Wednesday, 02.07.2014, Room G 140

Time	ID	Biophysics and Medical Physics I *Chair: Giovanni Dietler, EPFL*
15:00	801	**Dynamics and rheology of active glasses** *Joseph Brader, Thomas Farage, University of Fribourg, Chemin du Musée 3, 1700 Fribourg* We present a simple model for describing dense assemblies of active (self-propelled) spherical colloidal particles. For isotropic suspensions, we demonstrate that the glass transition is shifted to higher volume fraction by the addition of activity, in agreement with recent Brownian dynamics simulations. Activity-induced changes in the static structure factor of the fluid are predicted. The mechanical response of an active glass to applied strain is shown to be softer than the corresponding passive glass; both the nonergodicity parameter and the yield stress reduce with increasing activity.
15:30	802	**Balance of Forces at Play in Phospholipid Self-Assembly: Study of Selected Artificial Phospholipids** *Andreas Zumbuehl, Dep. of Chemistry, University of Fribourg, Chemin du Musée 9, 1700 Fribourg* The modular structure of phospholipids allows for a large variety of biophysical properties. Here, we present a combined effort of organic synthesis and biophysics. Our goal is to alter specific parts of the phospholipid structure and study the effects such changes have on phospholipid mono- and bilayer organization. In particular, we summarize our work on mechanosensitive liposomes. These vesicles are tight in the resting state but release their cargo when submitted to elevated shear stresses. The purely physics-based targeting using mechanosensitive liposomes represents a fresh approach in drug delivery.
15:45	803	**Universality of Behaviour in the Mesoscale Properties of Amyloid Fibrils** *Salvatore Assenza [1], Jozef Adamcik [2], Raffaele Mezzenga [2], Paolo De Los Rios [1]* *[1] Institute of Theoretical Physics, EPFL, 1015 Lausanne* *[2] Institute of Food, Nutrition & Health, ETHZ, Schmelzbergstrasse 9, 8092 Zürich* Amyloid fibrils are ubiquitous proteinaceous aggregates occurring in-vivo and in-vitro, with an invariant structural fingerprint at the molecular length scale. However, interpretation of their mesoscopic architectures is complicated because of diverse observable polymorphic states. We present an original constitutive model based on the minimization of the total energy per fibril and benchmark it on real amyloid fibrils studied by Atomic Force Microscopy. The constitutive model interprets correctly and quantitatively all the main mesoscopic topological features of amyloid fibrils, and establishes the emergence of a universal mesoscopic structural signature of the fibrils predicting a general, parameter-free law for their periodicity.
16:00	804	**Dissecting the immune response at a single-cell level via microfluidics** *Michael Junkin, Alicia Kästli, Savaş Tay* *Department of Biosystems Science and Engineering, ETH Zürich, Mattenstrasse 26, 4058 Basel* Cells inside living organisms function within highly complex and dynamic microenvironments. Lack of knowledge of such environments is a critical roadblock in biology. One way to increase understanding of such environments is by carefully looking at the fundamental unit of biology: the single cell. We have designed microfluidic systems to isolate single cells and conduct repeated non-destructive measurements upon them. We focus on immunity where large health needs remain but are hindered by lack of knowledge concerning complex immune reactions. We used our system to obtain diverse, quantitative measurements in response to dynamic immune stimuli. This has generated large, multiparameter datasets useful for developing predictive models of immune reactions.

16:15	**805**	**Structure and dynamics of thylakoid membrane systems during photosynthesis in vivo - revealed by small-angle neutron scattering (SANS)** *Renáta Ünnep [1], Gergely Nagy [1], Joachim Kohlbrecher [1], Győző Garab [2]* *[1] Paul Scherrer Institute, 5232 Villigen* *[2] Biological Research Centre, Temesvári krt. 62., HU-6726 Szeged* Investigating ultrastructural reorganizations in biological systems in vivo is challenging due to the limited number of suitable non-invasive techniques. Using SANS, which provides statistically and spatially averaged information on the repeat distances (RDs) of multilamellar membranes, we have revealed that the thylakoid membranes in live algal cells and whole leaves undergo small but well discernible RD changes associated with regulation of photosynthesis [1-3]. [1] Nagy G. et al. PNAS(2014) (in press). [2] Ünnep et al. BBA – Bioenergetics doi: 10.1016/j.bbabio.2014.01.017(2014). [3] Ünnep et al. Plant Physiol.Biochem. 10.1016/j.plaphy.2014.02.005(2014).
16:30		***Coffee Break***
Time	**ID**	**Biophysics and Medical Physics II** *Chair: Giovanni Dietler, EPFL*
17:00	**811**	**A mechanical sensor to rapidly determine antibiotic susceptibilities in bacteria.** *Giovanni Longo, Sandor Kasas, Giovanni Dietler* *LPMV - IPSB - EPFL, BSP - Cubotron, 1015 Lausanne* Antibiotics represent one of humanity's most important medical inventions, yet antibiotic resistance has emerged as a very significant health care problem. Suppressing the emergence and propagation of antibiotic-resistant bacteria is a major health issue. Nanomechanical sensors can detect movement of biological samples (from proteins to bacteria or cells) at the nanoscale. I will show how these devices can characterize bacterial resistances very rapidly (minutes, compared to days). I will demonstrate how this system can quantitatively determine, in less than 30 minutes, the antibiogram of bacterial species including slowly-growing microorganisms. Such extremely fast characterizations have been exploited to study Gram(+) (Staphylococcus aureus), Gram(-) (Escherichia coli) species and Mycobacteria.
17:15	**812**	**Three fields study of solvent deuteration influence on the Dynamic Nuclear Polarization process for hyperpolarized ^{13}C MRS and MRI** *Andrea Capozzi [1], Tian Cheng [1], Vincent Breukels [2], Jacques van der Klink [1], Arnaud Comment [1]* *[1] Institute of Physics of Biological Systems, EPFL SB IPSB GR-CO, Station 6, 1015 Lausanne* *[2] Inst. for Molecules and Materials, Radboud University, Geert Grooteplein 26-28, NL-6525 Nijmegen* Hardware as well as the sample composition can have strong effects on the absolute DNP enhancement [1]. In previous studies, it was reported that at 3.35 T, the field at which dissolution-DNP prepolarizers were originally working, deuteration of the glassing solvents of ^{13}C samples doped with nitroxyl radicals approximately doubles the nuclear polarization [2]. In recent years, dissolution-DNP experiments were performed at higher fields, showing that increasing the field yields higher ^{13}C polarization [3]. We show here the first three different fields DNP study demonstrating that complete deuteration does not yield to larger polarization at 7 T in samples prepared with nitroxyl radicals.
17:30	**813**	**Probing nanoparticle-protein complexation by light scattering** *Sandor Balog, Adolphe Merkle Institute, University of Fribourg, Rte de l'Ancienne Papeterie / P.O. Box 209, 1723 Marly 1* There is plenty room in our understanding about how nanoscale objects, e.g. colloidal nanoparticles, interact with living matter. In biological environment the nanoparticle surface is modified by the adsorption of proteins, and the interaction with the outer cell membrane and possible uptake reflects the adsorbed layer, rather than the bare nanoparticle itself. Medium-dependent alteration of nanoparticle properties may directly affect the colloidal stability, cellular uptake, intracellular fate, degradation, and clearance, and therefore, may determine the overall interactions with living matter. We show that light scattering is an excellent technique to characterize fundamental interactions of nanoparticles with proteins.

17:45	**814**	**Polarity, shape, and motion of migrating cells emerge from local protrusion/retraction transitions** *Franck Raynaud [1], Mark Ambühl [1], Ivo Sbalzarini [2], Jean-Jacques Meister [1], Alexander B. Verkhovsky [1]* *[1] Laboratory of Cell Biophysics, EPFL SB IPSB BSP, 1015 Lausanne* *[2] MOSAIC Group, Center for Systems Biology, Max Planck Institute of Molecular Cell, Pfotenhauerstr. 108, DE-01307 Dresden* The ability to break symmetry and move persistently is an essential property of most eukaryotic cells. To date, it is believed that a directional mechanism acts at the whole cell scale to orchestrate the cell edge dynamics. However, this description is limited in that it requires a preceding motion or a strong directional perturbation. We propose a novel principle of self-organization of cell activity: local edge dynamics depend on the distance from the cell center, but not on a global directional mechanism. We show that polarization, persistent migration and shape transformations are emergent properties resulting from the local edge dynamics.
18:00	**815**	**Force-induced globule-coil transition in Laminin Binding Protein and its role for viral – cell membrane fusion** *Sergey Sekatskii [1], Andrey Mikhaylov [1], Giovanni Dietler [1], Fabrizio Benedetti [1], Boris Zaitsev [2], Denis Korneev [2], Valery Loktev [2], Elena Protopopova [2], Pavel Belavin [3]* *[1] Laboratoire de Physique de la Matière Vivante, EPFL , BSP-408, 1015 Lausanne* *[2] Department of Molecular Virology for Flaviviruses and Viral Hepatitis, Vector, RU-630559 Koltsovo, Novosibirsk region* *[3] Institute of Cytology and Genetics Russian AS, Lavrentjev avenue 10, RU-630090 Novosibirsk* We report the results of experiments where we exploit the existence of two very distinct receptor regions in the flaviviral protein E, and different dependencies of the specific interactions involved on pH value, to clarify still unclear details of the flaviviral – cell membrane fusion process. The specific interactions of the pairs laminin binding protein (LBP) – purified Tick-Born Encephalitis Viral surface protein E and certain recombinant fragments of this protein, as well as West Nile Viral surface protein E and certain recombinant fragments of that protein, are studied by combined methods of Single Molecule Dynamic Force Spectroscopy (SDFS), enzyme immunoassay and a biosensor based on optical surface waves measurements.
18:15	**816**	**Co-nonsolvency of PNiPAM at the transition between solvation mechanisms** *Davide Calzolari [1], Irmgard Bischofberger [2], Veronique Trappe [1]* *[1] University of Fribourg, Physics Department, Ch du Musée 3, 1700 Fribourg* *[2] University of Chicago, Physics Department, 929 East 57th Street, 60637 Chicago, USA* We show that the co-nonsolvency of poly-N-isopropyl acrylamide (PNiPAM) in water/alcohol mixtures is to be understood as a transition between two distinct solvation contributions governing the phase behavior of PNiPAM: hydrophobic-hydration is the predominant contribution in the water-rich regime, while the classical mixing contributions are prevailing in the alcohol-rich regime. This is evidenced by distinct scaling relations denoting the energetic state of the aqueous medium as a key parameter for PNiPAM phase-behavior in the water-rich regime, while the volume fractions of water, alcohol and PNiPAM become relevant in the alcohol-rich regime. In the intermediate range of solvent composition, where neither hydrophobic-hydration nor the mixing contributions prevail, PNiPAM is insoluble.
18:30		***END***

821 Second harmonic scattering: Characterizing the interaction between lipid membranes and water

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Dioleoylphosphatidylcholine (DOPC) and Dioleoylphosphatidylserine (DOPS) are the main constituents of mammalian cell membranes. Molecular level understanding of cell membrane architecture often involves supported lipid membranes and invasive methods. We designed a second harmonic scattering (SHS) instrument that allows for investigating the molecular properties of liposome interfaces in aqueous solution, label-free, and substrate independent. Characterizing DOPC:DOPS composed liposomes, we find the water-lipid interaction (which is responsible for the SHS signal) increases up to a mixing ratio of 9:1 and remain unchanged at lower ratios. This value coincides with the saturation value for the mammalian membrane, when spontaneous apoptosis occurs.

822 Dynamics of Relaxation of DNA molecules on the surface: how rapid a 2D equilibrium is achieved

Andrey Mikhaylov, Giovanni Dietler, Justin Notzpekkanen, EPFL-IPSB, BSP, 1015 Lausanne

The process of transition of DNA molecules from three to two dimensions upon deposition onto the surface is studied. This process can result both in a 3D-2D projection and in 2D equilibrium. We demonstrate that the molecules are first attached to the surface keeping three-dimensional statistical distributions and then relax adopting two-dimensional equilibrium. We show that the timescale of such relaxation on mica surface treated with Mg ions is in the order of several minutes.

823 AFM Nanoscale Infrared Spectroscopy: Chemical Characterization at Single Amyloid Molecule Scale

Francesco Simone Ruggeri [1], Thomas Mueller [2], Tuomas Knowles [2], Serena Castro [3], Annalisa Pastore [3], Andrzej Kulik [1], Giovanni Dietler [1]
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[2] University of Cambridge, Department of Chemistry, Lensfield Road, Cambridge, UK
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Amyloids are proteins aggregates related to neurodegenerative disorders. During aggregation, monomeric proteins undergo internal structural rearrangement forming fibrils with a cross beta-sheet structure. Fourier transform infrared spectroscopy (FTIR) is central for studying conformational changes of proteins during fibrillation. Nevertheless, it gives only average information on the process. To investigate the chemical structure of amyloids by FTIR at the nanoscale, we utilized a thermomechanical technique based on Atomic Force Microscopy. We focused on different amyloidogenic proteins: alpha-synuclein, lysozyme and ataxin-3. We were able to acquire their chemically properties, by local spectra acquisition and IR maps, and distinguish within different amyloidogenic structures at the single molecule scale.

824 In vivo Hyperpolarized ^{13}C MRS using DPPH as polarizing agent

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Dissolution dynamic nuclear polarization (DNP) is a method to enhance by up to four orders of magnitude of the in vivo MRI signal allowing real-time imaging of metabolic processes [1,2]. Unpaired electron spins are used to increase the nuclear spin polarization of ^{13}C nuclei located on injectable biomolecules. Using a fast automated radical filtration and a rapid transfer of hyperpolarized ^{13}C molecules, we demonstrated that DPPH can be used to measure [1-^{13}C] pyruvate metabolic processes in vivo in rodent brain.

[1] .Ardenkjaer-Larsen J. H. et al., Proc. Natl. Acad. Sci. USA (2003)
[2]. Eichhorn T. R et al. , Proc. Natl. Acad. Sci. USA (2013)

825

DNA in confined geometry

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DNA is a very important object of study for geneticists and biologists as well as for physicist. It is important to understand the role of topology of DNA in confined geometry, to better understand such processes as DNA migration in nanofluidics devices or DNA compaction in Viral capsids. By combining Microfluidics device with Atomic Force Microscopy technique we were able to directly visualize and measure the effects of confining space on the statistical parameters of DNA. Our method enabled us to separate DNA based on its size and topology, with microfluidics device acting as a topological sieve.

826

Actomyosin bundle tension at the periphery of cell spreading on micropatterned substrate

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Cell shape and cytoskeletal tension are maintained by the activity of myosin II molecular motors and by cell-substrate adhesions. Substrate topology was reported to influence cell spreading, morphology and cell fate. Indeed, when constrained to spread on adhesive micropatterned substrates, cells exhibit reproducible curved actomyosin bundles at the cell periphery on non-adhesive surface and adhesion sites are localized at the adhesive pattern vertices. This suggests that a simple physical energy minimizing process drives cell adhesion considering the tensions within the bundle and along it. We measure these contractile tensions by active and passive mechanical probing and by morphological measurements.

827

Contact angle at the leading edge controls cell protrusion rate

Chiara Gabella [1], Elena Bertseva [1], Céline Bottier [1], Niccolò Piacentini [1], Alicia Bornert [1], Sylvia Jeney [2], Lazlo Forro [2], Ivo F. Sbalzarini [3], Jean-Jacques Meister [1], Alexander B. Verkhovsky [1]
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Membrane tension and pressure generated by actin polymerization are forces believed to define protrusion at the leading edge of migrating cells. Quantitatively, from Laplace's law, resistance to actin protrusion must depend on the geometry of membrane interface. We find that in migrating keratocytes, protrusion rate doesn't correlate with membrane tension, whereas strongly correlates with cell roundness, and that leading edge exhibits pinning on substrate ridges – a phenomenon characteristic of liquid drops. Results indicate that leading edge can be considered a triple interface as defined for liquid droplets, and that front contact angle controls actin polymerization load and cell velocity

828

Advanced microscopy techniques for biological studies

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Ricardo Armenta, University of Fribourg, Chemin du Musee 3, 1700 Fribourg

We employ different techniques, such as Stochastic Optical Reconstruction Microscopy (STORM) and Fluorescence Lifetime Imaging Microscopy (FLIM) to image structures of interest within the brain of the common fruit fly, Drosophila Melanogaster. The two techniques offer unique advantages. STORM allows us to overcome the diffraction limit and image objects ever so small, while FLIM can exploit nanosecond resolution to discern between signal and background.