnetfeldstärke 180 nT betrug. Die Versuchszeiten variierten zwischen 48 h und 5 Tagen, während ein Teil der jeweiligen Zellen den verschiedenen Magnetfeldbedingungen unterzogen wurde und ein anderer parallel dazu als Kontrolle diente. Als Untersuchungsmethoden fanden die Lichtmikroskopie, die Elektronenmikroskopie, die Rasterkraftmikroskopie, Immunfärbungen und Western-Blot-Analysen der Proteine Aktin und Connexin Verwendung.

AKB 100.6 Sa 16:45 Poster TU D

Induktion der Zelldifferenzierung durch die Verwendung nanostrukturierter und funktionalisierter Oberflächen — •Susanne Kirsch, Juliane Issle und Uwe Hartmann — Fachrichtung Experimentalphysik, Universität des Saarlandes, Im Stadtwald, 66123 Saarbrücken

Adam S.G. Curtis hat 1964 die These aufgestellt, dass Zellen auf die Topographie ihrer Umgebung reagieren können. In den letzten vierzig Jahren konnten mehrere Zelltypen dokumentiert werden, die stark auf eine Umgebungsstruktur im Mikrometerbereich antworten. Kürzlich konnte jedoch gezeigt werden, dass Zellen in vitro auch im Nanometerbereich beeinflusst werden können. Hierbei haben Strukturen mit Unterschieden in Höhe oder Abstand unterschiedliche Auswirkungen auf die einzelne Zelle. Das Spektrum reicht hier von verbesserter Adhäsion der Zelle an das Substrat, was meist der erste Schritt der Differenzierung ist, bis zur Apoptose der Zelle, dem programmierten Zelltod. Aber nicht nur die Topographie der Oberflächen selbst hat Auswirkungen auf die Zelle, die Nanostrukturen können auch mit biologisch wirksamen Molekülen, wie z.B. Wachstums- oder Differenzierungsfaktoren, funktionalisiert werden.

AKB 100.7 Sa 16:45 Poster TU D

Self-assembled peptide fibrils as novel biomaterials — •Patrick Mesquida[1], Rachel McKendry[1], and Cait MacPhee[2] — [1]Department of Medicine, University College London, UK — [2]Department of Physics, University of Cambridge, UK

Amyloid fibrils are self-assembled, beta-sheet-rich superstructures of peptides or proteins. Although these aggregates have first been found in connection with protein-misfolding diseases there is evidence that the ability to form fibrils is a thermodynamic property of any polypeptide chain rather than a result of specific, disease-related amino-acid sequences. Fibrils can easily be formed in-vitro from non-disease-related proteins and even from artificially "bottom-up"-synthesized peptide chains which have no biological function at all. Furthermore, functional groups can be incorporated without significantly disturbing the fibril superstructure. This is why amyloid fibrils have recently attracted considerable interest as potentially useful, novel biomaterial. Here, we present investigations of the physical properties of a specific fibrillar system, which forms well-defined nanorods of ca 10nm diameter, and of its interaction with surfaces.

AKB 100.8 Sa 16:45 Poster TU D

Measuring Mechanical Forces of Adherent and Locomoting Cells — •Claudia M. Cesa[1], Bernd Hoffmann[1], Norbert Kirchgessner[1], Ulrich Schwarz[2], and Rudolf Merkel[1] — [1]Institute of Thin Films and Interfaces, ISG-4, Research Centre Jülich — [2]Max Planck Institute of Colloids and Interfaces, Golm

During adhesion and locomotion most cell types apply mechanical forces to their substrates. These forces are generated and transmitted by an intricate protein machinery composed of the cytoskeleton, adhesion complexes, and the extracellular matrix.

We will describe a new technique for measuring mechanical forces developed by cells on substrates. In this method cells are plated on elastomeric layers exhibiting a microstructured surface. Using light microscopy cells and micropattern can be observed simultaneously under physiological conditions. The elastomeric layer is deformed by cellular forces. This deformation can be determined by tracking the displacement of the surface microstructures. Exploiting elasticity theory we are able to calculate cell forces and cellular force fields from the deformation of the substrate.

We will present the fabrication of microstructured, elastomeric substrates, a detailed characterization of their mechanical properties, as well as the resolution of the technique.

AKB 100.9 Sa 16:45 Poster TU D

Mechanical Properties and Shape Instabilities of Axons — •Pramod Pullarkat — Experimentalphysik-I, Universität Bayreuth, D95440-Bayreuth, Gramany

We present studies on the mechanical properties of axons using a newly developed flow-chamber technique. The role of various cytoskeletal components and their visco-elastic contributions to the mechanical properties of the axon will be presented. The cytoskeleton also plays an important role in certain shape instabilities observed in axons under abnormal conditions, both in-vivo as well as in-vitro. We have studied one such instability which is induced by osmotic-shocks. The remarkable dynamics of this instability will be discussed.

AKB 100.10 Sa 16:45 Poster TU D

Pyrolysis of wood - in-situ synchrotron scattering and nanoindentation experiments — •Gerald A. Zickler[1], Sérgio S. Funari[2], Thomas Schöberl[3], and Oskar Paris[1] — [1]Max Planck Institute of Colloids and Interfaces, Dept. Biomaterials, Am Mühlenberg 1, D-14476 Potsdam, Germany — [2]Hamburger Synchrotronstrahlungslabor, HASYLAB, DESY, Notkestr. 85, D-22603 Hamburg, Germany — [3]Erich Schmid Institute of Materials Science, Austrian Academy of Sciences, University of Leoben, Jahnstr. 12, A-8700 Leoben, Austria

The present study is focusing on structural and mechanical aspects of non-oxidising pyrolysis of native spruce wood, with the aim to transform the hierarchical structure of wood into nano-structured oriented carbon. Synchrotron radiation was used in combination with a custom made furnace to study wood pyrolysis in situ. Detailed time resolved small-angle and wide-angle scattering data from single wood slices provided deeper insight into the kinetics of cellulose degradation for temperatures up to 400°C. Furthermore nanoindentation was applied to characterise changes of cell wall hardness, Young's modulus, elastic and plastic parameters of the carbonaceous residue up to 2400°C.

AKB 100.11 Sa 16:45 Poster TU D

Helium vs. Nitrogen cooling of biological samples for Cryo Electron Tomography — •Gabriele Schweikert[1], Guenter Pfeifer[1], Uwe Luecken[2], Stephan Nickell[1], Wolfgang Baumeister [1], and Juergen Plitzko[1] — [1]Max-Planck-Institute of Biochemistry, Struktural Biology, 82152 Martinsried, Germany — [2]FEI Company, 5600 KA Eindhoven, The Netherlands

In the life sciences, cryo electron microscopy is used increasingly due to its power to reveal the structure of single protein complexes within their cellular context. The radiation-sensitivity of biological specimens, however, sets a limit to the possible examination using highly energetic electrons. We will present our findings concerning radiation damage and cryo-protection at L-He temperature in comparison to L-N2, especially with regard to the application of cryo electron tomography. We have obtained dose series of vitrified specimens of a crystalline surface layer (HPI-layer) at L-N2 and L-He temperature and analysed them by means of Fourier shell correlation. Additionally, we determined the relative mass loss during exposure using the log-ratio-technique. To assess the differences in ice density, we have measured the inelastic mean free path (MFP) of the electrons in low-density amorphous ice at L-N2 and high-density amorphous ice at L-He temperature at 300 kV accelerating voltage with an FEI Tecnai F30 instrument equipped with a Gatan imaging filter.

AKB 100.12 Sa 16:45 Poster TU D

Anomalous Flow in Microfluidic Poly(dimethylsiloxane) Channels — •Thanh Tu Duong, Alexandra Ros und Dario Anselmetti — Experimental Biophysics and Applied Nanosciences, Physics Faculty, Bielefeld University

The application of microfluidic devices in various bioanalytical fields requires a detailed knowledge of material properties. Today's microfluidic devices are fabricated using a variety of materials. Especially Poly(dimethylsiloxane) (PDMS) is the material of choice due to its low fabrication costs based on rapid prototyping. However, for microfluidic PDMS channels where one dimension is smaller than $20\mu m$, an anomalous flow behaviour is observed.
In a simple linear microfluidic channel sample from both reservoirs flows into the centre of the channel with a linear decreasing flow velocity. At first glance this behaviour is in contradiction to the equation of continuity, but on closer examination this phenomena is caused by the water permeability and evaporation of water through PDMS. Due to this effect the ionic strength of the buffer and hence the zeta potential changes in time. Therefore, control of the evaporation rate is crucial for future microfluidic applications based on PDMS. In this work we present a method to control and eliminate the evaporation of water through PDMS.

AKB 100.13 Sa 16:45 Poster TU D

DNA binding ligands investigated with optical tweezers. — •Andy Sischka[1], Katja Tönsing[1], Robert Ros[1], Heiko Ihmels[2], and Dario Anselmetti[1] — [1]Experimental Biophysics and Applied Nanosciences, Faculty of Physics, Bielefeld University — [2]Organic Chemistry, University of Siegen

We used a compact, single beam optical tweezer system to investigate mechanical properties of double stranded DNA in the presence of different binding ligands. Individual binding modes could be distinguished by analyzing the mechanical response of a lambda-DNA molecule to an applied external force. We compared the effects of the minor groove binder distamycin-A, a major groove binding alpha-helical peptide, the intercalators ethidium bromide, YO-1 and daunomycin as well as the bisintercalator YOYO-1 on lambda-DNA. Significant force hysteresis effects occurring during stretching/relaxation cycles with different velocities were found for daunomycin and YOYO-1. These time dependent mechanical properties directly reflect the kinetics of the binding and unbinding behaviour. Furthermore, mechanical properties of organic dyes particularly intercalating with dsDNA were investigated. These dyes change their absorption and fluorescence properties upon binding, and induce DNA damage during irradiation with visible light. Both binding interactions and photochemical modifications of the DNA result in the change of DNA structure may be usefull in applications of photochemotherapy of cancer.

AKB 100.14 Sa 16:45 Poster TU D

Protein diffusion in living cells: anomalous is normal — •Matthias Weiss — MEMPHYS–Center for Biomembrane Physics,University of Southern Denmark, Odense, Denmark& BIOMS–Center for Modelling and Simulation in the Biosciences, Heidelberg, Germany

Using fluorescence correlation spectroscopy (FCS) it is shown that (inert) macromolecules in the cytoplasm exhibit a size- and conformation-dependent anomalous sub-diffusion, i.e. the particles' mean square displacement $v(t)$ grows less than linear in time ($v(t) \sim t^{\alpha}$, $\alpha < 1$). By accompanying these observations with model simulations and *in vitro* experiments it is demonstrated that this behavior is a generic consequence of 'molecular crowding' [1]. In other words, the anomality α of the diffusion yields a quantifiable measure for the 'crowdedness' of a fluid on the molecular scale.

It is further highlighted that integral membrane proteins also move sub-diffusively on organellar membranes, e.g. in the endoplasmic reticulum and the Golgi apparatus [2]. Using a simulation approach, this observation is shown to be consistent with the postulated transient formation of oligomers during the process of protein sorting.

[1] Weiss et al., Biophys. J. **87**, 3518 (2004).
[2] Weiss et al., Biophys. J. **84**, 4043 (2003).

AKB 100.15 Sa 16:45 Poster TU D

A combined Langevin and adhesive dynamics approach to rolling adhesion of leukocytes — •Christian Korn and Ulrich Schwarz — Max-Planck-Institut für Kolloide und Grenzflächen, 14424 Potsdam

Extravasation of white blood cells (leukocytes) from the blood flow is preceeded by rolling adhesion on the vessel walls, which can be studied under controlled conditions in flow chamber experiments. Due to low Reynolds numbers the hydrodynamics is described by the Stokes equation. For the initial stages of rolling adhesion, elastic effects can be disregarded. Therefore we model the leukocytes as hard spheres in shear flow above a wall. Combing Stokes equation and Brownian motion leads to a Langevin equation which is known as the Stokesian dynamics equation. The presence of the wall leads to mobility functions which dependent on position and thus result in non-trivial noise terms in the Langevin equation. Specific binding through receptors on the cell and ligands on the wall is included in the Langevin equation as spring-like external forces (adhesive dynamics). Within this conceptual framework, we study adhesion to patterned ligands, the effect of loading rate, bond cooperativity and competition between different receptor-ligand systems.

AKB 100.16 Sa 16:45 Poster TU D

Measurement of viscoelastic properties of lipid membranes on a chip — •Daniel Steppich, Achim Wixforth und Matthias F. Schneider — Lehrstuhl für Experimentalphysik I, Biophysik, Universität Augsburg, Universitätsstr. 1, 86135 Augsburg

Lipid membranes can strongly affect the properties of the biological cells by an enormous change of their physical behaviour induced by small changes in specific external conditions. A premise for the understanding of many biological processes is therefore the knowledge of the viscoelastic properties, e.g. the compressibility and the elasticity. The viscoelastic properties of lipid bilayers are investigated with surface acoustic waves (SAW) using a novel designed biochip. Since SAWs have a higher accuracy in determine the mass loading or the absorption on surfaces, because of the operating frequencies over 100 MHz. We can also adjust our chips to specific questions, such as mass loading, viscosity or fluidics by the chip design, which results in different types of SAWs. In addition we study the effects of different parameters, e.g. changing in temperature or pH, and the elastic properties of soft films in an aqueous environment.

AKB 100.17 Sa 16:45 Poster TU D

Helical polymer fluctuations: From rigid bodies to floppy lines — •Nils Becker and Ralf Everaers — MPI-PKS Dresden, Nöthnitzer Str. 38, 01187 Dresden

Continuous models for semiflexible polymers have been successful in explaining the elastic properties of, e.g. DNA, actin, or microtubules, as measured in many recent single-molecule experiments. Their common starting point is an interaction energy depending on the curvature of the molecule centerline. The helical symmetry of the molecule then entails a coupling between translational and rotational fluctuations.

However, the centerline is a not completely straightforward abstraction. E. g., it need not lie within the molecule material. The basic *physical* objects that constitute a helical molecule or filament are its monomers. They see only local interactions, which are constant along the molecule in the respective monomer body frames. It is the local energies that are important for biological interactions with filament-binding proteins and tight winding.

Both the monomer and the filament length scale are biologically relevant. To bridge their gap, we investigate possible definitions of the centerline and the corresponding elastic energy, starting from monomer-step coordinates and interactions. We also present a way for local averaging of the helix turns, and offer a description of the monomer fluctuations in terms of "screw modes".

AKB 100.18 Sa 16:45 Poster TU D

Protrusion forces driving rapidly translocating cells — •Michael Gögler[1], Claudia Brunner[1], Allen Ehrlicher[1], Bernd Kohlstrunk[1], Detlev Knebel[2], and Josef Käs[1] — [1]Institute for Soft Matter Physics, University of Leipzig, Linnéstrasse 5, 04103 Leipzig — [2]JPK Instruments AG, Bouchéstrasse 12, 12435 Berlin

Cell motility is a fundamental process of many phenomena in nature, such as immune response, wound healing, and metastasis. Mechanisms of force generation for cell migration have been described in various hypotheses requiring actin polymerization and/or molecular motors, but quantitative force measurements to date have focused on traction forces. Here we present a direct measurement of the forward force generated at the leading edge of the lamellipodium and at the cell body of a translocating fish keratocyte. To elucidate the sub-cellular force generation machinery, we additionally determined the forward force of locomoting lamellar fragments, which lack their nuclei but remain motile. We positioned an elastic spring, the cantilever of a scanning force microscope (SFM), in front of a moving cell, which pushes this spring out of the way. The forward force was calculated using the detected vertical deflection of the cantilever in an elastic wedge model, which considers cellular deformation. Our measurements of the propulsive forces, which are in the lower nN range and agree with expectations, will provide quantitative insight into how a polymeric network of active and passive molecular components act in concert as an active locomoting machine.

AKB 100.19 Sa 16:45 Poster TU D

Dynamcis of Protein Binding to Nucleosomal DNA — •Wolfram Möbius and Ulrich Gerland — Department für Physik, LMU München

Binding of proteins to DNA target sites which are buried inside nucleosomes is sterically hindered and enabled only through thermal fluctuations. Such fluctuations temporarily unwrap the DNA from the histone, exposing a target site during a small fraction of the time [1]. We study this site exposure mechanism using a simple physical model, and examine its equilibrium properties as well as the dynamics. In particular, we characterize the effective interaction between two DNA-binding proteins, which is generated by the presence of the histones. This interaction is relevant for the molecular processes involved in transcription regulation.

[1] J. Widom, Quarterly Reviews of Biophysics **34**, 269 (2001)

AKB 100.20 Sa 16:45 Poster TU D

Nanoquakes meet Soft Materials — •Matthias F. Schneider and Achim Wixforth — a

Surface acoustic waves (SAW) are applied to mimic protein tissue and cell-tissue interactions. In contrast to flow chamber experiments the experiments are done on an open, plane surface allowing to manipulate and optically monitor the experiment simultaneously. For the first time the unfolding of proteins under shear flow conditions could be shown, underlining the potential of this technique for mimicking blood flow scenarios. Furthermore shear waves are used as biosensors in the sense of viscoelasticity experiments under dynamic conditions. Here we study the kinetics of adsorption/adhesion of membranes and cells on functionalized surfaces and follow the time course of protein membrane interactions.

AKB 100.21 Sa 16:45 Poster TU D

Morphometry of nutshells and foams — •Boris Breidenbach[1,2], Ulrike Wegst[2], and Klaus Mecke[1,2] — [1]Institut für theoretische Physik, Universität Erlangen — [2]MPI für Metallforschung, Stuttgart

In the development and design of new materials and structures, researchers more and more turn to nature for inspiration and assistance. An understanding of real-world hierarchical structures across a range of length scales is considered to be the key to optimise physical properties. High resolution 3D micro-computed tomography data of nutshells, bones, wood, and foams open the possibility to characterise and model biological structures and to relate macroscopic physical properties to the microstructure. Fast imaging at ESRF makes it even possible to study dynamic behaviour, e.g., the coarsening of foams. Huge datasets (2000^3) require the development of massively parallel algorithms for fast image reconstruction, filtering (edge preserving anisotropic diffusion), and seg-

mentation (region growing). Morphometry charts of Minkowski functionals such as volume V, surface area S, mean curvature H, and Euler characteristic χ provide robust structural indices of pore spaces to identify, for instance, scaling behaviour of pores. For isotropic and homogeneous sandstones the measurement of Minkowski functionals allows an accurate prediction of permeabilities and elastic properties directly from the segmented tomographic datasets of the pore space (PRL91,215506). Extending the integral geometric technique towards tensorial morphometric functionals, an application on biomaterials seems promising, because their generic anisotropic nature can be taken into account.

AKB 100.22 Sa 16:45 Poster TU D

Intramolecular dynamics of semiflexible macromolecules by Fluorescence Correlation Spectroscopy — •Roland G. Winkler[1], Simon Keller[2], and Joachim O. Rädler[2] — [1]IFF, Forschungszentrum Jülich, D-52425 Jülich — [2]Ludwig-Maximilians-Universität, Geschwister-Scholl-Platz 1, D-80539 München

A theoretical description of the dynamics of DNA molecules and actin filaments in solution as measured experimentally by fluorescence correlation spectroscopy is provided and compared to recent experimental results. Particular attention is payed to the contribution of the intramolecular dynamics to the fluorescence correlation function. Using a semiflexible chain model, a theoretical expression is presented for the fluorescence correlation spectroscopy correlation function. The dependence of this function on various model parameters like chain length, persistence length, and fluorescence label density is discussed. Our investigations show that the intramolecular dynamics provides a significant contribution or even dominates the correlation function as soon as the longest intramolecular relaxation time significantly exceeds the shortest experimentally accessible time.

AKB 100.23 Sa 16:45 Poster TU D

Overcharging of a sphere by a rodlike polyelectrolyte — •Andrey Cherstvy and Roland G. Winkler — IFF, Forschungszentrum Jülich, D-52425 Jülich

We investigate the complexation of a polyelectrolyte bendable rod with an oppositely charged spherical macroion. We take into account the electrostatic bending of the rod and its asymmetric charge neutralization by sphere charges. The spontaneous curvature of the rod towards the sphere results in a substantial overcharging of such a polyelectrolyte complex. Assuming a discrete helical charge distribution on the rod surface, we calculate its electrostatic energy and the electrostatic contribution to its bending and twisting elasticity modules. We show that the helix is easier bend than the corresponding linear array of charges and also that its electrostatic twist rigidity modulus may change sign when the helical pitch is changed. We compare our results with results of existing theories and discuss their possible applications for the description of the structure of nucleosome core particles and twisting/bending of DNA duplexes.

AKB 100.24 Sa 16:45 Poster TU D

Nonlinear Elasticity in Fibroblasts — •Pablo Fernandez, Pramod Pullarkat, and Albrecht Ott — Experimental Physik 1, Universität Bayreuth

Pulling 3T3 fibroblasts between two parallel surfaces and imposing small amplitude sinusoidal oscillations shows a crossover from a stress-independent elastic modulii regime to a stiffening one, where the elastic modulus E is approximately proportional to the average stress σ. Scaling the crossover stress σ_c by the zero stress elastic modulus E_0 leads to a universal "crossover strain"$\sigma_c/E_0 \simeq 8\%$. Experiments were done by sticking the cells either in a highly unspecific way (glutaraldehyde-aminosilane coating), or by means of fibronectin coating. In the first case, active responses are almost absent. The fibronectin coatings instead lead to rich active behaviour, and the stiffness and force scales are about one order of magnitude higher than with glutaraldehyde coatings. However, the stiffness-force relationship is qualitatively similar. Perturbing the cytoskeleton with specific drugs such as Latrunculin-A, ML-7 and Nocodazol strongly points towards the actomyosin system as responsible for the observed mechanical behaviour.

AKB 100.25 Sa 16:45 Poster TU D

On the behaviour of short Kratky-Porod chain — •Semjon Stepanow — Martin-Luther-Universität Halle, Fachbereich Physik, D-06099

Using the exact computation of a large number of moments of the end-to-end distribution function G(r,N) of the worm-like chain, we have established the analytical form of the coefficients in Taylor expansions of the moments for short chain lengths N. The knowledge of these coefficients enabled us to resummate the moment expansion of G(r,N) by taking into account consecutively the deviations of the moments from their stiff rod limit. Using this procedure we have derived the short chain expansion of the distribution function of the end-to-end distance, the structure factor, and the extension-force relation, which take into account the deviations of the moments from their stiff rod limit to the seventh order in N.

AKB 100.26 Sa 16:45 Poster TU D

ROTATION AND CONFORMATIONAL CHANGES OF THE EPSILON SUBUNIT OF F0F1-ATP SYNTHASE — •Marc Karle[1], Boris Zimmermann[2], Nawid Zarrabi[1], Monika Düser[1], Jörg Wrachtrup[1], and Michael Börsch[1] — [1]3. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart — [2]Institut für Physikalische Chemie, Universität Freiburg, Albertstr. 23a, 79104 Freibrug

Cellular ATP production is catalysed by membrane-bound F0F1-ATP synthase. An internal rotation of subunits couples the chemical reaction at three binding sites in the F1 part to proton translocation through the membrane-integrated F0 part. We apply single-molecule fluorescence resonance energy transfer (FRET) to examine the rotary subunit movements. Rotation is divided into three major steps with constant FRET level corresponding to three relative orientations (M. Diez et al. 2004 Nat Struct Mol Biol 11, 135). For epsilon-subunit rotation we have found distinct dwell times for the three different orientations, indicating heterogeneous catalytic rates at the three binding sites (M. Börsch et al. 2004 Biophys J 86, 181A, Part 2 Suppl). To support our single-molecule FRET analysis and to evaluate the statistical significance of the data set we also develop computer simulations of the signals, that help to unravel critical parameters. These simulations strongly support the non-equal catalytic rates.

AKB 100.27 Sa 16:45 Poster TU D

Proteins under shear stress on planar surfaces — •Stefan Nuschele[1], Stefan W. Schneider[2], Matthias F. Schneider[1], and Achim Wixforth[1] — [1]Universität Augsburg, Experimentalphysik1, Biophysik, Universitätsstr. 1, 86135 Augsburg — [2]Universität Münster, Abteilung Dermatologie, Von-Esmarch-Str. 56, 48149 Münster

Von-Willebrand-Factor (vWF) forms large fibers and mediates binding of blood platelets to the vascular endothelium at wounded and inflamed tissue. The released and activated protein undergoes a coil to fiber transition. In vivo among other things this procedure presumably is induced by blood shear flow. A dysfunction causes blood clotting diseases. By means of surface acoustic waves (SAW) we mimic the blood flow using a novel designed bio-chip. The blood vessels are imitated in two dimensions by hydrophilic channels in hydrophobic surface surrounding. The SAWs, adjustable in power, cause laminar flow. Using fluorescence microscopy we could proof the proposed model of activating the vWF. The combination of surface acoustic waves with flat fluidics and adapted surface structures enables new approaches to hemodynamic phenomena in vitro with reduction in sample volume to only a few μl.

Schneider at al. (2004) submitted APL

AKB 100.28 Sa 16:45 Poster TU D

Dynamics of Driven Polymers — •Xaver Schlagberger[1,2] and Roland Netz[1,2] — [1]Physics Dept., LMU München, Theresienstrasse 37, D-80333 München — [2]Physics Dept., TU München, James Franck Str., D-85748 Garching

Using hydrodynamic simulation methods and scaling arguments we consider an elastic rod which is moving in a gravitational or electric field through a quiescent fluid in the low-Reynolds-number limit. Hydrodynamic effects lead to rod bending and orientation perpendicular to the direction of motion, similar to what is seen in anomalous electric birefringence experiments on TM and FD viruses or polyelectrolytes. Static and dynamic scaling relations for the mean orientation as a function of rod length and elasticity are established. We also investigate the experimentally observed unfolding of polyelectrolyte coils in electric fields.

AKB 100.29 Sa 16:45 Poster TU D

An Analytical Approach to the Free-End Fluctuations of a Grafted Semiflexible Polymer — •Panayotis Benetatos[1] and Erwin Frey[1,2] — [1]Hahn-Meitner-Institut, Abteilung Theoretische Physik, Glienicker Straße 100, D-14109 Berlin, Germany — [2]Fachbereich Physik, Freie Universität Berlin, Arnimallee 14, D-14195 Berlin, Germany

Monte Carlo simulations have revealed a pronounced double-peak structure in the reduced probability distribution of the transverse fluctuations of the free end of a grafted semiflexible polymer with intermediate stiffness in two dimensions (Lattanzi et al., Phys. Rev E 69, 021801 (2004)). We show that this departure from unimodality is related to a similar behavior observed when a random walker is driven by a certain type of shear flow in the transverse dimension (ben-Avraham et al., Phys. Rev. A 45, 2315 (1992)). We explain it by adapting an effective-medium argument first used in the context of the diffusion-convection system. We also use this approach to obtain an approximate analytical expression for the complete probability distribution of the free-end fluctuations.

AKB 100.30 Sa 16:45 Poster TU D

Dynamics of Complex Crystal Growth in Diblock-Copolymer Solutions — •Antje Reinecke[1], Miles Page[1], Helmut Cölfen[1], and Hans-Günther Döbereiner[1,2] — [1]Max-Planck-Institute of Colloids and Interfaces, D-14424 Potsdam — [2]Departments of Biology and Physics, Columbia University, New York, NY 10027

We characterize $CaCO_3$ crystals grown from Na_2CO_3 and $CaCl_2$ solutions in a double jet reactor in the presence of Poly(ethyleneoxide)-block-Poly(methacrylic acid). We observe growth via rod, dumbbell and final sphere morphologies using electron and phase-contrast microscopy. It is well known that diblock-copolymer additives influence strongly crystal shapes and structure. However, so far, detailed structural and morphological sequences during crystal growth have not been reported. Extensive phase-contrast microscopy studies are statistically analyzed to provide the dynamics of shape distributions over time. Electron microscopy gives high-resolution images of faceted crystal shapes. X-ray scattering reveals lattice modifications and domain structure. Finally, we correlate crystal morphology to dynamic free ion concentration measurements using Ca^{++} sensitive electrodes.

AKB 100.31 Sa 16:45 Poster TU D

Dynamics of individual actin filaments in extensional flow — •Dagmar Steinhauser[1], Sarah Köster[1], Wolfgang Schnitzler[2], and Thomas Pfohl[1,2] — [1]Max-Planck-Institut für Strömungsforschung, Bunsenstraße 10, 37073 Göttingen — [2]Angewandte Physik, Universität Ulm, Albert-Einstein-Allee 11, 89081 Ulm

We are interested in the dynamics of biopolymers under extensional flow and the formation of condensed structures, bundles and networks induced by inter-chain and intra-chain linker molecules. Therefore, individual F-actin filaments were investigated in hydrodynamic focusing devices by means of fluorescence microscopy. The microfluidic devices were fabricated by using soft lithography and a stroboscopic laser light illumination was applied for imaging the biopolymers in a continuous flow. Adding actin binding proteins such as α-actinin or filamin, the dynamic of the association, bundling, and network formation of a few individual molecules can be observed.

AKB 100.32 Sa 16:45 Poster TU D

Conformations of worm-like chains in nanotubes — •Frederik Wagner[1], Gianluca Lattanzi[2], and Erwin Frey[1] — [1]Abteilung Theorie, Hahn-Meitner-Institut Berlin — [2]Physics Department, University of Bari

The conformations of polymers in a confining medium is not only a challenging problem in soft matter physics but also of great practical relevance. One ambitious goal is to localize transcription factors to a specific binding site on DNA which would require to confine DNA to structures smaller or at least comparable to its persistence length, $\ell_p \approx 50\,\mathrm{nm}$. In recent experimental setups [1] DNA was successfully confined to channels down to $35\,\mathrm{nm} \times 35\,\mathrm{nm}$ size.

These recent developments ask for a theoretical investigation of the statistical conformations of stiff polymers (e.g. DNA or F-Actin) in confining environments like tubes and channels. We have developed an off-lattice Monte-Carlo simulation as well as analytical approximations in the weakly-bending rod limit to arrive at a scaling relation for the (apparent) mean-square end-to-end distance $\langle R^2 \rangle$. All Monte-Carlo data are found to collapse on an universal scaling curve as a function of the ratio between persistence length ℓ_p and Odijk's deflection length ℓ_d. For fixed geometry this scaling plot can serve as a gauge in translating the experimental measured values into the real contour length L.

Three different scaling regimes are identified: the free polymer regime, an intermediate regime following de Gennes' 'blob' picture and — for strongly confined or stiff polymers — an Odijk scaling regime.

[1] Tegenfeldt, J. O. et al. Proc. Natl. Acad. Sci. 101, 10979 (2004)

AKB 100.33 Sa 16:45 Poster TU D

Beyond Replica-Exchange: An Efficient Method for Biomolecular Simulation — •Marcus Kubitzki and Bert de Groot — Max Planck Institute for Biophysical Chemistry, Computational Biomolecular Dynamics Group, Am Fassberg 11, 37077 Göttingen

Understanding protein function requires an extensive sampling of the systems' conformational space. In this respect, conventional molecular dynamics (MD) simulations are rather inefficient because of the currently accessible timescales of typically nanoseconds. Put differently, this sampling problem arises from the system being trapped in local-energy minima from which it can only infrequently escape at physiological temperatures.

Generalized ensemble algorithms greatly alleviate this trapping-problem. Among these methods, replica-exchange MD (REMD) has in recent years successfully been applied to a number of conformational studies of proteins. However, for simulations with full atomic resolution including explicit solvent even REMD is computationally prohibitive for many systems.

The efficiency of the REMD method is basically determined by the temperature differences between the simulated replicas. In explicit solvent simulations, these temperature steps are limited by the large number of degrees of freedom in the simulated system. Here, we systematically study ways to circumvent this problem and to achieve a highly efficient method for the conformational sampling in molecular simulations.

AKB 100.34 Sa 16:45 Poster TU D

Form follows function in living cells — •Jens Gerdelmann[1,2], Stefan Hammerschmidt[3], Hubert Wirtz[3], and Josef Käs[1] — [1]Universität Leipzig, Institut für Experimentelle Physik I, Physik der weichen Materie, Linnéstrasse 5, 04103 Leipzig — [2]Universität Leipzig, Paul-Flechsig-Institut für Hirnforschung, Abt. Neuroanatomie, Jahnallee 59, 04109 Leipzig — [3]Universität Leipzig, Abt. Pneumologie, Johannisallee 32, 04103 Leipzig

Probing living cells with an atomic force microscope to determine their mechanical properties is an established method. It has already been used to characterize the role of different cytoskeletal elements in the cells elasticity. In these former studies actin microfilaments have been identifies as a key player. We applied substances onto lung cells that are thought to lower these cells resistance to stretching (to lower the risk of respiratory stress syndrome) and measured their elasticity. Having found no direct elastic change, we are now focusing on initial results that indicate a morphological change, i.e. a flattening, in treated versus untreated cells. We propose that the treated cells have undergone a structural alteration, i.e. a loss of cell volume through flattening, to compensate their minor cytoskeletal depolymerisation. This reduction of the cells volumes would increase the actin concentration within the cell and thus assure the mechanical stability of the cells. Further results will show to what extent there is a delicate balance between elasticity and cell morphology.

AKB 100.35 Sa 16:45 Poster TU D

Optical tweezers for force measurements during voltage-driven DNA-translocation through a nanopore — •U. F. Keyser, B. Koeleman, D. Krapf, R. Smeets, N. H. Dekker, and C. Dekker — Kavli Institute of Nanoscience, Delft University of Technology, The Netherlands

We aim to measure in situ the forces acting on a DNA molecule that is traversing through a nanopore. We recently developed a technique for the controlled fabrication of nanometer sizes holes in silicon oxide or nitride membranes. We have shown that DNA molecules are pulled through such a nanopore by applying a voltage.

We have built optical tweezers with reflected light position detection that allow us to directly measure the forces and ionic current during the translocation process. The reflected light from the bead is used to monitor its position in three dimensions. A custom-made flow cell with optical access allows mounting nanopores in the optical tweezers and measure ionic currents.

We show simultaneous current and force measurements where

polystyrene and silica beads in the optical trap are used to block pores with various sizes. We will report on currently on-going experiments where we probe the force on a bead that is attached to a long DNA molecule inserted in the nanopore.

AKB 100.36 Sa 16:45 Poster TU D

Length and Temperature Dependence of Voltage-Driven Single Stranded DNA translocation — •U. F. Keyser, N. M. Wennersbusch, N. H. Dekker, and C. Dekker — Kavli Institute of Nanoscience, Delft University of Technology, The Netherlands

We study the translocation of single stranded DNA (ssDNA) molecules through alpha-hemolysin, a biological nanopore inserted into an artificial lipid bilayer. The stem of the pore has a diameter of only 1.5 nm which only can be passed by ssDNA. With a voltage we drive ssDNA through the pore which leads to a brief blockade of the ionic current. Our experiments show that the translcoation time increases linearly when adding poly(dA) ssDNA with a length ranging from of 20 to 100 bases. We studied also the influence of temperature on the translocation time between 8 and 20 degrees Celsius and find a non linear decrease with increasing temperature. It is possible to unzip double stranded DNA with the local electrical field in the pore. We present first measurements with several different molecules to investigate this effect.

AKB 100.37 Sa 16:45 Poster TU D

Morphology and mechanical characteristics of cellulose fibres. *In situ* investigations with X-ray scattering — •Klaas Kölln[1], Ingo Grotkopp[1], Manfred Burghammer[2], Stephan V. Roth[2,3], Christian Riekel[2], Sergio S. Funari[3,4], Martin Dommach[3,4], and Martin Müller[1] — [1]Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel — [2]ESRF, Grenoble, Frankreich — [3]HASYLAB, DESY, Hamburg — [4]MPI für Kolloid- und Grenzflächenforschung, Potsdam

Tensile tests on high-oriented natural fibres of flax and ramie combined with X-ray (micro) diffraction measurements were carried out at ESRF and HASYLAB. An improvement of the orientation function of the cellulose crystals with respect to the fibre axis upon increasing strain could be observed for the high-oriented fibres (cellulose I) as well as for fibres of regenerated cellulose (cellulose II). Scanning measurements with X-ray micro diffraction showed that regions which are already highly oriented suffer only minor effects while less well oriented regions undergo a marked increase of the orientation function at the beginning of the stretching procedure. The strain of the microfibrils during a constant strain rate experiment could be measured with a time resolution of a few seconds. On the basis of a simple mechanical model, Young's modulus of elasticity could be determined for the cellulose crystals. It is lower than values found in literature. The lateral contraction of the crystals could be observed both for cellulose I and cellulose II and Poisson ratios for these two materials were determined for the first time experimentally.

AKB 100.38 Sa 16:45 Poster TU D

Mechanical properties of microtubules measured with SPT: the effect of molecular motors — •Francesco Pampaloni[1], Gianluca Lattanzi[2], Thomas Surrey[1], Erwin Frey[3], Ernst H. K. Stelzer[1], and Ernst-Ludwig Florin[4] — [1]EMBL Heidelberg - Cell Biology and Biophysics Programme - Heidelberg (Germany) — [2]Physics Department - University of Bari (Italy) — [3]Department of Theoretical Physics - Hahn-Meitner Institute - Berlin (Germany) — [4]Center for Nonlinear Dynamics - University of Texas at Austin (USA)

Microtubules (MTs) play a fundamental role in imparting polarity to the cell, determining the plane of symmetry in cell division, and regulating cell movements and shape. With new powerful imaging and micromanipulation techniques and the application of theoretical models, the mechanical properties of single MTs and other cytoskeletal filaments can be analyzed in details. By using an assay based on single-particle tracking (SPT) and optical tweezers we recently discovered that the stiffness of MTs increases with their contour length; in other words, shorter MTs are more flexible than longer ones. This counter-intuitive property of MTs seems to have a fundamental role in the mechanics of the cell. There is also evidence that microtubules associated proteins (MAPs) can modulate the mechanical properties of MTs. In this talk, the effect of the kinesin-like protein Xklp1 on microtubules structure and mechanics is discussed. We also introduce a novel experimental approach aimed to elucidate the dynamic instability of MTs in three-dimension.

AKB 100.39 Sa 16:45 Poster TU D

Biomimetic adhesion studies on chemically biofunctionalized nanostructures — •Christine Selhuber[1], Irina Slizskaja[1], Nadine Walter[1], Fabian Czerwinski[1], Jaques Blümmel[1], and Joachim Spatz[1,2] — [1]Universität Heidelberg, Biophysikalische Chemie, INF 253, 69120 Heidelberg — [2]Max-Planck-Institut für Metallforschung, Stuttgart

Exploring the physics of cell adhesion is essential for a detailed understanding of highly complex biological processes involved in cell-cell or cell-tissue interactions.

We focus on experimental studies of adhesion as a function of ligand density and pattern architecture. Functionalized nanostructures from self-assembled diblock copolymers represent an ideal platform to vary these parameters. The nanostructures are described by hexagonal patterns of nanometer sized gold dots where location and separation of single dots can be precisely controlled over a wide length scale. Functionalization of gold nanopatterns with streptavidin provides an adhesive model interface for biotinylated probes.

To extract the different physical contributions to adhesion on nanostructures we make use of two biomimetic model systems: On the one hand we are using biotin-covered elastic beads for measuring their adhesion induced deformation. This deformation can be related to surface energy and is a first parameter of adhesive strength. On the other hand, biotin-containing vesicles are a well-established tool to investigate adhesion kinetics. This is especially the case since it enables to study adhesion cluster stability by application of external forces.

AKB 100.40 Sa 16:45 Poster TU D

Dynamics of DNA Condensation Investigated by Small Angle X-Ray Microdiffraction — •Rolf Dootz[1], Alexander Otten[2], Bernd Struth[3], and Thomas Pfohl[1,2] — [1]Max-Planck-Institut für Strömungsforschung, Bunsenstrasse 10, D-37073 Göttingen — [2]Angewandte Physik, Universität Ulm, Albert-Einstien-Allee 10, D-89069 Ulm — [3]European Synchrotron Radiation Facility, 6 rue Horovitz, B.P. 220, F-38043 Grenoble Cedex

The combination of x-ray microdiffraction and microfluidics is used to investigate the dynamic behavior of soft materials. A microfocused x-ray beam enables the observation of the association of biomaterials inside microfluidic channels. Using a hydrodynamic focussing device, the evolution of the DNA condensation induced by polyimine dendrimers as well as by histone proteins can be studied. Due to an extensional flow at the center of this device alignment of the material is induced which allows for an improved structural characterization. Furthermore, the influence of strain applied to these materials can be tested.

AKB 100.41 Sa 16:45 Poster TU D

Mechanosensitivität von Keratinozyten — •Mireille Martin[1], Dieter Reissig[2], Jürgen Salvetter[3], Stefan Schinkinger[1], Jochen Guck[1] und Josef Käs[4] — [1]Universität Leipzig, Physik weicher Materie — [2]Universität Leipzig, Institut für Anatomie — [3]Biotechnologisch-Biomedizinisches Zentrum Leipzig, Angewandte Stammzellbiologie — [4]Universität Leipzig, Physik weicher Materie

Vor allem für die Regeneration nach Verletzungen spielen die Keratinozyten der menschlichen Haut eine entscheidende Rolle. In der normalen Haut existieren verschiedene Differentierungsgrade dieser Zellen, von den basalen Stammzellen über transiente Zellen bis hin zu den oberflächlichen postmitotischen Zellen. Es wurde die Elastizität menschlicher Hautzellen mit Hilfe des Optical Stretchers gemessen. Dabei zeigte sich, dass sich diese Zellen im Gegensatz zu anderen menschlichen Zellen wie z.B. Fibroblasten durch eine ausgeprägte Mechanosensitivität auszeichnen. Bereits geringe mechanische Aktivierungen genügen, um die Keratinozyten zu einer aktiven mechanischen Antwort zu veranlassen. Dieses Verhalten könnte die Fähigkeit der Hautzellen zum schnellen Wundverschluß und zur Reepithelialisierung nach Verletzungen erklären. Weiterhin zeigte sich ein strain-hardening-Effekt der Zellen, d.h. die Keratinozyten versteifen sich unter zunehmendem mechanischen Zug. Auch das lässt sich gut im Zusammenhang mit den Eigenschaften und Funktionen der menschlichen Haut (Abschluß nach außen, Schutzfunktion) verstehen.

AKB 100.42 Sa 16:45 Poster TU D

Noninvasive measurement of retrograde flow and actin polymerization in neuronal growth cones — •Timo Betz, Daniel Koch, Daryl Lim, Michael Gögler, Allen Ehrlicher, Björn Stuhrmann, and Josef Käs — Univeristät Leipzig, Fakultät für Physik und Geowissenschaften, Abt. PWM, Linnestrasse 5, 04103 Leipzig

Cell motility in most eukaryotic cells is maintained by a complex interplay of actin polymerization at the leading edge of a cell and a steady flow of the actin network away from the leading edge in a process called retrograde flow. Over a decade ago, the inverse relationship between retrograde flow and the protrusion of the leading edge was discovered, but up to now the exact mechanism which drives this process has not been unraveled. To gain further insight into the mechanisms driving retrograde flow, we developed a new method that applies a cross-correlation algorithm to time series images of GFP-actin transfected neuronal cells (NG108-15) to calculate the retrograde flow field in growth cones. Furthermore, an estimation of actin polymerization rates is possible by comparing measured retrograde flow with the protrusion of the leading edge. Thus, we provide a noninvasive tool to explore how the interplay of the two counterbalancing processes of actin-polymerization and retrograde flow results in locomotion of neuronal growth cones.

AKB 100.43 Sa 16:45 Poster TU D

Entropic forces act as crosslinkers in entangled actin networks — •Rainer Tharmann[1], Sven van Teeffelen[2], A.R Bausch[1], and K. Kroy[2] — [1]Technische Universität München, Lehrstuhl für Biophysik, James-Franck-Strasse 1, 85747 Garching, Germany — [2]Hahn-Meitner-Institut, Abteilung Theorie, Glienicker Strasse 100, 14109 Berlin, Germany

Here we analyze in a rheological study that entropic forces act as effective "pseudo cross linkers" (PCL) to in vitro actin networks. The addition of low concentrations of poly ethylene glycol (PEG) in entangled actin networks results in a significant increase of the moduli. Two regimes can be distinguished: at low volume fractions of PEG the increase of the moduli is small, while for concentrations of PEG higher than a critical concentration $c^\star$ an drastic linear increase of the moduli can be observed. This increase of the moduli is similar to the scaling with $\sim R^2\,(R = c_{crosslinker}/c_{actin})$ as it is observed with biochemical crosslinkers. In sharp contrast to specific crosslinkers the entropically pseudo crosslinked networks show a not so pronounced shear hardening behavior. This can be explained by the possibility for the filaments to slip along the contour length.

AKB 100.44 Sa 16:45 Poster TU D

Texture analysis and 3D nanostructure of bone using synchrotron SAXS and WAXD — •Wolfgang Wagermaier[1], Himadri S. Gupta[1], Paul Roschger[2], Oskar Paris[1], Manfred Burghammer[3], Klaus Klaushofer[2], and Peter Fratzl[1] — [1]MPI-KGF, Biomaterials, Potsdam, Germany — [2]LBIO, 4th Med. Dept., Hanusch Hospital and UKH Meidling, Vienna, Austria — [3]ESRF, Grenoble, France

Bone is a biological composite material, consisting of a mineral particle reinforced collagen matrix, whose structure is adapted to physiological requirements. However, the design of the bone material at the sub-μm level is still poorly understood. Specifically, little is known about the material-level structure of the fundamental unit of compact bone - the lamellar osteon. We have combined microbeam (1 μm) synchrotron scanning diffraction and scattering with sample rotation to reconstruct the full 3D mineral particle distribution within single osteonal lamellae. Several osteons around blood vessels in compact bone were scanned. On the basis of the SAXS data a physical model was used to reconstruct the 3D orientation of the mineral particles. The wide angle x-ray diffraction (WAXD) data were analyzed by means of pole figures to find the mean orientation and texture of the mineral crystallite c-axis. Our results show mineral crystallite orientation has a fiber texture within single lamellae, but shows a smooth spatial variation around the cylindrical core of the osteon.

AKB 100.45 Sa 16:45 Poster TU D

Optical rheology of fibroblasts overexpressing different constituents of the actin cytoskeleton — •Karla Müller, Frank Sauer, Stefan Schinkinger, Jens Gerdelmann, and Josef Käs — Universität Leipzig, Fakultät für Physik und Geowissenschaften, Abteilung Physik der weichen Materie, Linnéstr. 5, 04103 Leipzig

The Optical Stretcher is a laser trap formed by two counter propagating divergent IR laser beams with tunable output power designed to determine the optical deformability of soft biological objects such as eukaryotic cells. Our initial results lead to the hypothesis that overexpression of actin filaments only in conjunction with the overexpression of an actin cross linking protein lead to significant cell stiffening. The rheological properties of cells can be determined by directly imposing a time, i.e. frequency, dependent stress on cells and monitoring the corresponding deformation, i.e. strain. From the measured data the complex shear modulus can be directly determined. The cell's elasticity and viscosity can be traced back to its molecular roots being a highly dynamic network of cytoskeletal polymers. In the talk, the rheological data presented will be compared to stress relaxation experiments performed with the optical stretcher and to other methods such as bead rheology or SFM techniques.

AKB 100.46 Sa 16:45 Poster TU D

Elasticity of Stiff Polymer Networks — •Claus Heussinger and Erwin Frey — Hahn-Meitner Institut, Berlin

We study the elasticity of two-dimensional networks of semiflexible polymers ("Mikado model"). The essential features incorporated into the model are the random geometry of the network and the anisotropic elasticity of its constituents.

In a first study, the elements are modeled as purely mechanical Euler beams (Wilhelm, Frey, PRL 2003). We show that there are three distinct scaling regimes, characterized by two characteristic length scales. In addition to a critical rigidity percolation region and a homogeneous elastic regime (dominated by beam compression) we find a novel intermediate scaling regime, where the elasticity of the network is dominated by bending deformations. The observations for the shear modulus can be rationalized by a crossover scaling ansatz that permits to collapse the data over eight orders of magnitude in the scaling variable.

In a second step, effective elastic properties of semiflexible polymers are implemented to study the entropic contributions to the polymer compliance and its effects on the scaling behaviour.

To get further insight into the nature of the force propagation, more complicated modes of deformation can be explored. As an example, we visualize force chains induced by the action of a microrheological probe.

AKB 100.47 Sa 16:45 Poster TU D

Structure formation in systems of mesoscopic rods — •Andreas Richter and Thomas Gruhn — MPI-KG, Am Mühlenberg 1, 14476 Golm

We perform Monte Carlo simulations of a system of spherocylindrical rods. The interaction of the rods is described by a square-well-rod potential (SWR potential) which, basically, is a spherical square-well potential integrated over the midaxes of the interacting rods. It resembles the interaction of hard spherocylinders with locally attractive forces such as van-der-Waals and/or depletion forces. We investigate a 1:1 bidisperse mixture of rods with rod lengths lx =(6+1)d and ly =(3+1)d where d is the diameter of the rods. We observe the formation of smectic monolayers that exclusively consist of the longer rods. The monolayers coexist with an isotropic mixture of short and long rods.

We also investigated a system of spherocylindrical rods with a length l = (8+1)d and an SWR model potential in the presence of planar substrates. Monte Carlo simulations for a monodisperse system of rods with a length l = (8+1)d were performed. High nematic order is found parallel with the walls in the first fluid layer that contacts the wall. In a slit pore between two coplanar substrates we observe nematic capillary condensation that depends on the pressure and the pore width.

AKB 100.48 Sa 16:45 Poster TU D

Protein adsorption on structured substrates — •Hubert Mantz, Anthony Quinn, Armin Nagel, and Karin Jacobs — FR 7.2 Experimental Physics - Soft Matter, Saarland University, D-66123 Saarbrücken

The ability of proteins to adsorb to almost all surfaces, plays a crucial role in both natural and synthetic processes, and can have unwanted but also desirable medical effects. In the oral cavity, for example, a protein film called pellicle, protects the integrity of oral hard tissues. Some of the adsorbed proteins subsequently facilitate bacterial adsorption and plaque growth as well.

The adsorption behaviour of proteins to surfaces depends on many factors, including the surface physicochemical properties. Self-assembled monolayers (SAMs) of thiols on gold are ideal for probing such interactions, because they are highly-ordered and their surface characteristics can be modified over a wide range (e.g. surface free energy). By patterning the surfaces, critical spatial dimensions for protein adsorption can be found.

This project aims to study the adsorption kinetics of different proteins in situ by using a SPR (surface plasmon resonance) measurement tech-

nique combined with ellipsometry, which has some advantages over the traditional approach. By that, more insight in the mechanisms of biofilm adsorption at solid/liquid interfaces shall be gained to control the adsorption of specific proteins, e.g. in the oral cavity. Offering the pellicle a substrate that allows adsorption only to certain proteins would be useful to prevent oral diseases.

AKB 100.49 Sa 16:45 Poster TU D

Protein conformation probed by fluorescence — •THOMAS GENSCH, THOMAS DERTINGER, THOMAS SORKALLA, ANDREAS HELTEN, KARL-WILHELM KOCH, INGO GREGOR, and JOERG ENDERLEIN — IBI1, Research Centre Juelich

We study the protein-protein interaction of membrane proteins (ion channels, enzymes) with regulating proteins and activating cofactors by fluorescence spectroscopy methods (time-resolved fluorescence spectroscopy, single molecule spectroscopy, Förster resonance energy transfer). The proteins are made fluorescent in the visible spectral region by two methods: 1. production of fusion proteins of the protein of interest with an autofluorescent protein (like the green fluorescent protein). 2. Specific labelling of single Cysteins with organic fluorophores functionalised with a maleimide group. The properties of two regulating, Ca2+-binding proteins (Calmodulin, GCAP) labelled with different fluorophores have been investigated in detail. Different protein conformations have been identified by different fluorescence properties of the fluorophores. Their Ca2+ dependence is investigated as well as the influence of binding events. First results from model FRET experiments will be presented.

AKB 100.50 Sa 16:45 Poster TU D

Dynamics of Semiflexible Polymers in Simple Flow — •TOBIAS MUNK[1], CHRIS H. WIGGINS[2], and ERWIN FREY[1] — [1]Ludwig-Maximilians-Universität, München — [2]Columbia University, New York

In this poster we address the question how a single stiff polymer moves in a two-dimensional viscous fluid environment. The model system we refer to is the biopolymer actin. The polymer is represented by a continuous two-dimensional space curve with a fixed length and a curvature-dependent bending energy. Furthermore we account for the constraint of inextensibility by introducing a Lagrange multiplier function into the hamiltonian. By invoking suitable eigenfunctions we obtain a system of coupled first order stochastic differential equations of the Langevin type, which can be solved numerically. In addition to the behaviour in shear flow and its relatives we study the polymer's behaviour in external electric fields. Thus we are able to study e.g. single trajectories and autocorrelation functions.

AKB 100.51 Sa 16:45 Poster TU D

Kinetic and nanostructural analysis of protein adsorption on tailored substrates — •ANTHONY QUINN, HUBERT MANTZ, and KARIN JACOBS — FR 7.2 Experimental Physics - Soft Matter, Saarland University, D-66123 Saarbrücken

The principal aim of this research is to identify the surface physicochemical properties that affect protein adsorption in the oral cavity, and ultimately to govern the structure and composition of the acquired salivary pellicle (the proteinaceous film that rapidly coats all intraoral surfaces). By controlling the composition of the pellicle on dental replacement materials via tailoring of their surface properties, it is anticipated that the rate and type of bacterial attachment can be reduced due to the highly specific nature of the bacteria/protein interaction. Hence the growth of dental plaque can be inhibited and the incidence of periodontal disease reduced.

A specific focus of this research will be on the effect of long-range forces emanating from the bulk material beneath any surface coating. For extremely thin surface coatings, such forces contribute to the total interfacial force, and hence alter protein adsorption. A combination of in-situ ellipsometry adsorption measurements, scanning probe microscopy, and wettability analysis are being undertaken to investigate these effects.

AKB 100.52 Sa 16:45 Poster TU D

Automated optical neuron guidance — •BJÖRN STUHRMANN, TIMO BETZ, ALLEN EHRLICHER, MICHAEL GÖGLER, DANIEL KOCH, and JOSEF KÄS — Institute for Soft Matter Physics, Universität Leipzig, Linnéstr. 5, 04103 Leipzig

We have used a tightly focused near-infrared laser beam positioned at specific locations of actively advancing neuronal growth cones to influence important elements of neuronal growth such as the direction taken by a growth cone [Ehrlicher et al. "Guiding neuronal growth with light" PNAS (2002)] and the contact between growth cones and cell bodies of other nerve cells. Automation of our technique for a careful systematic investigation of the phenomenon is achieved with self-written image processing software. This software is able to react to cell morphological changes with automated, well defined adjustment of laser radiation with high time resolution. The aforementioned optically controlled elements of neuronal growth are essential for the *in vitro* creation of topologically defined neuronal networks. We are combining optical neuron guidance with established surface patterning techniques. While biochemical patterning reliably restricts neuronal growth to defined tracks, optical guidance will determine growth directions at track crossing points and precisely lead a growth cone to its target. Optical neuron guidance is a promising tool for the creation of defined neuronal networks as assays for the elucidation of interneuronal communication.

AKB 100.53 Sa 16:45 Poster TU D

Near-field Electrodynamics of Biological Cells — •KORT TRAVIS and JOCHEN GUCK — Universität Leipzig, Fakultät für Physik und Geowissenschaften, Abteilung Physik der weichen Materie, Linnéstrasse 5, 04103 Leipzig, Germany

Understanding near-field interactions of coherent infrared light with biological cells is critically important for modern optical manipulation and trapping applications, such as the Optical Stretcher or the Optical Tweezers. With respect to classical scattering theory, considerations of refractive index and size classify cells in the "anomalous diffraction" regime. For this regime, the near-fields are best analyzed using exact approaches such as Mie theory, or the system transfer operator (T-matrix) formalism. In the present discussion, T-matrix formalism is used to evaluate general features of optical fields in and around cells. Specifically, the discussion will cover: electrodynamic characteristics of all objects in this optical size range; effects of surface deviations from ideal shape; effects of the inclusion of large organelles such as the nucleus; and finally, effects associated with local inhomogeneities in the refractive index. Key points in the analytical discussion are illustrated with examples from numerical simulation and from experimental results.

AKB 100.54 Sa 16:45 Poster TU D

Investigation of the TNF Mediated Apaptotic Pathway by Means of Fluorescence Correlation Spectroscopy — •CARSTEN TIETZ[1], MARGARITA GERKEN[1], ELMAR THEWS[1], ANJA KRIPPNER-HEIDENREICH[2], PETER SCHEURICH[2], and JÖRG WRACHTRUP[1] — [1]Institute of Physics, University of Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart — [2]Institute of Cell Biology and Immunology, University of Stuttgart, Allmandring 31, 70569 Stuttgart

We investigate the behavior of apoptosis mediating cell receptors (TNF-R1/2) before and after stimulation by means of FCS. Studies on TNF-R show that the response of the cell on stimulation with TNF is a slowing down of the diffusion by approximately one order of magnitude but only a very slight increase of the intensity per diffusing particle. Several experiments were carried out to reveal the origin of this slowing down. We can exclude aggregation of receptors, interaction of the cytoplasmic domain of the receptor with the cytoskeleton, and change of the viscosity of the whole plasma membrane. On the other hand, cholesterol depletion of the membrane with MβCD show no effect on the diffusion coefficient of activated TNF-R2 but TNF-R1 shows an increases of the diffusion coefficient after MβCD treatment. From this results we conclude that TNF-receptors can be associated with membrane micro domains. Whereas TNF-R1 can be associated with cholesterol rich domains, the TNF-R2 must be associated to a so far unknown type of domain.

AKB 100.55 Sa 16:45 Poster TU D

Self-organized vortical array of hydrodynamically entrained sperm cells — •INGMAR RIEDEL[1], KARSTEN KRUSE[2], and JONATHON HOWARD[1] — [1]Max Planck Institute for Molecular Cell Biology and Genetics, Pfotenhauerstr. 108, D-01307 Dresden — [2]Max Planck Institute for Physics of Complex Systems, Noethnitzer Str. 38, D-01187 Dresden

The emergence of spatiotemporal patterns is of great interest in many scientific disciplines. Examples range from physical self-assembly, oscillating chemical reactions, complex cellular processes and even social interactions. The maintenance of order within and among biological cells usually requires a permanent flux of energy in which case it is said to be dynamically self-organized. Here we report on a new dynamically self-organized pattern that is ordered at two different levels. First, hydro-dynamically

entrained sperm cells form vortices. And second, these vortices form a hexagonal array. The dynamics of a vortex resembles a quantized rotating wave. The vortical array emerges above a critical sperm density associated with a dynamic instability. Supported by numerical simulation we suggest a mechanism for the appearance of the array. This array represents an active gel with a chiral component.

AKB 100.56 Sa 16:45 Poster TU D

Structural studies and hydration kinetics of starch granules by synchrotron radiation microdiffraction — •Henrik Lemke[1,2], Jean-Luc Putaux[3], Manfred Burghammer[2], Martin Müller[1], and Christian Riekel[2] — [1]Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel — [2]European Synchrotron Radiation Facility, Grenoble, Frankreich — [3]CERMAV-CNRS, Grenoble, France

The structure and hydration kinetics of single starch granules from several biological sources were investigated by scanning X-ray microdiffraction. Combined small- and wide-angle scattering experiments at the 1 micron level allowed examining the variation of the amylopectin microstructure and the lamellar superstructure at multiple length scales in fully hydrated granules of 10-50 microns diameter. Differences in variation of azimuthal width of the equatorial 100-reflection and the meridional 9-nm peak agree to the model of a radial organization of amylopectin fibrils. Starch particles from different genetic origins appear to differ in small-angle scattering due to variations in lamellar ordering. A fast hydration kinetics of dried starch granules with about 7 sec half-time could be observed by synchronizing a drop-on-demand system with the data collection system. The timescale of hydration at the unit cell level and of the hydration-induced lamellar superstructure formation seem to be comparable.

AKB 100.57 Sa 16:45 Poster TU D

Φ-values and Transition States in Protein Folding — •Claudia Merlo and Thomas R. Weikl — Max Planck Institute of Colloids and Interfaces, Theory Division, 14424 Potsdam

Small single-domain proteins typically are two-state folders, i.e. they fold from the denatured to the native state without populating experimentally detectable intermediate states. The folding kinetics of two-state folders usually is explored through mutational Φ-value analysis. Φ-values are experimental measures of how the kinetics of protein folding is changed by single-site mutations. Φ-values measure *energetic* quantities, but are often interpreted in terms of the *structures* of the transition state ensemble. Here we present a simple analytical model of folding kinetics in terms of the formation of protein substructures. The model shows that Φ-values have both structural and energetic components. It thus provides a natural and general interpretation of Φ-values, including so-called "nonclassical"Φ-values less than zero or larger than one.

AKB 100.58 Sa 16:45 Poster TU D

Cross-talk Free Fluorescence Cross Correlation Spectroscopy in Living Cells — •Andrew Aird[1], Elmar Thews[1], Carsten Tietz[1], Reiner Eckert[2], and Jörg Wrachtrup[1] — [1]Institute of Physics, University of Stuttgart, Pfaffenwaldring 57, D?70550 Stuttgart — [2]Department of Biophysics, Institute of Biology, University of Stuttgart, Pfaffenwaldring 57, D?70550 Stuttgart

Fluorescence correlation spectroscopy (FCS) is now a widely used technique to measure small ensembles of labeled biomolecules even in living cells. Fluorescence cross correlation spectroscopy (FCCS) is more suited to detect synchronous movement of two biomolecules with different labels and so grants access to a wide variability of unsolved questions in cell biology. Autofluorescent proteins are labels being less cell perturbing in its appliance and highly specific in binding to the proteins in question. The method presented here fuses the advantages of these three techniques to analyze binding behavior of proteins in living cells. To achieve this, a common pair of autofluorescent proteins CFP and YFP is discriminated rather in excitation than in fluorescence to eliminate cross-talk in the detector channels and obtain an undisturbed cross correlation function. The setup is tested to work in living HeLa cells coexpressing the two fusion proteins Cx46/CFP and Cx46/YFP, which form hetero-labeled hexamers (connexones) and diffuse freely in the plasma membrane.

AKB 100.59 Sa 16:45 Poster TU D

Anisotropy of water adsorbed to cellulose fibres — •Ingo Grotkopp[1], Klaas Kölln[1], Stefan Janssen[2], and martin Müller[1] — [1]Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel — [2]SINQ, Paul-Scherrer-Institut, Villigen, Switzerland

Many unique features of water in plant cell walls have been reported over the last decades. Water adsorbed to the disordered regions of cellulose, the main constituent of plant cell walls, exhibits liquid dynamics below 0 °C and is therefore termed "non-freezing". The water molecules are thought to be inserted between individual hydrogen bonded cellulose chains, and they do not form crystalline ice networks. Upon cooling, an increasing part of the water molecules freezes in a gradual, heterogeneous glass transition to a new type of amorphous ice. The remainder is supercooled and is liquid down to 200 K with its dynamics being strongly retarded. Inelastic neutron scattering studies on water in oriented cellulose fibres show that the structural and dynamical properties of the water/ice network are anisotropic. This anisotropy allows us to conclude on the arrangement of water molecules in the semi-crystalline cellulose material.

AKB 100.60 Sa 16:45 Poster TU D

Coupling of driven and diffusive motion on one-dimensional lattices — •Hauke Hinsch, Paolo Pierobon, and Erwin Frey — Hahn-Meitner-Institut

The total asymetric exclusion process (TASEP) describes the driven motion of a single species of particles on a one-dimensional lattice with hard-core exclusion. Depending on the boundary conditions various non-equilibrium steady states of the density distribution are possible. For more realistic modelling of biological systems like motor molecules, TASEP has been extended recently (A. Parmeggiani et al, PRL 90, 086601) by coupling each lattice site to an infinite reservoir, resulting in the existence of multi-phase coexistence.

We present a study where the reservoir has a finite capacity. Specifically the reservoir is treated as lattice gas model with hard core particles governed not by driven but by diffusive motion. In this case it becomes important to take into account the time scales of the different processes. Upon studying the system by Monte-Carlo simulations and mean-field theory we have found that the density distribution depends crucially on the time scale ratio of the motion on the TASEP and the reservoir lane. Our results show that in some limiting cases the new model can be mapped on the original TASEP model with and without Langmuir kinetics.

AKB 100.61 Sa 16:45 Poster TU D

Toroids versus racquets: the collapse of semiflexible polymers of finite thickness — •Eugene Starostin and Ralf Everaers — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, D-01187 Dresden, Deutschland

We calculate the minimal energy shapes of a semiflexible polymer in a poor solvent. Following Schnurr, MacKintosh et al., our conformational energy includes the bending elastic component and the surface energy. We take into account the finite thickness of the molecule and reconsider the relative stability of rod-like, toroidal and "racquet" conformations. The main result is presented as a phase diagram computed for relatively short effective length. In agreement with earlier results in the zero-thickness approximation, thin filaments collapse into toroidal shapes. However, beyond a critical thickness, the kinetically preferred racquet state also turns out to be the ground state.

AKB 100.62 Sa 16:45 Poster TU D

Information theory reveals large-scale synchronisation of statistical correlations in Eukaryote genomes — •Manuel Dehnert[1], Werner E. Helm[2], and Marc-Thorsten Hütt[1] — [1]Bioinformatics Group, Department of Biology, Darmstadt University, Schnittspahnstr. 3-5, D-64287 Darmstadt — [2]Mathematics and Science Faculty, University of Applied Sciences, D-64295 Darmstadt

We study short-range correlations in DNA sequences with methods from information theory and statistics. We find a persisting degree of identity between the correlation patterns of different chromosomes of a species. Except for the case of human and chimpanzee inter-species differences in this correlation pattern allow robust species distinction: In a clustering tree based upon the correlation curves on the level of individual chromosomes distinct clusters for the individual species are found. This capacity of distinguishing species persists, even when the length

of the underlying sequences is drastically reduced. In comparison to the standard tool for studying symbol correlations in DNA sequences, namely the mutual information function, we find that an autoregressive model for higher-order Markov processes significantly improves species distinction due to an implicit subtraction of random background.

AKB 100.63 Sa 16:45 Poster TU D

Domain Size Influences the Diffusive Behavior of Nano-Particles in Langmuir Monolayers — •Florian Rückerl[1], Douglas Martin[2], Martin Forstner[3], and Carsten Selle[1] — [1]Universität Leipzig, Inst. Exp. Physik I, PWM, Linnéstr. 5, 04103 Leipzig — [2]Brandeis University — [3]UC Berkeley

We modelled protein diffusion in inhomogeneous cell membranes utilizing lipid monolayers at the air/water interface where liquid-condensed (LC) domains coexist in a liquid-expanded (LE) phase. The motion of negatively charged fluorescent latex beads as model proteins within LE phase was monitored by Single-Particle-Tracking. The diffusion of those particles was apparently affected by dipole-dipole interactions leading to observation of domain-associated movement. We calculated the shape of the electric field of the condensed domains dependent on the distance r to the domain ($r_{bead} < r < 20\mu m$). On altering the domain sizes, the resulting potential changes from $U \propto 1/|r|^3$ for a single dipole to $U \propto 1/|r|$ for large domain radii ($R > 10\mu m$). This is a significant change from a short to a long ranged potential.

Monte Carlo simulations support the influence of the interactions on model protein diffusion. Furthermore, the diffusion is affected by the potential depth and shape, leading to anomalous diffusion on different time scales, corresponding to the time needed for the model protein to cover the area of the size of the domain.

AKB 100.64 Sa 16:45 Poster TU D

Solid domains in fluid vesicles — •Erwin Gutlederer, Thomas Gruhn, and Reinhard Lipowsky — Max-Planck-Institute of Colloids and Interfaces, 14424 Potsdam, Germany

Recent experiments reveal the existence of solid domains in fluid vesicles when they are cooled below a certain temperature. In our theoretical approach we analyse thermodynamic properties of this domain formation and investigate how the internal ordering of the solid membrane affects the morphology of the vesicle. Monte Carlo simulations allow us to estimate free energy differences between vesicles with different solid domain shapes.

AKB 100.65 Sa 16:45 Poster TU D

Refractive Index Measurements of Single Cells — •Susanne Ebert, Kort Travis, and Jochen Guck — Universität Leipzig, Abteilung Physik weicher Materie, Linnéstr. 5, 04103 Leipzig, Germany

Techniques using light for the manipulation of cells and for the measurement of cell properties, such as the optical stretcher and the optical tweezers, require exact knowledge of the cells' refractive index. For the most effective use of these single cell techniques, a method to measure the refractive index of single cells is also necessary. Such a method has value in its own right for application as an inherent cell marker. In the present work, two such refractive index measurement methods are demonstrated. The first method involves the imaging of forward scattering patterns of cells in a collimated laser beam, and the second method, the measurement of the velocities of cells accelerated by Gaussian laser beams. From this data, the index of refraction is extracted by comparison with exact T-matrix calculations, and a self-consistent model of the dielectric properties of the cell is developed.

AKB 100.66 Sa 16:45 Poster TU D

Towards Scanning Near-Field Optical Microscopy on Free-standing Biological Membrane — •Simone K. J. Johnas[1], Christiane Hoeppener[2], Andreas Naber[2], and Michael Herrmann[3] — [1]HASYLAB@DESY, Notkestr. 85, 22607 Hamburg — [2]Universtaet Karlsruhe, Institut fuer Angewandte Physik, Wolfgang-Gaede-Str.1, 76131 Karlsruhe — [3]Zoologisches Institut II, Universitaet Karlsruhe

The nuclear pore complex (NPC) is a large macromolecular protein assembly embedded in the nuclear envelope (NE) of an eukaryotic cell. It controls tightly the exchange of all kinds of molecules between the cytoplasm and the nucleus. Thus NPCs play an important role for e.g. the metabolism of the nucleus and the effects of medicaments. Since the NPCs are densely packed in the membrane, conventional optical microscopy is not able to distinguish between two neighboured NPCs. By means of scanning near-field optical microscopy (SNOM) we have attained an optically resolved fluorescence image of dye-labeled NPCs in a functionally intact NE for the first time. Thus the aim of this project is a time-resolved oberservation of single transport events. A major obstacle towards this goal is the need of two compartments below and above the NE which mimic its natural environment. Possible preparation techniques and ways to image a freestanding membrane in a buffer solution with SNOM will be discussed. A new approach of the SNOM set-up guarantees the integrity of the soft biological membrane.

AKB 100.67 Sa 16:45 Poster TU D

Cell adhesion studies with quantum dot labeled cells on structured surfaces — •Tim Liedl, Stefan Kudera, Wolfgang J. Parak, and Friedrich C. Simmel — Department Physik, LMU München, Geschwister-Scholl-Platz 1, 80539 München

The adhesion properties of various cell lines are investigated using microcontact printing techniques. Complex patterns composed of hydrophobic and hydrophilic regions are stamped onto a glass substrate to probe cell mobility and the minimal area required for cell adhesion. Several cell lines are investigated in co-culture after labeling the individual cell lines with fluorescent colloidal nanocrystals with different colors. Due to their reduced tendency to photobleach, nanocrystals are particularly suitable as long term markers. Microcontact printing is performed with polydimethyl siloxane (PDMS) stamps with octadecyltrichlorosilane as an ink. Master stamps with feature sizes on the order of 1 μm are defined in the negative photoresist SU-8 using standard optical and electron beam lithography.

AKB 100.68 Sa 16:45 Poster TU D

High resolution CARS microscopy with chirped excitation — •Ondrej Burkacky and Andreas Zumbusch — Department Chemie, LMU München, Butenandtstraße 11, 81377 München

Coherent anti-Stokes Raman scattering (CARS) microscopy puts us in a position to obtain molecular information at high spatial resolution without the use of labels. Both chemical composition and structural features are visualized by their vibrational spectra.

For efficient signal generation in the nonlinear processes involved, ultrashort laser pulses with high peak intensities are needed. However, the corresponding broad bandwidths limit the spectral resolution achieved. Therefore we introduced the method of chirping the pulses in a well-controlled manner. This leads to a narrower instantaneous bandwidth of the chirped pulses and consequently to a higher spectral resolution. In addition, the narrow spectral region probed can be shifted within the range of the much broader laser bandwidth of the ultrashort laser pulses by simply varying the temporal delay between the two pulses. We demonstrate how this approach can be used to obtain spectral and spatial high resolution images with large contrast in a variety of specimens.

Th. Hellerer, A.M.K. Enejder, A. Zumbusch, Appl. Phys. Lett. 85 (2004) 25

AKB 100.69 Sa 16:45 Poster TU D

Merging Microfluidics and Optical Tweezers: a versatile Microtechnology Platform — •Christian Schmitz[1,2], Kai Uhrig[1,2], Jennifer Curtis[1,2], and Joachim Spatz[1,2] — [1]Max-Planck-Institut für Metallforschung, Stuttgart — [2]Universität Heidelberg, Biophysikalische Chemie, Heidelberg

Microfluidic devices offer unique advantages in handling of small sample volumes. This is particularly important in bioanalysis and biotechnology. Furthermore, the miniaturization of flow systems leads to remarkably improved performance in separation and detection of reagents. As a step towards a more flexible and versatile system design we created a new technology platform by merging the techniques of holographic optical tweezers (HOTs) and microfluidics. HOTs can produce and independently steer one to hundreds of optical traps. It provides the possibility to non-invasive assembly and manipulation of micrometer size objects as well as to measure forces. The scale at which the microtechnology platform operates allows complete spatial and chemical control of the microenvironment und thus for the study of biological and biomimetic systems at a cellular level. We apply the system for probing complex biopolymer networks: F-Actin networks are engineered and their physical properties are studied as actin cortex model systems.

AKB 100.70 Sa 16:45 Poster TU D

Stacking interactions in a lattice model of DNA/RNA — •Christian Simm[1], Sanjay Kumar[2], and Ralf Everaers[1] — [1]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, 01187 Dresden — [2]Department of Physics, Banaras Hindu University, Varanasi 221 005, India

The binding strength of DNA/RNA strands is of crucial importance for many biological processes. Examples are the formation of DNA bubbles during transcription, RNA secondary stucture or hairpin formation in ssDNA and miRNA. Current lattice models of DNA only include of the effects of hydrogen bonding between complementary bases. We introduce an extension which accounts for base stacking interaction and the polarity of the DNA strand. We use Monte-Carlo simulations of the model to present results which show the effects of this extension and compare it to the simpler model.

AKB 100.71 Sa 16:45 Poster TU D

Retinal Glial Cells as Living Optical Fibers — •K. Franze[1,2], S. Schinkinger[1], K. Travis[1], A. Reichenbach[2], and J. Guck[1] — [1]Abteilung Physik Weicher Materie, Universität Leipzig — [2]PFI für Hirnforschung, Universität Leipzig

Vision is one of our most important senses. The cells responsible for converting light into electrical impulses are the photoreceptor cells (PRs). However, due to the sequence of evolution, the vertebrate retina is the "wrong way round": in order for light to reach the PRs, it must first pass through several retinal layers of different types of cells. Especially under low-light conditions additional structures are required which guarantee optimal utilization of the light. These structures ideally span the entire thickness of the retina and guide the light through all of the cell layers to the PRs. Only the so-called Müller cells, the principal retinal glial cells, have this ability. Furthermore, these cells contact every single PR.

In the present work, the light guiding properties of individual Müller cells were studied. Cells were aligned in a two-beam IR laser trap, additional visible light was sent through the cells, and the light guiding efficiency of the cells for visible light was measured. These measurements unambiguously demonstrate the light guidance function of Müller cells. The observed intensity dependent transmittance might serve as a protective mechanism of the inverted retina against photo damage of the PRs.

AKB 100.72 Sa 16:45 Poster TU D

Dimers in a 1-d lattice gas: a model for molecular motors collective dynamics — •Paolo Pierobon[1,2], Thomas Franosch[1], and Erwin Frey[1,2] — [1]Hahn-Meitner Institut, Abteilung Theorie, Glienicker Str.100, D-14109 Berlin, Germany — [2]Fachbereich Physik, Freie Universität Berlin, Arnimallee 14, D-14195 Berlin, Germany

The transport of molecular motors along microtubules closely resembles the dynamics of a driven lattice gas of dimers without conservation of particles. The motion of the dimers is unidirectional, asymmetric and stochastic: its properties are encoded in the well studied totally asymmetric simple exclusion process (TASEP). We extend this model by including the possibility of attachment/detachment kinetics and the fact that as dimers they occupy two lattice sites. We study the stationary phase diagram by means of Monte Carlo simulations combined with a continuum description (based on an extended mean field theory). Novel unexpected regimes are identified, where the system is "frustrated".

AKB 100.73 Sa 16:45 Poster TU D

Cytoskeletal assembly in optical neuronal guidance. — •Allen Ehrlicher, Timo Betz, Bjoern Stuhrmann, Michael Goegler, Daniel Koch, and Josef Kaes — Universität Leipzig, Fakultät für Physik und Geowissenschaften, Linnestr. 5, D-04103 Leipzig

The ability to control neuronal growth is a fundamental goal of neuroscience. Although various techniques have been used previously, it has been shown recently that optical gradients can also be used to guide the advancing edge of the growth cone in neuronal cell lines [Ehrlicher et al. PNAS 2002]. While this effect has been observed for different neuronal cell types, the underlying interactions behind the effect are unclear. In this study we examine the contribution of microtubules to the effect. Using disrupting and stabilizing drugs such as nocodazole and taxol, we selectively modified the microtubule structure during and without optical guidance, and visualized their dynamic distribution using fluorescent markers. A better understanding of the cytoskeletal dynamics in optical guidance will not only help to improve the effect, but contribute valuable insight into neuronal growth as well as cellular motility in general.

AKB 100.74 Sa 16:45 Poster TU D

Adhesion-induced domain formation of membranes with long and short stickers — •Mesfin Asfaw, Reinhard Lipowsky, and Thomas R. Weikl — Max Planck Institute of Colloids and Interfaces, Theory Division, 14424 Potsdam

Biological membranes contain domains which serve important functions, e.g. in signaling, budding, or adhesion. The formation of these domains can be driven by a phase separation of the lipid bilayer, or by the aggregation of membrane-embedded macromolecules. We consider the adhesion of membranes with various types of adhesion molecules, or 'stickers'. The stickers differ in their characteristic lengths and binding energies. During membrane adhesion, the length mismatch of the stickers causes a separation into distinct domains, provided the sticker concentrations exceed a critical threshold. This mechanism of adhesion-induced phase separation into domains with long and short stickers has been recently observed during T cell recognition. We characterize the rich equilibrium phase behavior of these membranes using scaling estimates and Monte Carlo simulations.

AKB 100.75 Sa 16:45 Poster TU D

Loop-closure principles in protein folding kinetics — •Thomas R. Weikl — Max Planck Institute of Colloids and Interfaces, Theory Division, 14424 Potsdam

How fast and on which routes does a protein fold into its native structure? The answer to this central question of protein folding kinetics appears to depend, to some degree, on generic aspects of the protein structure. One of these aspects is the average localness of structural contacts, which correlates with the folding rates of small single-domain proteins. Another aspect is presented here: The folding routes of many small proteins seem to be dominated by simple loop-closure dependencies between the structural elements. These loop-closure dependencies help to rationalize why mutations in some structural elements strongly affect the kinetics, while mutations in other structural elements don't. They also explain characteristic changes in the kinetic impact of structural elements when the chain connectivity is altered by circularization or circular permutation.

AKB 100.76 Sa 16:45 Poster TU D

On the growth control of epithelial cell populations in-vitro — •Dirk Drasdo[1], Jörg Galle[1], and Markus Löffler[2] — [1]Interdisciplinary Center for Bioinformatics, Kreutzstr. 7a, 04103 Leipzig — [2]Institute for Medical Informatics, Statistics and Epidemiology, 04103 Leipzig

We present a 3d individual cell based biophysical model to study the effect of normal and malfunctioning growth regulation and control on the spatial-temporal organization of growing cell populations in vitro, ranging from monolayer growth to growing tumor spheroids. The model includes explicit representations of typical epithelial cell growth regulation and control mechanisms, namely (i) a cell-cell contact mediated form of growth inhibition, (ii) cell-substrate contact dependent cell-cycle arrest, and (iii) cell-substrate contact dependent programmed cell death. The model cells are characterized by experimentally accessible biomechanical and cell-biological parameters. We study by variation of these cell-specific parameters and apply selective knock-outs of growth regulation and control mechanisms to investigate how the different mechanisms collectively act together. We show that our simulation studies cover the growth behaviour of epithelial cell populations ranging from stem cell populations up to tumor cell lines in vitro.

AKB 100.77 Sa 16:45 Poster TU D

Active vs. Passive Microrheology — •Daisuke Mizuno, Frederick C. MacKintosh, and Christoph F. Schmidt — Dept. Physics, Vrije Universiteit, Amsterdam, NL

We have performed passive and active 2-particle microrheology (MR) in actin solutions by using the same micron-sized colloidal particles as a probes. In passive MR, viscoelasticity is measured from the correlated thermal fluctuations of the probe particles. In active MR, one probe particle is sinusoidally driven by an oscillating optical trap while the correlated motion of the other one is detected by laser interferometry. In equilibrium, both methods give the same results. In non-equilibrium, however, such as in living cells, random, nonthermal stress fluctuations prevent the use of the fluctuation-dissipation theorem. Probe motions are influenced by e.g. the activity of motor proteins or directional polymerization/depolymerization of actin and microtubules. Active components also modify the viscoelastic response of the cytoplasm. The main aim of our research is to gain a better understanding of microscopic dynamics in

such non-equilibrium systems by combining active and passive microrheology.

AKB 100.78 Sa 16:45 Poster TU D

Dynamics of DNA looping under tension — •Ulrich Gerland — Department Physik and CENS, LMU München, Germany

The interaction of proteins bound to DNA is often dependent on the formation of DNA loops. The dynamics of this process can be probed in detail by applying a force to the ends of the DNA with single-molecule techniques. Motivated by ongoing experiments, I study both the equilibrium statistics and the dynamics of DNA looping under tension, using a combination of numerical and analytical techniques. In particular, I characterize the force-dependence of the peak in the looping probability and looping rate as a function of the separation between the DNA sites. I will discuss how the looping kinetics under tension can be used to indirectly obtain information on enzymes whose action depends on DNA looping.

AKB 100.79 Sa 16:45 Poster TU D

High-Frequency Microrheology of Wormlike Micelles — •Mark Buchanan[1], Maryam Atakhorrami[2], Jean-François Palierne[3], Frederick C. MacKintosh[2], and Christoph F. Schmidt[2] — [1]Dept. Physics, University of Oslo, Norway — [2]Dept. Physics, Vrije Universiteit, Amsterdam, NL — [3]Lab. Physique, Ecole Normale Sup. Lyon, FR

We have measured the frequency-dependent shear modulus of entangled solutions of wormlike micelles by high-frequency microrheology and have compared the results with those from macrorheology experiments done on the same samples. Using optical microrheology based on laser interferometry we have measured loss and storage moduli over six decades in frequency up to about 100 kHz. We present data over a decade in concentration in the entangled regime and find good agreement between micro- and macrorheology, thus validating recently developed microrheology techniques. By collapsing data for different concentrations, we furthermore determine both the concentration scaling of the plateau modulus and a power-law exponent of the complex shear modulus at high frequencies.

AKB 100.80 Sa 16:45 Poster TU D

Monte Carlo Simulation of Lipid Bilayers with Rigid Inclusions — •Olaf Lenz und Friederike Schmid — Universität Bielefeld, Fakultät für Physik

We have investigated the effects of inclusions (for example proteins) on a lipid bilayer close to it's fluid–gel (main) transition on a mesoscopic scale of a few tens of nanometers by means of a coarse-grained Monte-Carlo simulation.

We use a very efficient and simple bead-spring model of one hydrophilic head bead connected to six hydrophobic tail beads for the lipids and a model of "phantom" solvent beads that do not interact with each other for the solvent environment. In this model, the lipids self-assemble to form a lipid bilayer and the bilayer exhibits the fluid–gel transition. We observe a tilted gel state and an "interlocked" gel state which possibly is related to the well-known "ripple phase" of bilayers. The inclusions are represented by rigid, hydrophobic cylinders that roughly correspond to α-helices.

In the liquid phase, an ordering of the lipid tails is induced in the vicinity of the rigid inclusion. Close to the phase transition, the range of this effect grows. In the tilted gel phase, a long-ranged, directed point defect of the lipid tail ordering was observed. This defect leads to the destruction of the gel phase and therefore shifts the critical temperature of the phase transition to lower temperatures. Furthermore, the defect is expected to strongly influence the interaction between inclusions on a scale of a few times the size of the inclusion.

AKB 100.81 Sa 16:45 Poster TU D

Analysis of the Protein-Protein Association Free Energy Studied by Brownian Dynamics Simulations — •Alexander Spaar — Center for Bioinformatics, Saarland University, Im Stadtwald, D-66041 Saarbrücken, Germany

We carefully analyzed the trajectories from Brownian Dynamics (BD) simulations in order to study protein-protein encounter on the example of barnase and barstar, a well characterized model system of electrostatically steered diffusional association. The individual positions and orientations of the proteins during all trajectories are stored in occupancy maps. By interpreting the occupancy maps as probability distributions and by defining a local entropy function we are able to compute the 6-dimensional entropy landscape for the encounter of the two proteins. Together with the configuration dependent electrostatic and desolvation energies, the association free energy is obtained as the sum of these terms. In the free energy profile along the reaction path, which is defined as the path along the minima in the free energy landscape a characteristic minimum at small distances shows up, suggesting this to be used as the definition of the encounter state. The association free energy profiles are compared for different ionic strength and temperature of the solvent.

AKB 100.82 Sa 16:45 Poster TU D

In-plane and out-of-plane fluctuation of synthetic glycolipid lamellae under controlled osmotic pressure and temperature — •Emanuel Schneck[1], Florian Rehfeldt[1], Bruno Demé[2], and Motomu Tanaka[1] — [1]Technische Universität München — [2]Institut Laue-Langevin

The in-plane and out of plane cooperativity in artificial models of cell glycocalix was studied using the D16 membrane diffractometer coupled with a climate chamber. Rocking curves of oriented multilamellar stacks using the 2D detector (reciprocal space maps, $q_\parallel$ vs. q_x) allow for the analysis of the scattering along different orientations referring to in-plane and out-of-plane contributions independently. In-plane membrane fluctuations produce diffuse scattering along $q_\parallel$, while fluctuations of the periodicity affects the sharpness of the Bragg peaks along q_z (specular reflectivity). The analysis of the measured lamellar periodicities yields quantitative force-distance relationships, which clearly reveal the competitive interplays of repulsive hydration forces and attractive "zipper" forces depending on the conformation of carbohydrate head groups.