BP 44: Biotechnology & Bioengineering

Time: Wednesday 15:00–16:45 Location: H45

Invited Talk BP 44.1 Wed 15:00 H45

Physics for the Origins of Life — •Dieter Braun — Systems Biophysics and Center for NanoScience, LMU Muenchen, Amalienstr. 54, D-80799 Munich

The origin of life is located between the astronomy, geology and chemistry of early Earth and biology. Can concepts from physics help to bridge the gap between dead and living matter? Our experiments show that phase transitions, cooperative binding and non-equilibrium couplings can make headway towards understanding a stable replication and selection of the first living genetic molecules.

1. A phase transition of DNA or RNA oligomers into hydrogels is found under non-equilibrium driving. Only molecules with matching gene sequences form one hydrogel. This highly nonlinear phase transition can allow for an unusual, yet robust sequence replicator.

2. The cooperative of joining of three DNA strands implement hypercycle dynamics in sequence space. Besides providing replication under serial dilution and feeding, the hyperexponential growth make majority sequences outcompete minority sequences. By this, diversity is stabilized even under diffusional mixing.

3. Thermal gradients in porous rock implement the thermal cycling required in above experiments. Such a setting can accumulate genetic molecules, enhance their polymerization, encapsulate them by vesicle formation and drive their replication dynamics by thermal convection. The fluid interaction with a continuous feeding flow allow longer strands to outcompete faster growing short strands and drive evolution towards increasing complexity.

BP 44.2 Wed 15:30 H45

Investigation of light harvesting complex LHCBM6 for dye-sensitized solar cells — •Fabian Schmid-Michels[1], Nina Lämmermann[2], Olaf Kruse[2], and Andreas Hütten[1] — [1]Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany — [2]Faculty of Biology, Algae Biotechnology & Bioenergy, Bielefeld University, Germany

Light harvesting complexes (LHC) or antenna complexes participate in photosynthesis by harvesting sunlight and transferring the excitation energy to the reaction centre. By channelling this energy elsewhere it is possible to use LHC either as a dye for dye-sensitized solar cells or as energy harvesters for artificial photosynthesis (AP). Solving this challenge could lead to a more efficient regenerative fuel production. To investigate LHCBM6, dye sensitized solar cells were prepared on ITO glass with the LCHs bound to TiO2 nanoparticles. Different binding types were evaluated by electrical measurements and microscopy (AFM, SEM).

BP 44.3 Wed 15:45 H45

Microscale Thermophoresis to Diagnose alpha1-Antitrypsin Deficiency Disorder in Plasma — •Evgeniia V. Edeleva[1,2], Therese Dau[3], Susanne A.I. Seidel[1], Dieter Jenne[3], and Dieter Braun[1,2] — [1]Systems Biophysics, LMU, Munich, Germany — [2]Quantitative Biosciences Munich (QBM), Munich, Germany — [3]Comprehensive Pneumology Center (CPC), Munich, Germany

Conventional diagnostics of deficiency disorders is often limited to the measurement of concentration, not the affinity of the deficient component. In case of alpha1-antitrypsin (AAT) deficiency disorder, AAT plasma level is low in patients due to the genetic mutation. However, measured concentration of AAT does not correlate with the manifestation of symptoms. We hypothesized that AAT affinity to its target neutrophil elastase is different in plasma of different patients.

We developed a competition assay based on the physical phenomenon of thermophoresis. Our assay assesses the affinity of AAT in addition to its concentration. The measurement is performed directly in the natural milieu of blood plasma. The three-body binding problem is used to fit the experimental data.

The amplitude of thermophoresis correlates with symptoms manifestation in patients. Further measurements suggest a previously unknown component in plasma, capable of modulating the affinity of AAT to the target. Our work highlights the possibility of assay development in the natural environment of blood plasma with thermophoresis with the promise to significantly improve the management of AAT deficiency.

BP 44.4 Wed 16:00 H45

Study of Reaction Networks with High-Throughput Nanoliter Thermophoresis — •Ferdinand Greiss[1], Franziska Kriegel[2], and Dieter Braun[1] — [1]Systems Biophysics, Quantitative Biosciences Munich (QBM), LMU, Munich, Germany — [2]Molecular Biophysics, LMU, Munich, Germany

Quantifying the cooperative effect of protein binding is important and a well-established field in biochemistry. For instance, the binding of oxygen to hemoglobin is a widely known and thoroughly studied case of a positive homotropic binding reaction. This means that oxygen together with other oxygen molecules is binding in a positive cooperative manner. Many biological relevant reaction networks, e.g. transcription factors binding to DNA, include heterotropic binding interactions, both being negative or positive as well as with weak or strong cooperative effects.

We use synthetic DNA constructs as a simplified testbed to study the cooperative effects in heterotropic reaction networks with microscale thermophoresis (MST). All three DNA species have two different binding sites that can only access one partner. The advantage of the assay is that only one species needs to be labeled. The binding reaction network can be studied by independent single-point mutations, both in experiment and by theory.

With a newly designed high-throughput micro-scale thermophoresis setup, we are able to sample the large concentration space in a rapid, robust and user-friendly way.

BP 44.5 Wed 16:15 H45

GALA - A cell penetrating peptide with a trigger — Johannes Franz[1], Denise Schach[1], Will Rock[1], Christoph Globisch[2], Steven Roeters[3], Sander Woutersen[3], Christine Peter[2], Mischa Bonn[1], Sapun Parekh[1], and •Tobias Weidner[1] — [1]MPI für Polyerforschung, Mainz, Germany — [2]Universität Konstanz, Germany — [3]University of Amsterdam, The Netherlands

Cell-penetrating peptides are promising for drug delivery into cells. Since the cell uptake mainly involves endocytic mechanisms, the enclosure of peptides within endosomes is still an unresolved challenge for biomedical applications * the peptide and its cargo are trapped in the *recycling bin* of the cell. The peptide GALA, a viral fusion mimic is triggered by pH, and takes advantage of the decreasing pH during endosome maturation to selectively attack endosomal membranes. Below pH 6, the sequence folds into a helix and disrupts biomembranes. We used surface specific sum frequency generation (SFG) spectroscopy jointly with fluorescence imaging and molecular dynamics simulations to study GALA in action at interfaces. We show that the lipid bilayer radius-of-curvature has a negligible effect on GALA-induced membrane leakage and that GALA remains pH responsive after inserting into a lipid membrane. The peptide can be reversibly *switched* between its inactive and active states after incorporation into the hydrophobic environment of lipid membranes, even after substantially interacting with lipid chains. GALA-based delivery is a potentially safe, effective route towards effective endosomal escape strategies. JACS 137, 12199*12202 (2015); ChemComm 51, 273-275 (2015); JCP 141, 22D517 (2014).

BP 44.6 Wed 16:30 H45

Compact helical antenna for smart implant applications — •Dmitriy Karnaushenko, Daniil Karnaushenko, Denys Makarov, and Oliver G. Schmidt — Institute for Integrative Nanosciences, IFW Dresden, Helmholtzstraße 20, Dresden, 01069 Germany

Smart implants are envisioned to monitor bioprocesses in the human body. Hence, their compactness is highly desirable to minimize discomfort during and after the implantation. If the length of the device is about 5 mm and the diameter less than 0.5 mm, it can be implanted using standard medical syringes. In this spirit, electronic devices self-assembled into compact tubular architectures[1] possess the desired dimensions and reveal biosensory capabilities[2] or can be used as neuro-interfaces[3]. Integration of antennas into self-assembled devices will allow remote implant monitoring, drug release or stimulation of biological tissues. In this work, a self-assembled helical antenna operating in the ISM radio band is presented[4]. Our novel material platform permits fabrication of antennas with operation frequencies at 2.4 GHz with a total length of only 5.5 mm. To tune the resonance fre-

quency, the helical antenna is encapsulated with a dielectric material. Moreover, the revealed communication between the helical antenna and a smartphone highlights the potential of this technology for medical applications. [1] O. G. Schmidt et al., Nature 2001, 410, 168. [2] C. S. Martinez-Cisneros et al., Nano Lett. 2014, 14, 2219. [3] D. Karnaushenko et al., Adv. Mater. 2015, DOI 10.1002/adma.201503696. [4] D. D. Karnaushenko et al., NPG Asia Mater. 2015, 7, e188.