BP 7: Posters I

Time: Monday 17:00–19:30 Location: Poster A

BP 7.1 Mon 17:00 Poster A

Counterion Dynamics in DNA Electrophoresis — •Sebastian Fischer[1], Ali Naji[2], and Roland Netz[1] — [1]Physik Department, Technische Universität München, 85748 Garching, Germany — [2]Department of Chemistry and Biochemistry, University of California, Santa Barbara, CA 93106-9510, USA

We present Brownian Dynamics simulations of a coarse grained model for DNA in aqueous NaCl solution, moving under the influence of an externally applied electric field. The electrophoretic DNA mobility obtained is shown to agree almost quantitatively with experimental data. As theoretically predicted, the DNA mobility is found to decrease logarithmically with increasing salt concentration due to partial screening of hydrodynamic interactions caused by the adverse motion of oppositely charged ions.

Apart from the DNA mobility we focus on the mobility of the counterions in the immediate vicinity of the polymer which we find to be negative, *i.e.* the Na^+ ions are dragged along by the DNA, albeit at diffent speed. This result contrasts with a common theoretical concept where counterions in close proximity to the DNA polymer are assumed to move at the same velocity [2]. In contrast to the DNA mobility the Na^+ mobility increases with increasing salt concentration. At some point, the direction of motion changes from aligned to adverse with respect to the polymer. For weakly charged polymers the salt concentration dependence of the counterion mobility can be calculated using Green's function methods.

[1] G. S. Manning, J. Phys. Chem. **85**, 1506 (1981)

BP 7.2 Mon 17:00 Poster A

Fullerenes Can Induce Toxic Physical Changes of DNA — •Fabian Czerwinski and Lene B. Oddershede — Niels Bohr Institute, Blegdamsvej 17, Copenhagen

Fullerenes are fascinating symmetric carbon nanostructures. Nowadays, they are widely used because of their characteristic physical and chemical properties. Until now research has been mainly focused on commercial applications of fullerenes. Only a few investigations have addressed the potential biological hazards, one of which is that fullerenes are believed to alter the elastic properties of DNA upon binding.

In our experiments we use optical tweezers with sub-piconewton and nanometer resolution to probe the structural changes and the potential damages which fullerenes might induce on single DNA molecules. Therefore, force-extension relations can be obtained under physiological conditions while varying the concentration of different types of fullerenes.

It has theoretically been predicted [1], that certain fullerenes can function as a minor-groove binder to double-stranded DNA, thus altering its elastic properties significantly. Fullerenes are capable of causing severe damage inside living organisms by forming DNA regions which are not accessible for proper enzymatic functions. A further goal of the study is to establish fullerenes as a tool for a more detailed investigation of DNA-protein interactions, such as the trafficing of polymerases or the packing by procaryotic proteins.

[1] Zhao, Striolo and Cummings: BiophysJ (89):3856-62, 2005.

BP 7.3 Mon 17:00 Poster A

Exact Models for Denaturation Transitions of Nucleic Acids — •Thomas Rudolf Einert and Roland Netz — Technische Universität München, Garching, Germany

Stretching of double-stranded DNA leads to the denaturation of the molecule. A stretching force $F \approx 65\,\mathrm{pN}$ leads to a structural transition where DNA changes from its native state (B-DNA) to a stretched state (S-DNA). At even higher forces DNA denatures and the two DNA strands are separated from each other. We present a model with which force-extension curves can be calculated.

Thermodynamics of loops – especially multi-branched loops – in RNA are still not very well understood. We show that the melting curves and the melting temperatures are very sensitive to the modeling of the statistical weight of a loop employing recursion relations to calculate the partition function. Using the asymptotic form for the statistical weight $y^m m^{-c}$ of a loop of length m known from polymer theory we are able to solve the equations exactly and find a delicate dependence of the critical behavior on the loop exponent c.

BP 7.4 Mon 17:00 Poster A

Impact of alternative genetic codes on the stability of proteins — •Stefanie Sammet[1], Andreas Buhr[1], Ugo Bastolla[2], and Markus Porto[1] — [1]Institut für Festkörperphysik, Technische Universität Darmstadt, Germany — [2]Centro de Biologia Molecular, "Severo Ochoa", Campus UAM, Cantoblanco, 28049 Madrid, Spain

While nearly all free-living species use the same genetic code for the translation of genes into amino acid sequences, slightly different genetic codes are used in mitochondria and in some intracellular bacteria. In addition, the mitochondria genome mainly codes for membrane proteins, which have peculiar thermodynamic properties since they have to deal with a lipidic environment. While there has been a lot of work concerned with the optimality of the standard genetic code, it remains unclear whether alternative codes provide any advantage to the proteins they code for. We present a model based on mutations and purifying selection on thermodynamic properties, which takes into account that mitochodrial genome present a distinctive mutation bias. On the basis of point mutations in the DNA, the effects of different genetic codes on stability against unfolding and misfolding are examined. Furthermore, the robustness of proteins against mistranslations is considered.

BP 7.5 Mon 17:00 Poster A

Isothermal DNA Nanotube Self Assembly Using Chemical Dilution — •Thomas Sobey[1,2], Stephan Renner[1,2], Ralf Jungmann[1,2], and Friedrich Simmel[1,2] — [1]Center for NanoScience and Department of Physics, Geschwister-Scholl-Platz 1, 80539 Munich, Germany — [2]Physics Department E14, Technical University Munich, James-Franck-Straße, 85748 Garching, Germany

DNA-based supramolecular nanostructures are rapidly advancing in complexity and reproducibility, and are exciting because of their ability to act as scaffolds for other nano- and micro- sized objects, as molecular devices, and in molecular computation.

Those structures used for scaffolding and molecular computation are (generally) formed through a slow temperature annealing process in buffer, allowing the assembly to occur correctly. We have developed a successful isothermal room temperature procedure that reproduces this. It is based on slowly decreasing the concentration of a denaturing agent(formamide), which 'simulates' the thermal annealing step. With this process we have reproduced DNA nanotube structures previously realized by Mao et. al. using conventional annealing.

We are currently working to develop this technique with tile-based structures, algorithmic self-assembly, and also DNA origami. In addition, we attempt to create these DNA-based nanofilaments inside vesicles to act as an artificial cytoskeleton.

BP 7.6 Mon 17:00 Poster A

Orientation - Defined Stretching and Fixing of DNA by AC Voltage Induced Electro-Osmotic Flow — •Venkatesh Alagarswamy Govindaraj[1], Simone Herth[1], Anke Becker[2], Andreas Hütten[1], and Günter Reiss[1] — [1]Thin Films and Nano Structures, Department of Physics, Bielefeld University, Bielefeld, Germany — [2]Institute for Genome Research and Systems Biology, CeBiTec, Bielefeld University, Bielefeld, Germany

Application of DNA stretching at a single molecule level has become an attractive domain of research in the field of bioelectronics, genomics and nanobiotechnology. It was already reported that DNA could be stretched in an orientation-defined way between two electrodes with a gap of several micrometers using masks. In this work a new electrode design was fabricated to facilitate an orientation-defined stretching of dsDNA across a channel of submicron width. Tagged DNA strands of defined length were synthesized by Polymerase Chain Reaction using pUC19 as template. The forward and reverse primers were 5'-tagged with thiol and biotin, respectively. The tagged DNA strands were then dielectrophorized on modified interdigitated electrodes with oppositely placed castellation at an intermediate frequency in order to induce electro-osmotic flow. The stretched DNA was observed through laser confocal microscopy using intercalating dye such as acridine orange. This method enables characterization of single molecule dynamics and its consequent application in DNA based electronics, DNA templated nano structures, mutation detection and DNA-protein interaction studies.

BP 7.7 Mon 17:00 Poster A

Exposure of transcription factor binding sites in single nucleosomes and nucleosome arrays — •Wolfram Möbius[1,2] and Ulrich Gerland[2] — [1]Arnold Sommerfeld Center for Theoretical Physics (ASC) and Center for NanoScience (CeNS), LMU München — [2]Institute for Theoretical Physics, Universität zu Köln

Nucleosomes do compactify eukaryotic DNA, as a consequence burying long stretches of DNA. Nevertheless, transcription factors can bind to the DNA which may be achieved by temporarily unwrapping stretches of DNA from the histone complex (site exposure mechanism). Recently, we theoretically studied the dynamics of this mechanism in single nucleosomes, motivated by analogous experiments. Now, the thermodynamics of nucleosome arrays becomes experimentally accessible. We present first results of corresponding Monte Carlo simulations and compare it with the situation in single nucleosomes.

BP 7.8 Mon 17:00 Poster A

Surface-Enhanced Fluorescence for microarray sensitivity improvement — •Eric Le Moal[1], Emmanuel Fort[2], and Sandrine Lévêque-Fort[3] — [1]Institut für Physikalische und Theoretische Chemie, Universität Bonn, Wegelerstr. 12, D-53115 Bonn — [2]Laboratoire Matériaux et Phénomènes Quantiques, Université Paris Diderot-Paris7, Bât. Condorcet, 10 rue A. Domon et L. Duquet, F-75205 Paris cedex 13 — [3]Laboratoire de PhotoPhysique Moléculaire, Université Paris Sud, Bât. 210, F-91405 Orsay cedex

Fluorescence is the prevailing labeling technique in biosensors and microarrays. However, the detection of very low molecular concentrations and the precise localization of biomarkers are often limited by the weakness of the fluorescence signal. We present a new method based on sample substrates that improve in sensitivity the fluorescence detection. These active substrates consist in glass slides covered with silver and alumina films and can directly be used with common detection setups. Fluorescence enhancement affects both excitation and decay rates and is strongly dependant on the distance to the metal surface. Additional improvements are achieved by structuring the metallic layer. Surface roughness indeed allows converting into light the energy that is non-radiatively transferred by the fluorescent molecules to the substrate. We measured a signal enhancement by more than 40-fold on a DNA microarray with a commercial scanning device. Reaching a highly sensitive detection on a DNA microarray allows operating with less genetic material, which may be of major interest when this quantity is limited, e.g., in biomedical diagnosis.

BP 7.9 Mon 17:00 Poster A

Modeling Background Intensity in Affymetrix GeneChips — •K. Myriam Kroll[1], Gerard Barkema[2,3], and Enrico Carlon[1] — [1]Institute of Theoretical Physics, KU Leuven, Celestijnenlaan 200D, 3001 Leuven, Belgium — [2]Institute for Theoretical Physics, Universiteit Utrecht, Leuvenlaan 4, 3584 CE, Utrecht, The Netherlands — [3]Institute-Lorentz for Theoretical Physics, University of Leiden, Niels Bohrweg 2, 2333 CA Leiden, The Netherlands

A new physical model for the calculation of the background intensity in Affymetrix GeneChips is introduced. We identify two major sources of background noise; the first is related to the sequence composition (CG-rich sequences are expected to have higher affinities for non-specific hybridization than e.g. AT-rich sequences). The second is due to local dependence of intensities from locations which are the physical neighbors of a specific spot on the chip. Both effects are incorporated in a background functional whose free parameters are fixed via minimization on a training data set. In all data analyzed, the sequence specific parameters strongly correlate with empirically determined stacking free energies in solution. Moreover, we find an overall agreement with experimental background data. We show that our physics/physical-chemistry model globally performs better in calculating background intensities than approaches which are only based upon statistics. Thus, our model provides an interesting alternative method for background subtraction schemes in Affymetrix GeneChips.

BP 7.10 Mon 17:00 Poster A

Nanoengineered Polymer Capsules: Tools for Controlled delivery and Site Specific Manipulation — •Raghavendra Palankar[1], Oliver Kreft[1], Andre Skirtach[1], Yannic Ramaye[1], Margorzata Garstka[2], Gleb B. Sukhorukov[2], Sebastian Springer[2], and Mathias Winterhalter[1] — [1]Jacobs University Bremen — [2]Max-Planck Institut Golm

Hollow nanometer-sized containers are of increasing interest in nanotechnology, since they can protect proteins, enzymes or drugs from hostile surroundings and provide an optimal microenvironment. Here we report on functionalized nanocapsules as intracellular reporters providing a new tool in cell biology. Cell active molecules, hormones, enzymes or reporter molecules may be hidden from the outside, protected against chemical and biological degradation, targeted to specific compartments inside a cell and released in a controlled manner. For example we loaded capsules with antigenic peptides and inject the capsule with electroporation. We describe here the laser-triggered release of peptides into the interior of a cell which is followed by their binding to MHC class I molecules, and the subsequent movement of the peptide-class I complex to the plasma membrane.

Sukhorukov GB et al. Multifunctionalized Polymer Microcapsules: Novel Tools for Biological and Pharmacological Applications. Small 3 (2007) 944-55.

BP 7.11 Mon 17:00 Poster A

Motility and membrane protein dynamics of trypanosomes in a microfluidic environment. — •Eric Stellamanns[1], Niko Heddergott[2], Thomas Pfohl[1], and Markus Engstler[2] — [1]Max PIanck Institute for Dynamics and Self-Organization, Bunsenstr.10, 37037 Göttingen, Germany — [2]Technical University of Darmstadt,Department of Cellular Dynamics, Schnittspahnstr. 10, 64287 Darmstadt, Germany

The bloodstream parasite, Trypanosoma brucei, causative organism of the sleeping sickness in human and domestic livestock, is highly adapted to its fluidic environment. Placed in serum, trypanosomes swim in an auger-like motion with velocities up to 20 microns per second - much slower than the host's bloodstream. The resulting drag forces are strong enough to move surface bound antibodies towards the posterior cell pole, where they are rapidly internalized and digested. This strategy of escaping the immune system is possible as long as the cell is able to propel with a net direction.

In order to analyze such protein sorting with respect to cell motility, we combine microfluidics with optical tweezers and state of the art fluorescence microscopy. We study the influence of confinement, fluid viscosity and obstacles on the cell movement and therefor on their immune escape.

BP 7.12 Mon 17:00 Poster A

Investigation of erythrocytes cell-cell adhesion forces using holographic optical tweezers — •Achim Jung[1], Matthias Brust[1], Patrick Steffen[1], Christian Wagner[1], Ingolf Bernhardt[2], Ljubomira Ivanova[2], Lars Kaestner[3], and Peter Lipp[3] — [1]Department of Physics, Saarland University, 66041 Saarbrücken, Germany — [2]Central Isotope Laboratory/Laboratory of Biophysics, Saarland University, 66041 Saarbrücken, Germany — [3]Institute for Molecular Cell Biology, Saarland University, 66424 Homburg, Germany

Prostaglandin E_2 (PGE_2) and lysophosphatidic acid (LPA) are released from activated platelets. Using fluorescence imaging, spectral imaging and the patch-clamp technique, we recently provided evidence that these lipid-mediators at physiological concentrations activate a non-selective cation-channel in human red blood cells (RBCs). This results in a Ca^{2+} influx and the consecutive intracellular Ca^{2+} concentration increase. Ca^{2+} increases elicits the Ca^{2+}-activated K^+ channel (Gardos channel) in the RBC membrane resulting in K^+ efflux and shrinkage of the cells. By means of holographic optical tweezers we investigate the inter-cellular adhesion forces between individual RBC arising after mediator stimulated increase of the intracellular Ca^{2+} concentration. We are going to compare this force to depletion controlled cell-cell adhesion forces in polymer solutions. Based on our results we conclude that the PGE_2 and LPA responses of RBCs reveal a direct and active participation of these cells in blood clot formation.

BP 7.13 Mon 17:00 Poster A

Three-dimensional Fluorescence Lifetime Imaging with a light sheet based microscope (SPIM-FLIM) provides an excellent signal-to-noise ratio — •Manuel J. Neetz, Klaus Greger, Emmanuel G. Reynaud, and Ernst H.K. Stelzer — European Molecular Biology Laboratory (EMBL), Meyerhofstrasse 1, D-69117 Heidelberg, Germany

Fluorescence Lifetime Imaging (FLIM) (Gadella, 1993) in combination with modern microscopes allows one to determine the spatial distribution of specific molecular interactions. A FLIM setup operating on three dimensional (3D) live specimens requires optical sectioning capabilities, a low sample exposure and a physiologically relevant en-

vironment (Pampaloni, 2007). The optical sectioning capabilities of scanning approaches are limited due to high photobleaching rates and long acquisition times while widefield based setups do not provide optical sectioning at a reasonable noise level. The combination of EMBL's Single Plane Illumination Microscopy (SPIM) (Huisken, 2004; Greger, 2007) with frequency domain FLIM overcomes these limitations by decreasing photobleaching rates as well as increasing the signal-to-noise ratio significantly. It thus utilizes the fluorophores more efficiently. Hence, our approach is particularly well suited for investigating cellular interactions in 3D. We use our setup to acquire fluorescence lifetimes of EGFP labelled E-Cadherin in complex multi-cellular MDCK cysts to study cell-cell adhesion under relevant conditions. E.g., the ratio between cell surfaces in contact with each other and their volumes is manyfold as compared to conventional assays.

BP 7.14 Mon 17:00 Poster A

Endothelzellen und Glatte-Muskel-Zellen auf strukturieren Oberflächen — •Sarah Biela, Su Yi, Stefanie Korte, Britta Striegl, Ralf Kemkemer und Joachim P. Spatz — MPI für Metallforschung, Stuttgart

Bei der Behandlung von Aderverengung bei Herzkreislauferkrankungen setzt die moderne Medizin auf intravaskuläre Stent-Implantate. Stents weiten die Ader und verhindern den völligen Verschluss und somit Infarkte. Häufige Folgeprobleme dieser Behandlung sind Entzündungen, Thrombose und Wiederverschluss durch unkontrolliertes Wachstum von Glatten Muskel-Zellen, genannt Restenose. Ein neuer Ansatz in der Forschung ist der Versuch, neue Materialien und Beschichtungen für Stents zu finden, um Restenose zu verhindern und das Einwachsen in die Endothelzellschicht zu fördern.

Ziel meiner Arbeit ist es, verschiedene Reaktionen der zwei Zelltypen (Endothel- und Glatte Muskel-Zellen) gegenüber äußeren stimulierenden Faktoren zu finden. Mein Interesse gilt dabei besonders Oberflächenchemie, Topographie, elektrischen Feldern und externen mechanischen Kräften. Die Zellen werden auf flachen und dreidimensionalen Substraten (Stents) beobachtet, sowohl unter statischen, als auch unter Scherfluss-Bedingungen.

Auf nicht transparenten Substraten werden die Zellen mit einem aufrechten Mikroskop und mit Hilfe von Fluoreszenz-Markern beobachtet. Auf PDMS-Mikro-Strukturen zeigen Endothel- und Glatte Muskel-Zellen eine weniger signifikante Ausrichtung nach der Struktur als Fibroblasten.

BP 7.15 Mon 17:00 Poster A

Close Packed μm-Wells as Culture System for hMSCs — •Julia Schölermann, Ralf Kemkemer, and Joachim P. Spatz — Max-Planck-Institute for Metals Research, Dept. of New Materials & Biosystems & University of Heidelberg, Dept. of Biophysical Chemistry, Heisenbergstr. 3, D - 70569 Stuttgart

Current culture and differentiation systems for human mesenchymal stem cells (hMSCs) lack control of the microenvironmental niche of single cells since local cell densities and therefore distribution of cell secreted or bound signalling molecules and the individual cell's mechanical environment differ within a population. A common method in inducing chondrogenesis is hMSC pellet culture. Distribution of matrix proteins within these pellets has been shown to be rather heterogeneous (Murdoch, 2007) highlighting different cell fates gathered in one population. Therefore, a culture system for hMSCs was designed that allows for controlled cell densities in spatially separated containers exhibiting a homogeneous geometric environment. Microsphere lithography was applied covalently attaching glass beads sized between 8 and 170 μm to Si wafers using silane chemistry. These structures were used as blueprints for casting polydimethylsiloxane (PDMS) yielding close packed arrays of hemispheres. Microstructured PDMS samples were used as hMSC culture substrates and differentiation was monitored using real time PCR. Necessity of PDMS functionalisation was assessed on non-structured samples showing that plasma treatment was sufficient in promoting hMSC survival whereas fibronectin seemed to unspecifically elevate osteogenesis related transcription factors.

BP 7.16 Mon 17:00 Poster A

Optical force based investigations of cell mechanical concepts during phagocytosis — •Felix Kohler[1], Holger Kress[2], and Alexander Rohrbach[1] — [1]University Freiburg, Freiburg, Germany — [2]Yale University, New Haven, USA

Macrophages internalize bacteria during phagocytosis, which is a central mechanism in the immune system. Still, only little is known about the mechanical properties of phagocytosis, in particular when mediated by cellular tentacles, i.e. filopodia. We used optical tweezers-based microscopy to investigate different mechanical concepts of the cell to take up 1 micron beads, which serve as synthetic bacteria. The motion of an optically trapped bead was tracked interferometrically in 3D with nanometer precision at a microsecond timescale. On the one hand, the measurement of the thermal bead fluctuations during the binding to the cell membrane enabled the observation of individual receptor-ligand bond formation. On the other hand, the measurement of the mean bead displacements allowed determining retraction forces of filopodia at various retraction speeds. We measured F-actin dependent 36-nanometer steps inside living cells during filopodia retraction likely belonging to actin-based molecular motors[1]. Steps remained clearly visible even at force regimes clearly beyond the stall force of a single myosin motor. This seems to indicate a kind of inter-motor coupling, a phenomenon which we try to explain by a stochastic multistate model.

[1] Kress, H., E.H.K. Stelzer, D. Holzer, F. Buss, G. Griffiths, and A. Rohrbach, PNAS, Vol.104, 2007, 11633 - 11638

BP 7.17 Mon 17:00 Poster A

Rigidity percolation in networks of stiff fibers — •Boris Schaefer[1], Claus Heussinger[1,2], and Erwin Frey[1] — [1]Arnold Sommerfeld Center for Theoretical Physics, LMU München, Theresienstraße 37, 80333 München — [2]Université Lyon I, LPMCN, Villeurbanne, France

We study the elasticity in random networks of stiff fibers. It is well known that by decreasing the density of fibers, these networks lose their stability and undergo a rigidity percolation transition that is distinct from the usual connectivity percolation. We present a self-consistent theory on Cayley-tree level that allows to determine both the percolation threshold as well as the critical exponent for the elastic modulus. The theory is based on the recognition that for stiff fibers stretching excitations are suppressed and the elastic energy is dominated by the bending mode ("floppy modes"). By suitably averaging over the quenched random structure we pin-point the role of architectural features, such as network anisotropy, on the critical properties of the system.

BP 7.18 Mon 17:00 Poster A

Characterizing circular semiflexible polymers — •Karen Alim and Erwin Frey — Arnold Sommerfeld Center for Theoretical Physics and CeNS, Department of Physics, Ludwig-Maximilians-Universtät München, Theresienstr. 37, 80333 München

Circular polymers such as viral DNA, plasmids or cytoskeletal bundles play a crucial role in various biological processes. We examine the shape of circular semiflexible polymers over their whole range of flexibility observing two distinct shape regimes depending on the flexibility of the polymer [1]. For small perimeter to persistence length the fluctuating rings exhibit only planar, elliptical configurations. At higher flexibilities three dimensional, crumpled structures arise. Analytic calculations confirm the qualitative behavior of the shape parameters and the elliptical shape in the stiff regime.

Further characteristic measures for circular semiflexible polymers are derived based on an elastic rod model with anisotropic bending stiffness and twist stiffness [2]. In this polymer ribbon model the geometric constraint causes an effective stiffning of bending modes and a coupling of bending and twisting modes. Furthermore, our model predicts the mean square diameter of a ribbonlike ring thus giving a novel parameter to determine bending and twist stiffnesses of polymers and especially bundles in experiments.

[1] K. Alim and E. Frey, *Shapes of semiflexible polymer rings*, Phys. Rev. Lett. **99**, 198102 (2007)

[2] K. Alim and E. Frey, *Fluctuating semiflexible polymer ribbon constrained to a ring*, Eur. Phys. J. E, in press

BP 7.19 Mon 17:00 Poster A

Nonlinear dynamic response of semiflexible polymers — •Benedikt Obermayer[1], Wolfram Möbius[1,2], Oskar Hallatschek[3], Klaus Kroy[4], and Erwin Frey[1] — [1]Arnold Sommerfeld Center and Center of NanoScience, Ludwig-Maximilians-Universität München, Theresienstr. 37, 80333 München — [2]Institut für Theoretische Physik, Universität zu Köln, Zülpicher Str. 77, 50937 Köln — [3]Lyman Laboratory of Physics, Harvard University, Cambridge, MA 02138, USA — [4]Institut für Theoretische Physik, Universität Leipzig, Postfach 100920, 04009 Leipzig

We have theoretically analyzed the anisotropic nonlinear dynamic re-

sponse of semiflexible polymers to external driving fields. Crossover scaling laws are extracted from a coarse-grained equation of motion that governs the propagation and relaxation of backbone tension and follows from a rigorous perturbation theory. Our analytical results are compared to simulation data for a variety of force protocols. We address explicitly the dependence on boundary conditions and other implications relevant for experiments and computer simulations, such as the influence of finite extensibility and microstructure.

BP 7.20 Mon 17:00 Poster A

Orientational correlations in a wormlike chain — •Semjon Stepanow — Universität Halle, Institut für Physik, 06099 Halle

We present results of the study of the distribution function of a wormlike chain with fixed orientation of one chain end, and as well as tangent correlation functions of segments along the chain with and without a global constraint on the chain.

BP 7.21 Mon 17:00 Poster A

Conformation of a semiflexible polymer in a disordered environment — •Sebastian Schoebl[1], Abigail Klopper[2], and Klaus Kroy[1] — [1]Institut für Theoretische Physik, Universität Leipzig, Leipzig — [2]Max-Planck-Institut für Physik komplexer Systeme, Dresden

Biological cells are affected by the structural and mechanical properties of polymers and polymeric networks in an essential way. A particularly interesting question is how the conformations of a polymer in the cytoplasm is affected by molecular crowding. Despite the prolific attention paid to the analogous problem in flexible polymer networks in recent years, little is understood about how their stiffer counterparts respond to a disordered environment. We investigate the equilibrium and non-equilibrium conformations of semiflexible polymers in a variety of potential landscapes by Monte Carlo simulations. The polymer is represented as a Heisenberg chain, i.e. a discretised wormlike chain. Relevant observables such as the end-to-end distribution function and the tangent-tangent correlation function are evaluated.

BP 7.22 Mon 17:00 Poster A

Theory of Mechano-Transduction in Cells — •Sebastian Sturm[1], Jens Glaser[1], and Klaus Kroy[1,2] — [1]Institut für theoretische Physik, Universität Leipzig, Vor dem Hospitaltore 1, 04103 Leipzig — [2]Hahn-Meitner Institut, Glienicker Straße 100, 14109 Berlin

No higher forms of life could exist without the ability of biological cells to quickly sense and react to changes in their environment. In general, stimuli excite the cell membrane and have to be transmitted to the nucleus. Mechano-transduction through the cytoskeleton may arguably provide the fastest pathway for mechanical stimuli. Understanding the dynamics of tension propagation through biopolymer networks is thus an important task.

Our approach combines two highly successful recent theoretical developments: (i) a systematic theory of tension propagation in single semiflexible polymers [1]; (ii) the glassy wormlike chain (GWLC) model [2], which accounts for the influence of a crowded environment on polymer dynamics. We discuss asymptotic solutions of the theory for different force protocols to derive experimentally relevant predictions.

[1] O. Hallatschek, E. Frey and K. Kroy, Phys. Rev. Lett. 94, 077804 (2005)
[2] K. Kroy and J. Glaser, arXiv:0705.0490

BP 7.23 Mon 17:00 Poster A

Microtubule dynamics depart from wormlike chain model — Katja M Taute[1], •Francesco Pampaloni[2], Erwin Frey[3], and Ernst-Ludwig Florin[1] — [1]Center for Nonlinear Dynamics, University of Texas at Austin, 1 University Station C1610, Austin TX 78712, U.S.A. — [2]Cell Biology and Biophysics Unit, European Molecular Biology Laboratory, Meyerhofstraße 1, 69117 Heidelberg, Germany — [3]Arnold Sommerfeld Center for Theoretical Physics and CeNS, Department of Physics, Ludwig-Maximilians-University at München, Theresienstraße 37, D-80333 München, Germany

We study the dynamics of the tip's thermal fluctuations of grafted microtubules in the length range of 2-30 um, by employing high precision particle tracking on attached fluorescent beads. First mode relaxation times were extracted from the mean square displacement in the transverse coordinate. For short microtubules, the relaxation times were found to follow an L^2 dependence instead of L^4 as expected from the standard wormlike chain model. As these time scales are determined by an interplay of filament stiffness and friction, persistence lengths and drag coefficients were examined. The persistence lengths show a complex dependence on overall filament length and indicate a plateau value of ~600 um for microtubules shorter than ~ 5 um. This behavior is consistent with the elastic properties of bundles of wormlike filaments and hence suggests modeling microtubules as bundles of their constituent protofilaments. Our results emphasize that microtubule mechanics can be understood as a consequence of their complex protofilament architecture.

BP 7.24 Mon 17:00 Poster A

Optimization of a thermal Brownian Motor — •Florian Berger, Tim Schmiedl, and Udo Seifert — II. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart

Since the introduction by Feynman, thermal Brownian ratchets have served as a model for a microscopic engine in a thermal environment. Following this route, we consider the motion of an overdamped Brownian particle in a periodic potential, which is divided into two regions with different temperatures T_1 and T_2. Within these two thermal environments the stochastic movement of the particle is influenced by different noise. This fact can be used to obtain a net flux in one direction for a properly chosen potential. By attaching a load to the particle we construct a heat engine that operates between the two heat baths. The dependency of the flux on the potential evokes the question: What is the optimal shape of the potential that maximizes the flux and thus the power of the engine for a given load? We calculate optimal shapes of the potential for different choices of model parameters like ratio of the two temperatures, length of the two regions and load.

BP 7.25 Mon 17:00 Poster A

Contraction waves in chains of spontaneous oscillating sarcomeres. — •Stefan Günther and Karsten Kruse — Saarland University, Theoretical Physics Department, Saarbrücken

Sarcomeres are the elementary force generating elements of skeletal muscle and consist of a regular arrangement of myosin motors and actin filaments. Under appropriate conditions, sarcomeres have been found to oscillate spontaneously [1]. Chains of sarcomeres show spontaneous contraction waves [2] displaying complex dynamics. We have proposed a microscopic model of sarcomere dynamics, which generates spontaneous oscillations resulting from force-dependent motor detachment rates [3]. By rigidly coupling several sarcomeric elements into a linear chain, non-trivial wave solutions emerge. With parameters deduced from single molecule experiments, we find wave solutions in quantitative agreement with experiments. Furthermore, we find spontaneous nucleation and annihilation of waves as reported, for example, in [2].

[1] Yasuda, Shindo, and Ishiwata, Biophys. J. 70 (1996)
[2] Sasaki et al, J. Muscle Res. Cell Motil. 26 (2005)
[3] Guenther, and Kruse, NJP in press

BP 7.26 Mon 17:00 Poster A

Manipulation of biological filaments by electric fields — •Christoph Wigge[1], Horst Hinssen[2], and Simone Herth[1] — [1]Thin Films and Nanostructures, Faculty of Physics, Bielefeld University — [2]Biochemical Cell Biology, Faculty of Biology, Bielefeld University

The induced alignment of biological filaments on surfaces has the potential to provide controllable geometries for lab on a chip like structures. Actin with a diameter of 7-8 nm and microtubules with a diameter of 25 nm were chosen to study filamentous structures of different size ranges. Both types of supramolecular aggregates show polarity and can be manipulated with electric fields. Many of the earlier experiments were performed as gliding assays, where the surfaces were structured and coated with the motor proteins. In this work, the so called bead geometry is used in which filaments are structured on different surfaces and motor proteins glide on these filaments transporting cargos. This approach has the advantage that not only biological filaments but also inorganic cargos, such as magnetic nanoparticles can be transported and manipulated. In this project biological filaments are manipulated on a chip by applied electrical fields. The alignment process is controlled by light microscopy, scanning electronmicroscopy (SEM) and atomic force microscopy (AFM). The goal of this project is to create a "Y"-structure made of biological filaments, which allows magnetic nanoparticles loaded with motor proteins to be separated using magnetic fields.

BP 7.27 Mon 17:00 Poster A

Superdiffusive motion with fractional power-law exponents in cytoskeleton-bound microbeads — •Max Sajitz-Hermstein, Claus Metzner, Raupach Carina, and Fabry Ben — Department Of Physics, University of Erlangen, Germany

The spontaneous random motion of microbeads bound to the cytoskeletal (CSK) network of living cells is a non-Brownian process [1]. The mean-squared-displacement (MSD) of the bead as a function of lag time shows a sub-to-superdiffusive transition that arises from the interplay of uncorrelated noise, dominating at short time scales, and persistent traction forces, dominating at longer times scales [2]. However, the fractional powerlaw exponent of the superdiffusive bead motion in the range from 1-2 is unexplained. We propose an analytical model for the CSK dynamics that accounts for superdiffusive behavior with fractional power-law exponents. The CSK is described as a network of elastic springs (stress fibers) undergoing gradual changes of rest length and stiffness due to ATP-driven processes. In addition, new fibers emerge spontaneously, generating an increasing and finally saturating prestress, which is coupled to the reinforcement of focal adhesions. The fiber growth is catalyzed by enzymes which constitute a limited, shared resource of the cell. We demonstrate that superdiffusion with a fractional powerlaw exponent arises naturally by a multiplicative noise process. Our model accounts quantitatively for the MSD data. [1] C. Raupach et al., Phys. Rev. E 76, 011918 (2007) [2] C. Metzner et al., Phys. Rev. E 76, 021925 (2007)

BP 7.28 Mon 17:00 Poster A

Mechanosensitive pattern formation in active cytoskeletal networks — •Volker Schaller[1], Ronny Peter[1], Falko Ziebert[2], and Walter Zimmermann[1] — [1]Theoretische Physik I, Universität Bayreuth, 95440 Bayreuth, Germany — [2]Materials Science Division, Argonne National Laboratory, 9700 S Cass Avenue, Argonne, IL 60439, USA

We present a one-dimensional model combining two of the main features of active biopolymer solutions, namely the molecular motor driven active transport of filaments and the (visco-)elastic properties of filament networks held together by crosslinkers or entanglement effects.

It is shown that the pattern forming mechanisms, associated to the motor-mediated transport of filaments, are substantially altered if coupled to a filament network: in case of a permanent network, the long-range clustering of filaments changes either to stationary periodic filament density patterning or to propagating pulses. However if the network is viscoelastic, molecular motor activity can lead to traveling or standing filament density waves[1].

Moreover we investigate the mechanosensivity of pattern formation and the contractive behavior of the network.

[1]R. Peter and V. Schaller and F. Ziebert and W. Zimmermann; *Pattern formation in active cytoskeletal networks*, Submitted to: New J. Phys.

BP 7.29 Mon 17:00 Poster A

Functional and structural characterisation of plasmodium falciparum actin-I — •Stefan Schmitz, Munira Grainger, Iwan A.T. Schaap, Simone Harder, Irene T. Ling, Antony A. Holder, and Claudia Veigel — National Institute for Medical Research, London, UK

A novel form of acto-myosin regulation has recently been proposed in which the polymerization of actin filaments regulates various types of apicomplexan motility, including parasite invasion of malaria merozoites into red blood cells of the mammalian host. Although it is difficult to visualize filamentous actin within the parasite, we found that actin is one of the most abundant proteins in the merozoite stage of the Plasmodium falciparum life cycle and that monomeric actin extracted from merozoites could be polymerized in the presence of F-actin stabilizing drugs rhodamine-phalloidin or jasplakinolide. In in-vitro motility assays, the average filament velocity of malaria F-actin over rabbit myosin subfragment HMM was indistinguishable from that of rabbit skeletal actin. However, malaria actin filaments polymerized in presence of rhodamine-phalloidin appeared spot-like in fluorescence microscopy, while rabbit skeletal actin prepared under similar conditions had the usual length of several micrometers. Using electron microscopy we found that Malaria actin filaments were on average only about 100 nm long. In order to resolve structural differences between mammalian and malaria F-actin we investigated both forms using atomic force microscopy and negative stain electron microscopy.

BP 7.30 Mon 17:00 Poster A

In vitro assembly and characterization of keratin intermediate filaments — •Anke Leitner[1], Katrin Hübner[1], Othmar Marti[1], Harald Herrmann[2], and Tatjana Wedig[2] — [1]Ulm University, Institute Of Experimental Physics, Germany — [2]Division of Molecular Genetics, German Cancer Research Center Heidelberg, Germany

The aim of this work is to compare the properties of in vitro assembled keratin intermediate filaments with those of authentic keratin cytoskeletons. We will show the details of the assembly process of the keratin filaments. In a first step the recombinant keratin 8/18 dimers assemble into tetramers. In the second step the tetramers form unit length filaments (ULF). In a third step, the ULFs longitudinally anneal into loosely packed filaments and radially compact into mature intermediate filaments. The properties of the assembled filaments are investigated by means of atomic force microscope (AFM) and photonic force microscope (PFM) and are compared to those of cytoskeletons prepared from cultured human pancreatic cancer cells (line Panc 1).

BP 7.31 Mon 17:00 Poster A

Linear and nonlinear laser-trapping microrheology — Daisuke Mizuno[1] and •Christoph F. Schmidt[2] — [1]Kyushu University, Fukuoka, Japan — [2]Georg-August-Universität, Göttingen, Germany

We have developed a high-bandwidth technique for active 2-particle microrheology (AMR) with which we can probe linear and nonlinear responses of soft materials. Micron-sized colloidal probe particles are driven by an oscillating optical trap, and the resulting correlated motions of neighboring particles are detected by laser interferometry. Lock-in detection at the driving frequency and at its second harmonic makes it possible to measure the linear and the non-linear response of the embedding medium at the same time. We demonstrate the sensitivity of the method by detecting a second-harmonic response in water which is of purely geometric origin and which can be fully understood within linear hydrodynamics.

BP 7.32 Mon 17:00 Poster A

High-resolution probing of active cellular traction forces — Daisuke Mizuno[1], Rommel Bacabac[2], Catherine Tardin[2], David Head[3], and •Christoph F. Schmidt[4] — [1]Kyushu University, Fukuoka, Japan — [2]Vrije Universiteit, Amsterdam, The Netherlands — [3]University of Tokyo, Tokyo, Japan — [4]Georg-August-Universität, Göttingen, Germany

Living cells mechanically probe their environment, which can consist of an extracellular matrix to which they adhere or of other cells. The response of the environment directly affects internal regulatory processes. In this study, we have quantitated the active traction force of mechano-sensitive osteocyte-like cells (MLO-Y4) in a simple suspended geometry with a pair of optical traps of adjustable stiffness. By alternatingly actively probing the cells with an oscillating force and passively observing shape fluctuations, we could detect forces generated by the cells and at the same time follow the change of their mechanical properties. We found that intracellularly generated force was more efficiently transmitted to the sites of adhesion between the cell and the probes when the traps were stiffer than the cell. We propose that cells sense the elastic response of their surroundings by using their own stiffness as a reference.

BP 7.33 Mon 17:00 Poster A

Transport through OmpF channels simulated using molecular dynamics — •Soroosh Pezeshki, Catalin Chimerel, Mathias Winterhalter, and Ulrich Kleinekathöfer — Jacobs University Bremen, Campus Ring 1, 28759 Bremen, Germany

Ion transport through the outer membrane porin (OmpF) of E. Coli is simulated using all atom molecular dynamic simulations. The temperature dependence of the conductance is determined at different salt concentrations and the results are compared to experimental measurements. The agreement between experiment and simulations is very reasonable. Using the atomistic details obtained from the simulations, it is possible to analyze the behavior of the pore and ions during the simulations. Here special attention was put on ion pairing. Furthermore, constraining part of the pore in the simulations can change the conductivity drastically. This allows to draw conclusions about the influence of different parts of the pore (e.g. the beta barrels, the loops, etc.) on the current.

BP 7.34 Mon 17:00 Poster A

Localized heating effects in optical tweezers investigated us-

ing ionic currents through nanopores — •Jan Henning Peters and Ulrich Felix Keyser — Institut für Experimentelle Physik I, Universität Leipzig

Optical tweezers are a powerful and widely used experimental tool in biological physics including single molecule investigations. The strongly focused laser-beam in such a setup can reach power densities in the order of $10^8 W/cm^2$ that cause significant heating exceeding 10K per Watt of incident laser power for a 1064nm-Laser ([1],[2]). As the reaction constants of biomolecules are temperature dependent, heating effects should be considered in biophysical experiments.

The ionic current through a nanopore depends on the local temperature in a well-defined manner and hence can be used for temperature measurements with high spatial resolution [1]. We compare experiments using nanopores with numerical finite element calculations and investigate the dependence of heating effects on parameters like geometry and thermal conductivity of water and nanopore material. We were able to confirm earlier findings as the logarithmic dependence of the maximal temperature on the size of the system [2] and also gain a more detailed insight into the temperature distribution found in optical tweezers.

[1] U. Keyser, et al., Nano Letters Vol. 5 No. 11 2253-2256
[2] E. Peterman, et al., Biophys. Journal Vol. 84, 1308-1316

BP 7.35 Mon 17:00 Poster A

Simulating an Efflux Pump: Opening the Exit Duct TolC — •Robert Schulz and Ulrich Kleinekathöfer — Jacobs University Bremen, Campus Ring 1, 28759 Bremen,Germany

Bacteria, such as E. coli, use efflux pumps to regulate the permeation of water soluble substances through cell membranes. To allow transport through the outer membrane part of the efflux pump, the so-called TolC, its periplasmic coiled-coil has to be opened [1]. Using all-atom molecular dynamics simulations, including about 200 000 atoms, one is faced with the problem that the conformational changes take place on a timescale far larger than computationally affordable even on today's supercomputers. Hence, it was investigated whether the opening of TolC and several mutants can be forced by applying an electric field and thereby inducing an extra force by the ions that are solvated in the surrounding water. The rate of opening can easily be traced by calculating the distances of the monomers' tails from the trimer's planar center of mass. From the obtained data, ion density, potential maps, and ion currents have been calculated. It is planned to investigate the other constituents of the efflux pump as well.

[1] J. Eswaran, E. Koronakis, M.K. Higgins, C. Hughes, and V. Koronakis, Curr. Op. Struct. Biol. **14**, 741 (2004).

BP 7.36 Mon 17:00 Poster A

Quantum dots as substrates for nuclear-cytoplasmic transport. — •Ulrike Schmitz-Ziffels, Birgit Klaiberg, Jan-Peter Siebrasse, and Ulrich Kubitscheck — Institut für Physikalische und Theoretische Chemie, Wegelerstr. 12, 53115 Bonn

Nuclear-cytoplasmic transport of macromolecules is accomplished by the nuclear pore complex (NPC) - a transport machine imbedded in the nuclear envelope (NE). The NPC enables high selective translocation across the NE, known to be facilitated by the interaction of soluble transport receptors with the NPC's nucleoporins. However, detailed mechanisms and kinetics of the translocation still remain unknown. Single molecule fluorescence microscopy provides a direct observation of processes at the NPC with excellent spatial and time resolution. We use functionalized biocompatible quantum dots as transport substrates to investigate nuclear import in permeabilized cells at the single particle level. As bright and photostable probes, quantum dots yield an excellent localization precision ($<$ 10nm). This is of great importance when tracking the import complex through the approximately 100 nm long NPC. Experiments with NTF2-functionalized quantum dots demonstrated that a specific interaction with the NPC can be achieved. We detected nuclear import of the smallest, green fluorescent quantum dots, yet their fluorescence is not bright enough to yield the required localization precision. The brighter red fluorescent quantum dots on the other hand could not pass the NPC, due to their larger stokes radius. Currently we are focussing on the preparation of smaller red fluorescent substrate-conjugated nanoprobes.

BP 7.37 Mon 17:00 Poster A

Stochastic model for mitochondria transport along the cytoskeleton — •Thomas Sokolowski and Heiko Rieger — Theoretische Physik, Universität des Saarlandes, PF 151150, D-66041 Saarbrücken

Inside an eukaryotic cell mitochondria master a variety of vital tasks: They keep up the production of ATP, thus providing the energetic base for cellular processes, regulate the programmed cell death and act as strongly dynamic Ca^{2+} buffers, just to name a few of its functions. In the last years it became evident that the mitochondria distribution and the Ca^{2+} concentration influence themselves mutually. Based on previous approaches, we develop a stochastic model for the intracellular organelle transport processes including the dynamics of the cytoskeleton and various patterns of transport. We investigate the impact of different cell geometries and the variation of cytoskeleton parameters on the distribution of the mitochondria.

BP 7.38 Mon 17:00 Poster A

Influence of Receptor Mobility and Micropatterning upon Biomembrane Adhesion — •Susanne Fenz[1], Cornelia Monzel[1], Sabine Dieluweit[1], Kheya Sengupta[2], and Rudolf Merkel[1] — [1]Institute of Bio- and Nanosystems 4: Biomechanics, Research Centre Jülich, Germany — [2]CRMC-N (UPR CNRS 7251), Luminy, Marseille, France

The adhesion of cells is a complex process essential for life. It is caused by specific binding between biomolecules that form supramolecular structures at late times. However, the initial steps of cell adhesion, where physical forces dominate, are barely understood. Therefore we developed and quantitatively analyzed a simplified model system. Cell adhesion was mimicked by vesicles, with the specific binding being mediated by the biotin neutravidin complex. Micropatterns of adhesion-competent and repulsive areas were produced by microcontact printing. The adhered vesicle exhibited areas of fluctuating and frozen membrane, corresponding to the underlying pattern. From Reflection Interference Contrast Microscopy (RICM) analysis we obtained the distribution of height fluctuations yielding the potential of interaction. Printed pattern and receptor density were varied systematically. To further investigate the correlation between vesicle adhesion and receptor mobility a supported lipid bilayer was used as substrate. Thus, the lipid coupled receptors were able to diffuse freely. The process of vesicle adhesion was monitored in RICM as well as fluorescence microscopy. We found vesicle adhesion induced distinct protein enrichment in the adhesion disc accompanied by a decrease in diffusivity.

BP 7.39 Mon 17:00 Poster A

Model Membranes under Tension — •Jörg Neder[1], Beate West[2], Friederike Schmid[2], and Peter Nielaba[1] — [1]Department of Physics, University of Konstanz, 78457 Konstanz — [2]Department of Physics, University of Bielefeld, 33615 Bielefeld

Recently O. Lenz and F. Schmid [1] introduced a simple coarse-grained model to study lipid layers and their phase transitions. Using an extension of this model we are investigating the influence of an applied surface tension to a bilayer membrane by Monte Carlo simulations. We recorded pressure profiles and calculated the area per lipid as a function of tension for temperatures ranging from the gel phase to the liquid phase of the system. Another aim of our work is the investigation of lipid-mediated interactions between two anchored cylindrically shaped model proteins. We compared the tensionless state to states with non-vanishing surface tension. Our results indicate that the agglomeration behavior of the model proteins is only weakly influenced by an additional tension. We are also working on semi-grand-canonical simulations [2] of lipid bilayers forming tubular objects and the influence of incorporated model proteins on their properties.

[1] O. Lenz and F. Schmid, *Phys. Rev. Lett.* **98**, 058104 (2007)
[2] F. Schmid, et al., *Comp. Phys. Comm.* **177**, 168 (2007)

BP 7.40 Mon 17:00 Poster A

Lateral diffusion of receptor-ligand bonds in membrane adhesion zones: Effect of thermal membrane roughness — •Heinrich Krobath[1], Gerhard Schütz[2], Reinhard Lipowsky[1], and Thomas Weikl[1] — [1]Max-Planck-Institut für Kolloid- und Grenzflächenforschung, Wissenschaftspark, D-14476 Potsdam-Golm — [2]Johannes-Kepler-Universität Linz, Institut für Biophysik, A-4040 Linz

The adhesion of cells is mediated by membrane receptors that bind to complementary ligands in apposing cell membranes. It is generally assumed that the lateral diffusion of mobile receptor-ligand bonds in membrane-membrane adhesion zones is slower than the diffusion of unbound receptors and ligands. We find that this slowing-down is not only caused by the larger size of the bound receptor-ligand complexes, but also by thermal fluctuations of the membrane shape. We model

two adhering membranes as elastic sheets pinned together by receptor-ligand bonds and study the diffusion of the bonds using Monte Carlo simulations. In our model, the fluctuations reduce the bond diffusion constant in planar membranes by a factor close to 2 in the biologically relevant regime of small bond concentrations.

BP 7.41 Mon 17:00 Poster A

Monte-Carlo simulations of a coarse-grained model for lipid membranes — •Beate West and Friederike Schmid — Fakultät für Physik, Universität Bielefeld, Universitätsstr. 25, 33615 Bielefeld

A simple coarse-grained model for self-assembling lipid membranes is presented. The "lipids" are represented by short linear spring-bead chains, which self-assemble to membranes due to the presence of a computationally cheap "phantom" solvent environment. These membranes may contain "transmembrane proteins", represented by cylinders with diameters corresponding to the diameter of an alpha-helix. The system is studied by Monte Carlo simulations at constant pressure using a parallel code with a newly devised domain decomposition scheme. Pure fluid membranes are characterized in some detail. The pressure profiles and the fluctuation spectra are calculated, and the elastic constants are extracted. Then, the membrane distortions caused by single embedded proteins are determined as a function of the lipid-protein interaction strength. These distortions influence the effective interactions between proteins, which are obtained by determining the protein-protein pair-correlation function with umbrella sampling techniques.

BP 7.42 Mon 17:00 Poster A

Diffusion of single actin filaments bound to cationic model membranes — •Lydia Woiterski, Florian Rückerl, Josef Käs, and Carsten Selle — Universität Leipzig, Physik Weicher Materie, Linnéstr. 5, 04103 Leipzig

Actin is one of major components of the cytoskeleton in eukaryotic cells. The filaments form a quasi-two-dimensional network - the so-called actin cortex that plays an important role for motility and adhesion. It is associated with the inner leaflet of the cell membrane via protein anchors and was suggested to control protein motion. Thus, it is of great interest to elucidate the nature of interaction of polymerized actin and lipid membrane models. In previous work it was reported that binding of filamentous actin to cationic lipid membranes is governed by Coulomb interactions [Sengupta et al. 2006]. Under certain conditions, these liquid membranes show coexistence of ordered and disordered phases. We propose that actin binding can be regulated by the phase state and that preferential binding to one of the coexistent phases occurs due to varied surface charge density. First, the binding process of F-actin is studied using giant vesicles prepared from mixtures of phosphatidylcholine, the cationic lipid DOTAP, and cholesterol that adsorb actin filaments which is monitored by fluorescence microscopy. Secondly, the diffusion of single actin filaments adsorbed to supported bilayers is investigated by single polymer tracking in order to study how the domains confine the lateral motion of the polymer.

[1] Sengupta, K., E.Sackmann, et al. (2006), Langmuir 22(13): 5776.

BP 7.43 Mon 17:00 Poster A

Interactions of nanoparticles and semiflexible polymers with inhomogeneous membranes — Florian Rückerl, Lydia Woiterski, Josef A. Käs, and •Carsten Selle — University of Leipzig, Institute for Experimental Physics I, Linnestraße 5, 04103 Leipzig, Germany

Lateral diffusion within membranes plays a major role in biologically important processes as signal transduction. We present experimental studies on diffusion of proteins within or at a variety of inhomogeneous model membranes where two differently ordered phases coexist. We use Langmuir monolayers, planar supported bilayers and giant unilamellar vesicles as membranes in order to rule out effects of surrounding medium and geometry. The diffusants range from fluorescent spheric nanoparticles to linear semiflexible polymers (f-actin) whose motion is monitored by single-particle or single-polymer tracking. Associated to ordered domains, dimensionally reduced motion was observed for nanoparticle diffusion in monolayers and bilayers. Monte-Carlo simulations demonstrate that model protein diffusion can be strongly affected by both the strength of these interactions and the domain size. We conclude that cellular membranes might use similar mechanisms to adjust two-dimensional diffusion for the control of biochemical reactions within the membrane. Furthermore, we expect that our experiments might contribute to a better understanding of actin-membrane interactions.

BP 7.44 Mon 17:00 Poster A

Characterization of polymer-supported native membranes by X-ray and neutron reflectivity — •Fernanda Rossetti[1], Emanuel Schneck[1], Stefan Kaufmann[1], Murat Tutus[1], Oleg Konovalev[2], Giovanna Fragneto[3], and Motomu Tanaka[1] — [1]Biophysical Chemistry Laboratory II, University of Heidelberg, Germany — [2]European Synchrotron Radiation Facility, Grenoble, France — [3]Institut Laue Langevin, Grenoble, France

Polymer-supported artificial and/or native membranes attract increasing interest as planar models of cell membranes. Immuno-fluorescence labeling experiments have demonstrated that native cells and microsomes can be spread on polymer "cushions" based on ultrathin films of regenerated cellulose. However, structures of such "two-dimensional biological membranes" on the molecular level are still unknown. This poster will present a quantitative study–performed by X-ray and neutron reflectivity measurements at the solid-liquid interface–of structures of bio-membranes on cellulose cushions that mimic the extracellular matrix (ECM). The films are prepared by Langmuir-Blodgett transfer, so that the thickness can be controlled within nm accuracy in the range of ˜ 5-50 nm. It will be shown that the deposition of several types of natural bio-membrane extracts (sarcoplasmic reticulum membranes, human erythrocyte ghosts, HeLa cell membrane extracts) results in a clear change in the global shape of the reflectivity curves for cellulose supports of different thickness. The observed changes coincide with the formation of homogeneous polymer-supported lipid membranes over a macroscopically large area.

BP 7.45 Mon 17:00 Poster A

Micromachined apertures for x-ray structure analysis of free-standing lipid membranes — •André Beerlink and Tim Salditt — Institut für Röntgenphysik, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

A wealth of functional and physiological properties of membranes has been derived from patch clamp and other electrophysiological methods carried out on small membrane patches. At the same time, a wealth of structural information of single and multi-component membranes has been provided by x-ray and neutron scattering techniques, mostly on isotropic suspensions or on planar model bilayers, composed of a controlled lipid/protein composition. The combination of functional and structural studies has to date been rarely achieved. We want to put forward a model system which well developed in membrane electrophysiology, but which was previously not amenable to structural studies, i.e. single freely suspended bilayers spanned in between two separate fluid compartments. To this end, stability and size of the freely suspended membranes must be addressed, and requires new technological tools of sample and aperture preparation. We propose an experimental setup allowing for freely suspended bilayers in aqueous solution spanning a controlled aperture between two compartments (differing in pH, ion concentrations etc.), and amenable to a collimated and focused synchrotron reflectivity experiment beam, as well as to a highly collimated and partially coherent beam for x-ray phase contrast imaging. Such a setup can open the door to a wide range of experiments, probing structure and conductivity simultaneously.

BP 7.46 Mon 17:00 Poster A

Effect of Cholesterol on the Collective Dynamics of Phospholipid Membranes — •Beate Brüning[1,2], Tim Salditt[2], and Maikel C. Rheinstädter[3] — [1]Institut Laue-Langevin, Grenoble, France — [2]Institut für Röntgenphysik, Georg-August Universität Göttingen, Germany — [3]Department of Physics and Astronomy, University of Missouri-Columbia, USA

Phospholipid membranes often serve as simple model systems to understand basic properties of their far more complex biological counterparts. Only recently, the collective short wavelength dynamics in a model membrane system (DMPC), i.e., the corresponding dispersion relation, were investigated by inelastic neutron scattering techniques [1]. The insertion of the membrane-active molecule cholesterol, which is known to regulate membrane fluidity, membrane permeability and the lateral mobility of proteins, is now a first step towards the understanding of coherent dynamics in physiologically relevant membrane systems. While the structure of phospholipid/cholesterol systems is well studied, their short scale dynamics are so far largely unknown. We have studied the influence of cholesterol to the collective short wavelength fluctuations of the phospholipid acyl chains using inelastic neutron scattering. The measurements were carried out with thermal

as well as cold neutrons on the three-axis spectrometers IN12 and IN8 at the high flux reactor of the ILL in Grenoble, France. We were able to determine the dispersion relations within the plane of the membranes in the fluid and in the liquid ordered phase.

[1] M.C. Rheinstädter et al., Phys. Rev. Lett. 93, 108107 (2004).

BP 7.47 Mon 17:00 Poster A

Translational Brownian motion and rotational shape deformations of freely suspended micron-sized phospholipid vesicles — •Christoph Herold, Eugene P. Petrov, and Petra Schwille — Biophysics / BIOTEC, TU Dresden, Tatzberg 47-51, 01307 Dresden

Do shape fluctuations of a body suspended in a viscous fluid affect its translational diffusion coefficient? Theoretical studies [1, 2] predict the effect as large as ∼20%. However, to the best of our knowledge, this prediction has never been challenged experimentally. We carry out video microscopy studies on freely suspended fluorescently labeled giant unilamellar vesicles (GUVs) with radii in the range of $R = 2 - 7\mu$m, both in the tensed state and showing pronounced shape fluctuations ($|\Delta R| / \langle R \rangle \sim 0.1$). In contrast to the predictions [1, 2], we find that vesicles, irrespectively of the presence or absence of shape fluctuations, follow the Einstein−Stokes relation within our experimental uncertainty (2% for the GUV radius and 3% for the diffusion coefficient). In addition, we study the apparent rotational diffusion of undulating vesicles. We find that the rotational diffusion of the principal axis of the gyration tensor of the vesicle image is about two orders of magnitude faster than that of a rigid spherical body and is closely related to the slowest shape relaxation rate of the vesicle.

[1] E. van der Linden *et al.*, Physica A **162**, 99 (1989).
[2] M. Schwartz, G. Frenkel, Phys. Rev. E **65**, 041104 (2002).

BP 7.48 Mon 17:00 Poster A

Specular and Off-Specular Neutron Scattering from Solid-Supported Multilayers of Cell-Surface Model Membranes under Bulk Buffers — •Emanuel Schneck[1], Bruno Demé[2], Christian Gege[3], Richard Schmidt[3], and Motomu Tanaka[1] — [1]Physikalisch-Chemisches Institut, Universität Heidelberg, INF 253, 69120 Heidelberg, Germany — [2]Institut Laue-Langevin, B.P. 156, F-38042 Grenoble Cedex 9, France — [3]Fachbereich Chemie, Universität Konstanz, Fach M 725, D-78457 Konstanz, Germany

Oriented, solid-supported phospholipid membrane multilayers, containing synthetic glycolipids (membrane-anchored Lewis-X oligosaccharides) at various well defined concentrations were studied by specular and off-specular neutron scattering. The samples act as model systems for the study of saccharide mediated inter-membrane interactions, which play key roles in the mechanism of cellular adhesion, a process of outstanding biological importance. Recent in-vitro experiments suggest that membrane-anchored Lewis-X, a basic component of blood group antigens, induces cellular adhesion in the presence of calcium ions. Furthermore, several 2D-NMR studies evidenced that Lewis-X forms homophilic dimers in the presence of calcium ions. A new self-developed liquid cell is used for measurements with bulk buffers at various ion concentrations. The planar sample geometry allows for the identification of out-of-plane and in-plane scattering vector components and offers the possibility to study quantitatively the influence of ions on oligosaccharide-mediated inter-membrane interactions and on membrane bending rigidities.

BP 7.49 Mon 17:00 Poster A

Specular and Off-Specular Neutron Scattering from Solid-Supported Glycolipid Membrane Multilayers — •Emanuel Schneck[1], Florian Rehfeldt[2], Bruno Demé[3], Christian Gege[4], Richard Schmidt[4], and Motomu Tanaka[1] — [1]Physikalisch-Chemisches Institut, Universität Heidelberg, INF 253, 69120 Heidelberg, Germany — [2]Lehrstuhl für Biophysik E22, Technische Universität München, D-85748 Garching, Germany — [3]Institut Laue-Langevin, B.P. 156, F-38042 Grenoble Cedex 9, France — [4]Fachbereich Chemie, Universität Konstanz, Fach M 725, D-78457 Konstanz, Germany

Solid-supported glycolipid membrane multilayers, acting as well-defined model systems for the study of saccharide-mediated inter-membrane interactions, were studied by specular and off-specular neutron scattering. Experiments were carried out at controlled temperatures and humidities, as well as under bulk water using a self-developed liquid cell. Force-distance relationships were recorded by measuring at various osmotic pressures. Mechanical properties of the studied membranes (i.e. bending moduli and inter-membrane compression moduli) were extracted by comparing scattering signals to reciprocal space maps simulated in the framework of smectic crystal theory. The results demonstrate that distinct variations in the oligosaccharide headgroup structures of the glycolipid molecules can result in significant changes in bending modulus and inter-membrane interactions.

BP 7.50 Mon 17:00 Poster A

Pattern formation in membranes due to electrostatic protein-lipid interacion — •Sergio Alonso[1], Karin John[2], and Markus Baer[1] — [1]Physikalisch-Technische Bundesanstalt, Berlin, Germany — [2]Université J. Fourier, Grenoble, France

We study the formation of protein patterns near membranes of living cells by mathematical modelling. The formation of protein domains by electrostatic lipid-protein interactions and the nonequilibrium biochemical reaction cycle of proteins near the membrane give rise to complex dynamics. On the other hand, Calcium is a intracellular signal which controls numerous processes, including the activity of the proteins attached to the membrane. We incorporate the effects of the calcium in a previous model for the dynamics of such proteins in the membrane.

BP 7.51 Mon 17:00 Poster A

X-Ray Investigations on Langmuir and LB Films — •Volker Schön and Patrick Huber — Saarland University, 66123 Saarbrücken, Germany

We present the set up Butterfly X-Ray Reflectometer suitable for the investigation of liquid samples.

We demonstrate it's potential with measurements of OTS/DTS on a silicon substrate and Langmuir films (phospholipid DPhPC and Block Copolymer PFMA-PEO-PFMA (with variable molecular lengths and ratios) as well as mixtures of these components) on an aqueous subphase alongside with a proper subtraction of the subphase bulk scattering background and an accessibiltiy of 7-8 orders of magnitude in reflected intensity.

BP 7.52 Mon 17:00 Poster A

The effect of antibiotic binding to bacterial membrane proteins on drug accummulation — •Tivadar Mach[1], K R Mahendran[1], Andrey Bessonov[1], Enrico Spiga[2], Isabel Sousa[3], Helge Weingart[1], Paula Gameiro dos Santos[3], Matteo Ceccarelli[2], and Mathias Winterhalter[1] — [1]Jacobs University Bremen, Campus Ring 1, 28759 Bremen, Germany — [2]Università di Cagliari, 09042 Monserrato (CA), Italy — [3]Universidade do Porto, Rua do Campo Alegre, 4169-007 Porto, Portugal

One of the main mechanisms through which bacteria exhibit resistance to antimicrobials is reduced drug accummulation. A change in permeability of the bacterial membrane for highly effective hydrophilic drugs can be effected by resistant bacteria through the modification or abscence of certain transmembrane proteins. We investigate the permeation pathways of several b-lactam and fluoroquinolone antibiotics into the bacterial cell by the reconstitution of a single bacterial porin into an artificial planar lipid bilayer, measuring the binding of antibiotic molecules through the time-resolved modulation of a small-ion current. Combining these conductance results with fluorescence spectroscopy, molecular dynamics simulations and Minimum Inhibitory Concentration assays, we conclude that efficiency of permeation for antimicrobials depends strongly on their association constant with bacterial pores, with the binding energy counteracting the loss of free entropy of the antibiotic confinement in the channel - potentially leading the way to new antibiotic design.

BP 7.53 Mon 17:00 Poster A

Artificial Organelles from Giant Unilamellar Vesicles — •Jakob Schweizer and Petra Schwille — Biotec/TU Dresden, Tatzberg 47, 01307 Dresden, Germany

Giant Unilamellar Vesicles (GUV) constituted from lipid bilayers serve as a model system for the minimal cell. However, they are also an ideal tool to synthesize sub-cellular structures in order to mimic intracellular processes. Here we present a way to construct a rudimentary artificial chloroplast from purely biological raw materials using merely three main components: lipids, bacteriorhodopsin and F0F1-ATP synthase. Powered by photon absorption bacteriorhodopsin pumps protons into the vesicle, whereas the F0F1-ATP synthase utilizes the emerging proton gradient to produce ATP. The most crucial step is therefore the reconstitution of the functional proteins into the GUVs in the correct orientation. Establishing an artificial chloroplast can provide further

insight into the evolution of biological chloroplasts. Moreover, these photo-sensitive systems will also serve as miniature power plants, providing the ATP essential for more complicated cellular model systems. Besides protein reconstitution and proteo-GUV formation we want to present methods to proof the protein activity of BR and the ATP-synthase in GUVs.

BP 7.54 Mon 17:00 Poster A

Diffusion of glycosylphosphatidylinositol (GPI)-anchored bovine prion protein (PrPc) in supported lipid membranes studied by single-molecule and complementary ensemble methods. — •Thomas Schubert[1,2], Michael Bärmann[2], Monika Rusp[2], Walter Gränzer[3], and Motomu Tanaka[1,2] — [1]Biophysikalische Chemie II und BIOQUANT, Universität Heidelberg, 69120 Heidelberg, Germany — [2]E22, Technische Universität München, James-Frank-Str, 85748 Garching, Germany — [3]Institut für Tierhygiene, TU München, Weihenstephaner Berg 3, 85354 Freising-Weihenstephan, Germany

In this work bovine cellular bovine prion protein (PrPc) was incorporated in supported lipid membranes and its lateral diffusion was studied by single-dye tracking (SDT) and a complementary ensemble method, fluorescence recovery after photobleaching (FRAP). FRAP results demonstrated very high mobile fractions of up to 94 %, confirming that most of the GPI-anchored PrPc are freely diffusive in the fluid supported membrane matrix. Moreover, the lateral diffusivity of PrPc significantly depends on the pH of the buffer. To complement the ensemble results obtained by FRAP, the statistical variation of lateral diffusion coefficients of individual PrPc molecules in the supported membranes were measured with SDT. Simulation-based statistical analysis indicated that in addition to the expected statistical scatter there is a significant spread of diffusion coefficients. In further experiments, 2D membrane electrophoresis also indicated non-uniform PrPc molecules.