MA 17: SKM Dissertation Prize

Time: Tuesday 10:30–12:30 Location: TRE Ma

Invited Talk MA 17.1 Tue 10:30 TRE Ma

Chemotaxis of Sperm Cells: A generic principle for robust chemo-navigation along helical paths — •Benjamin M. Friedrich — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — Weizmann Institute of Science, Rehovot, Israel

Directed motion of biological cells in response to external cues requires coordination of cell sensation and cell motility. I discuss this interplay in the context of sperm chemotaxis and characterize a novel and universal navigation strategy. Sperm cells propel themselves in a liquid by regular bending waves of their whip-like flagellum. They can detect water-borne chemical cues released from the egg and steer their swimming paths upwards a concentration gradient. Detection of a gradient relies on temporal sampling of the concentration field along circular and helical swimming paths. I present a theoretical description of this navigation strategy and prove its robustness with respect to parameter variability and input noise. Robustness is crucial for reliable biological function and input noise might have been an evolutionary driving force in selecting cellular navigation strategies. The theory bridges the gap between experimentally well-characterized sperm chemotaxis in confined experimental geometries along circular paths and the biologically relevant case of unrestricted swimming along helical paths.

Invited Talk MA 17.2 Tue 11:00 TRE Ma

Photonic structures inspired by nature — •Mathias Kolle[1,3], Heather Whitney[2], Maik Scherer[3], Pedro Cunha[3], Moritz Kreysing[3], Jeremy Baumberg[3], and Ullrich Steiner[3] — [1]School of Engineering and Applied Sciences, Harvard University, Cambridge, US — [2]School of Biological Sciences, University of Bristol, Bristol, UK — [3]Cavendish Laboratory, University of Cambridge, Cambridge, UK

Biomimetic and bio-inspired efforts to produce novel photonic structures have attracted increasing research interest in recent years. Nature offers an enormous diversity of multifunctional micro- and nanostructures that induce outstanding, distinctive, dynamic coloration and high reflectivity. Various intriguing photonic structures have been identified on the wing cases of beetles, the scales of butterflies, the feathers of birds, in the shells of marine animals and also on the petals of flowering plants. Flora and fauna provide a huge reservoir of blue-prints for novel artificial optical materials and photonic systems. Here, we present a study of floral diffraction elements that provide a visual cue for pollinators, the development of mechanically tunable bio-inspired planar photonic elements and the artificial mimicry of the photonic structure found on the wing scales of the Indonesian butterfly *Papilio blumei*. State-of-the-art optical characterization by microspectroscopy and spectro-goniometry and optical modeling, including FDTD simulations, provide understanding of the working principles of the natural photonic elements. Artificially controlled self-assembly combined with alternative nanofabrication techniques is used in the development of the bio-inspired optical systems.

Invited Talk MA 17.3 Tue 11:30 TRE Ma

Playing with Nano-LEGO: Self-Assembly of Patchy Particles — •Daniela Kraft — Van 't Hoff Laboratory for Physical and Colloid Chemistry, Debye Institute for NanoMaterials Sciences, Utrecht University, Utrecht, The Netherlands

Self-assembly of colloidal particles into larger structures bears potential for creating materials with unprecedented properties, such as full photonic band gaps in the visible spectrum. For such self-assembly, uniform colloids are quite limited as building blocks since their shape is the only control parameter. Much more promising in this respect are colloids with site-specific attractions. However, so far such 'patchy' colloids have only been studied *in computero* as their attainment in the laboratory has proven to be quite a challenge. Here we report two novel experimental realizations of patchy particles, focusing in particular on the simplest case of colloids with one patch only. These building blocks are used to built up new colloidal structures in solution, analogous to a 'Nano-LEGO'. The intriguing similarities between the obtained colloidal assemblies and models for molecules or surfactant micelles are discussed. We quantify the latter by employing a theoretical micelle model and compare our results to Monte Carlo and Molecular Dynamics simulations.

Invited Talk MA 17.4 Tue 12:00 TRE Ma

Controlling Excitons: Concepts for Phosphorescent Organic LEDs at High Brightness — •Sebastian Reineke — TU Dresden, Institut für Angewandte Photophysik, Dresden, Germany

Organic light-emitting diodes (OLEDs) attract much attention being a promising, energy-efficient technology with high color quality for display and lighting applications. Phosphorescence emitting materials prove to be inevitable because they can convert electrons into photons with an efficiency of one. Owing their comparably long exciton lifetime, non-linearities at high excitation levels noticeably reduce the emission efficiency (efficiency roll-off).[1] Thus, especially the understanding and optimization of OLEDs (monochrome and white) at high, application-relevant brightness – typically a few thousand candela per square meter – are of high interest.

This contribution starts with a discussion of triplet-triplet annihilation (TTA) – the process that dominates the roll-off – in an efficient phosphorescent system.[2] The results reveal that the nano-composition of the mixed film, where emitter molecules form aggregates, strongly decreases the high brightness efficiency. Based on these results, concepts for phosphorescent OLEDs will be introduced that show improved performance. Approaches to reduce TTA by altering the emission layer design as well as concepts for improved light-outcoupling will be discussed both for monochrome and white OLEDs.[2]

[1] M. A. Baldo *et al.*, Phys. Rev. B **62**, 10967 (2000).

[2] S. Reineke *et al.*, Appl. Phys. Lett. **91**, 123508 (2007) and **94**, 163305 (2009); Nature **459**, 234 (2009); Adv. Mater. **22**, 3189 (2010).