Working Group "Young DPG"
Arbeitskreis junge DPG (AKjDPG)

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This year, there will be three PhD Focus Sessions. While this opportunity for PhD students to organise their own session at the SKM Meeting is already well established in MA, there will be this year for the first time such sessions in DS/HL and SOE/DY/BP.

During the lunch breaks, several lunch talks offer opportunities and carrier paths both inside and outside academia. On Wednesday, the industry day offer deeper insights into artificial intelligence.

As usual, we also offer the opportunity to ease the hard scientific program and to learn about interesting topics in the atmosphere of the traditional EinsteinSlam. Slammers will have the possibility to present physical topics and to convince the audience that they are the right person to own the Golden Albert.

Lunch Talks

PSV I	Mon	13:15–13:45	H2	**Physik im Patentwesen und anderen Feldern außerhalb der Forschung** — •Michael Schramm
PSV II	Mon	13:15–13:45	H15	**A career in science: Should I stay or should I go?** — •Martin Wolf
PSV III	Tue	13:15–13:45	H2	**Berufseinstieg als Physikerin im R&D Bereich bei Infineon Technologies AG** — •Alexandra Bausch
PSV IV	Tue	13:15–14:00	H15	**Getting your research funded by the DFG - formal and informal aspects** — •Michael Mössle, Manfred Bayer
PSV V	Wed	13:15–13:45	H2	**Still close to academia: the job as an editor at the Nature Research Group** — •Tobias Rödel, Benjamin Heinrich, Konstantin Hirsch
PSV VI	Wed	13:15–14:00	H15	**"Go public!" (Wie) wollen wir Wissenschaft kommunizieren?** — •Axel Lorke, Nicolas Wöhrl
PSV VII	Thu	13:15–13:45	H2	**Als Physiker in der Automobilelektronik** — •Thomas Riepl
PSV VIII	Thu	13:15–14:00	H15	**Being a PhD Candidate in Physics** — •Erich Runge, Rima X. Schüssler, Philipp Jäger

Sessions

AKjDPG 1.1–1.9	Tue	9:30–13:15	H32	**PhD Focus Session: Photoluminescence of halide perovskites: What does it tell us and what not? (joint session DS/AKjDPG/HL)**
AKjDPG 2.1–2.4	Wed	9:30–12:40	H38	**PhD Focus Session: Biogenic spin phenomena (joint session MA/AKjDPG)**
AKjDPG 3.1–3.8	Thu	15:00–18:45	H17	**PhD Focus Session: Theory of Stochastic Processes with Applications in Biology (joint session SOE/BP/DY/AKjDPG)**

AKjDPG 1: PhD Focus Session: Photoluminescence of halide perovskites: What does it tell us and what not? (joint session DS/AKjDPG/HL)

Perovskite Solar Cells (PSCs) have recently emerged as a new research field due to their rapid increase in power conversion efficiency. Many research groups formerly working in other fields such as in DSSC, organic solar cells and thin film solar cells, quantum dots, single molecules have jointly created a new research field. Photoluminescence spectroscopy is a technique used rather widely in all of these fields as a simple standard method. Applying specific models and theory, photoluminescence can however be converted into an advanced characterization technique. The models and analysis tools used for this have been unique to the specific fields so far and now tend to collide when PSCs are measured and analysed.

This symposium therefore aims to give a brief overview of advanced models and analysis tools which allow a more nuanced interpretation of photoluminescence emission of perovskite solar cell materials. In a mix of introductory talks, invited expert talks and contributed talks we will explore how certain models have been used to analyse PSCs and argue why and under what conditions a certain model can or cannot be applied to perovskite solar cells.

Organizers:

- Juliane Borchert, Clarendon Laboratory, Department of Physics, University of Oxford, Parks Road, Oxford OX1 3PU, United Kingdom
- Klara Suchan, Lund University, Kemicentrum, Naturvetarvägen 16, 22362 Lund, Sweden
- Tobias Seewald, Department of Physics, University of Konstanz, Universitätsstr. 10, 78457 Konstanz, Germany

Time: Tuesday 9:30–13:15 Location: H32

Invited Talk AKjDPG 1.1 Tue 9:30 H32

Photoluminescence Analysis of Thin Films: What can it tell us about (Perovskite) Solar Cells? — •Thomas Unold — Helmholtz-Zentrum Berlin für Materialien und Energy

Photoluminescence analysis has been an important analytical tool in semiconductor characterization, and depending on the experimental conditions can reveal detailed information about various optical and electronic properties such as radiative recombination, non-radiative recombination, defects, carrier trapping and the quasi-Fermi level splitting[1-4]. The technique can be applied to thin films as well as to complete solar cell devices, but may require additional analysis to consider the presence of either free surfaces or built-in electrical fields, additional recombination processes as well as partial charge extraction. In the ideal case different types of luminescence measurements yield a consistent picture of the material properties and the limitations of device performance. Different aspects of such photoluminescence analyses will discused with a special focus on how results obtained on (hybrid) perosvkites comply with the state-of-the-art knowledge on more common inorganic semiconductor materials. [1] T. Unold, L. Gütay, in Advanced Characterization Techniques for Thin Film Solar Cells, Wiley VCH (2011) 151-175. doi.org/10.1002/9783527636280.ch7 [2] F. Staub et al., Phys. Review Applied 6 (2016) 044017 [3] C. Hages et al., Adv. Energy Mater. 7(2017) 1700167 [4] M. Stolterfoht et al., Nature Energy 3 (2018) 847.

AKjDPG 1.2 Tue 10:00 H32

In-situ film formation studies of metal-halide perovskite layers — •Katrin Hirselandt[1,2], Rahim Munir[1], Florian Mathies[1], Aboma Merdasa[1], Emil J. W. List-Kratochvil[2], and Eva Unger[1,2] — [1]Helmholtz-Zentrum Berlin für Materialien und Energie, Kekuléstraße 5, 12489 Berlin, Germany — [2]Institut für Physik, Institut für Chemie & IRIS Adlershof, Humboldt-Universität zu Berlin, Brook-Taylor-Str. 6, 12489 Berlin, Germany

By optimizing the perovskite fabrication process during spin-coating by introduction of complex solvent blends and quenching steps, solar cells with power conversion efficiencies above 22% have been realized on small active areas. Reproducing published fabrication procedures is not trivial as process conditions vary from place to place and adapting methodologies developed for small-area devices based on spin-coating to larger area devices even less so. Understanding the film formation during different stages of processing allows for a more rational approach to translate deposition strategies to scalable processing methods.

In this study we compared the temporal evolution of MAPbI3 and Cs0.05(FA0.83MA0.17)0.95Pb(I0.83Br0.17)3 (3CAT) covered substrates during spin-coating using a fibre-optic based photoluminescence and reflection spectroscopy setup. Varying the time of a crystallization-inducing anti-solvent drip, we identified a much narrower process window for MAPbI3, compared to 3CAT corroborated with scanning electron microscope images of annealed samples. We here present insight into the difference in crystallization kinetics of these different standard formulations for perovskite processing.

Invited Talk AKjDPG 1.3 Tue 10:15 H32

Defect activity in lead halide perovskite semiconductors — •Silvia Motti — Clarendon Laboratory, Department of Physics, University of Oxford, Parks Road, OX1 3PU, Oxford, United Kingdom

Perovskite semiconductors have recently emerged as promising materials for optoelectronic applications, with photovoltaic efficiencies that have now reached over 23%. Great research effort has been employed towards understanding how the perovskite crystalline and electronic structure relates to their remarkable defect tolerance and surprisingly long carrier lifetimes and high open circuit voltages. At the same time, the material instability often interferes with experimental observations, besides posing a major challenge for commercial application. A comprehensive investigation of defect activity in lead halide semiconductors was conducted by combining computational studies with experimental evidences from optical spectroscopy. It was possible to identify the most predominant charge-trapping point defects in MAPbBr3 and MAPbI3 and their role in recombination dynamics, explaining the defect tolerance in these semiconductors. Moreover, the reactivity of such defects under external stimuli could be associated with the photoinstabilities observed in these materials, allowing for the development of successful strategies to control them. This understanding opens the possibility of developing intelligent fabrication methods and further optimizing performance and stability of perovskite optoelectronic devices.

AKjDPG 1.4 Tue 10:45 H32

The impact of lead iodide on the recombination kinetics in metal halide perovskites — •Aboma Merdasa[1], Alexandros Kiligaridis[2], Carolin Rehermann[1], Mojtaba Abdi-Jalebi[3], Jonas Stöber[2], Boris Louis[2], Marina Gerhard[2], Samuel D. Stranks[3], Eva L. Unger[1,2], and Ivan G. Scheblykin[2] — [1]Young Investigator Group Hybrid Materials Formation and Scaling, Helmholtz-Zentrum Berlin für Materialen und Energie, Berlin, Germany — [2]Chemical Physics and NanoLund, Lund University, Lund, Sweden. — [3]Cavendish Laboratory, Department of Physics, University of Cambridge, Cambridge, United Kingdom.

Metal halide perovskites are promising semiconductor materials for photovoltaic devices with solar cell efficiencies soaring over 20%, but understanding the fundamental operational principles are lagging behind. One example is the role and influence of lead iodide (PbI2) reportedly being both beneficial and detrimental for a device. Herein, we present a study on the impact of lead iodide on the charge-carrier recombination kinetics in methylammonium lead triiodide (MAPbI3) thin films. We simultaneously acquire spectrally-resolved photoluminescence quantum yield and time-resolved photoluminescence lifetime at excitation wavelengths ranging from 450 nm to 780 nm during hours of light-soaking, and identify a unique radiative recombination mechanism occurring at the PbI2/MAPbI3 interface when charge carriers are generated in PbI2. We thereby provide important insight into the long-debated question of whether excess PbI2 is beneficial or detrimental for charge carrier dynamics in perovskite solar absorber materials.

15 min. break

Invited Talk AKjDPG 1.5 Tue 11:15 H32

Beyond traditional use of photoluminescence: Assessing halide perovskites quantitatively and qualitatively — •Carolin Sutter-Fella — Lawrence Berkeley National Laboratory, Berkeley, California, US

Hybrid metal halide perovskites have recently transformed the landscape of light harvesting solar energy materials while showing promise in a range of other optoelectronic applications. These materials do not only show exceptional optoelectronic properties and apparent defect tolerance but are also easy to synthesize via solution processing. Nevertheless, there are non-radiative recombination losses which have to be characterized and ideally tied back to synthesis conditions.

In the first part of this talk I will cover our work on quantitative photoluminescence quantum yield measurements under variation of the halide as well as cation. This quantity will be related to the device relevant open circuit voltage (Voc) by comparing the electrically measured Voc to the optically implied Voc. In the second part I will show how in situ photoluminescence spectroscopy can be used to monitor perovskite film and nanoparticle formation. I will reveal the onset of semiconducting properties during synthesis and the correlation to other material characteristics such as morphology and crystal phase. The work provides guidance to a fast screening of the synthetic parameter space and ultimately controlled experimental procedures that yield high device efficiencies.

AKjDPG 1.6 Tue 11:45 H32

Temperature dependent charge carrier transport in MAPI single crystal thin films — •Alexander Biewald[1], Richard Ciesielski[1], Nadja Giesbrecht[1], Kathrin Handloser[1], Pablo Docampo[2], Thomas Bein[1], and Achim Hartschuh[1] — [1]Department Chemie und (CeNS), LMU München, Deutschland — [2]School of Electrical and Electronic Engineering, Newcastle, UK

Methylammonium lead iodide (MAPI)-based thin-film solar cells today reach power conversion efficiencies of more than 20 % [1]. The material is prototypical for the large class of perovskite semiconductor materials for photovoltaic applications and is therefore at the focal point of research interest to a global community. Here, we present an all-optical study of the charge carrier diffusion properties in large-crystal MAPI thin films using photoluminescence microscopy [2]. We vary the temperature between 170 K and room temperature, thus remaining in the tetragonal crystal phase [2]. We probe the local material properties of individual crystal grains within a PMMA-coated MAPI thin film and find a steady increase of the diffusion constant towards lower temperatures. In a previous paper we found that grain boundaries in such thin films act as solid walls for diffusing charge carriers [2], which we also see at low temperatures.

[1] M. A. Green, et al., Solar cell efficiency tables (version 52), 2018.
[2] R. Ciesielski, et al., ACS Appl. Mat. & Interfaces. 10 (9), 7974-7981 (2018).
[3] N.O. Yamamuro, et al., J. Phys. Chem. Solids 53 (7), 935-939 (1992).

Invited Talk AKjDPG 1.7 Tue 12:00 H32

Photophysics of Sn-based hybrid perovskites — •Maria Antonietta Loi — Zernike Institute for Advanced Materials, University of Groningen, Groningen, The Netherlands

Thanks to the intensive research efforts of a large scientific community over the past years, lead (Pb)-based hybrid perovskite solar cells have reached impressive (>23%) power conversion efficiency. Against the initial criticism about their instability, also large improvements in the thermal and photo stability of this kind of solar cells were obtained in the last years. Despite these outstanding accomplishments, the toxicity of lead causes concerns about the possible large-scale utilization of this new type of solar cell. Among the various alternatives to lead, Sn has been recognized to have a great potential, as the Sn-based hybrid perovskites display excellent optical and electrical properties such as high absorption coefficients, very small exciton binding energies and high charge carrier mobilities. Recently solar cells with efficiencies approaching 10% have been reported. In my presentation I will report about important features of the photophysical properties of formamidinium tin triiodide. Photoluminescence spectra are highly assimetric at the high-energy edge. This is accompanied by the unusually large blue shift of the time-integrated photoluminescence with increasing of the excitation power. These phenomena are associated with very slow hot carrier relaxation and state-filling of band edge states. Most importantly, the hot carrier photoluminescence is evident not only upon pulsed excitation but also with continuous wave one.

AKjDPG 1.8 Tue 12:30 H32

Metastable defects in perovskite semiconductors reveal microscopic insight into non-radiative processes — •Marina Gerhard[1], Boris Louis[1,2], Rafael Camacho[2], Aboma Merdasa[3], Alexander Kiligaridis[1], Jun Li[1], Alexander Dobrovolsky[1], Johan Hofkens[2], and Ivan G. Scheblykin[1] — [1]Division of Chemical Physics and NanoLund, Lund University, Box 124, 22100 Lund, Sweden — [2]KU Leuven, Molecular Imaging and Photonics, Celestijnenlaan 200f, Box 2404, 3001 Leuven, Belgium — [3]Helmholtz-Zentrum für Materialien und Energie GmbH, Kekulestraße 5, 12489 Berlin, Germany

Metal halide perovskites are an interesting model system for fundamental studies of non-radiative processes due to their photoluminescence (PL) fluctuations on a timescale of milliseconds to seconds, also referred to as 'blinking'. This phenomenon is attributed to the presence of metastable defects, able to switch between a passive (not quenching) and an active (quenching) configuration. Here, we study temperature dependent blinking of methylammonium lead iodide nanocrystals using PL microscopy. Monitoring the behavior of individual defects allows us to understand their concerted contribution to macroscopic quantities, such as the temperature dependent PL quantum yield. We find that both the quenching efficiency and the switching rate of the metastable defects decrease with decreasing temperature. Based on a simple mechanistic picture, we estimate activation barriers for the switching on the order of 200-800 meV. This energy range suggests that the switching mechanism could be related to ion migration.

AKjDPG 1.9 Tue 12:45 H32

Panel Discussion (with invited speakers) — •Thomas Unold[1], Silvia Motti[2], Carolin Sutter-Fella[3], and Maria Antonietta Loi[4] — [1]Helmholtz-Zentrum Berlin für Materialien und Energy — [2]Clarendon Laboratory, Department of Physics, University of Oxford, Parks Road, OX1 3PU, Oxford, United Kingdom — [3]Lawrence Berkeley National Laboratory, Berkeley, California, US — [4]Zernike Institute for Advanced Materials, University of Groningen, Groningen, The Netherlands

Do pre-existing models hold? Or do we need novel approaches to fully understand perovskite photoluminescence?

AKjDPG 2: PhD Focus Session: Biogenic spin phenomena (joint session MA/AKjDPG)

Time: Wednesday 9:30–12:40 Location: H38

5 min opening remarks

Invited Talk AKjDPG 2.1 Wed 9:35 H38
Magnetism in biomedicine: basics and applications — •Kannan Krishnan — Departments of Materials Science & Physics, University of Washington, Seattle, WA 98195, USA

Recent developments in synthesis and optimization of magnetite nanoparticles allows for reproducible control of their complex magnetic relaxation behavior even in *extreme* biological environments. This has enabled us to address two of the principal challenges in biomedicine, i.e. detecting disease at the earliest possible time prior to its ability to cause damage (imaging and diagnostics) and delivering treatment at the right place, at the right time whilst minimizing exposure (targeted therapy with a triggered release). Currently, our work is focused on Magnetic Particle Imaging (MPI), a tracer-based, whole-body imaging technology with high contrast (no tissue background) and nanogram sensitivity. MPI is linearly quantitative with tracer concentration, and has zero tissue depth attenuation; it is also safe and uses no ionizing radiation.

In this talk, I will introduce the underlying physics of MPI, and describe results in the development of highly optimized and functionalized nanoparticle tracers for MPI. I will then present state-of-the-art imaging results of preclinical in vivo MPI experiments of cardiovascular (blood-pool) imaging, stroke, GI bleeding, and cancer, all using rodent models. If time permits, I will introduce diagnostic and therapeutic applications of magnetic nanoparticles. Finally, this talk will highlight conceptual ideas that help bridge the gap for physical scientists interested in working on translational problems in biomedicine.

Invited Talk AKjDPG 2.2 Wed 10:15 H38
Spin-dynamics of a magnetic nanoparticle chain. — •Michael Winklhofer — Carl von Ossietzky Universitaet Oldenburg, Germany

Magnetic nanoparticle chains occur in nature as magnetosomes in magnetotactic bacteria. A typical magnetosome chain consists of 10-20 magnetite particles (Fe3O4, 35 - 60 nm particle size), whose individual magnetic dipolar moments add up to produce a stable intracellular compass needle that keeps the cell body of the bacterium aligned with the Earth' s magnetic field. The potential of magnetosomes isolated from bacteria for biomedical applications (magnetic hyperthermia and MRI) is due to the relatively large magnetic moment per particle (magnetic single-domains) and the biological membrane that surrounds each particle, thereby preventing phase separation and allowing for functionalization. Since the particles magnetically interact through dipolar coupling only, a magnetosome chain exhibits intriguing spin-wave dynamics. As will be shown here, both experimentally and theoretically, magnonic features such as band gaps depend on the geometric structure of the chain. Magnetic bacteria therefore have promising structures for applications in magnonics at the nanoscale.

Discussion (10:45 - 11:00)

Coffee Break (11:00 - 11:15)

Invited Talk AKjDPG 2.3 Wed 11:15 H38
Magnetic materials for biodetection — •Galina V. Kurlyandskaya[1,2] and Alexander P. Safronov[2] — [1]Departamento de Electricidad y Electrónica and BCMaterials, Universidad del País Vasco UPV-EHU, 48080 Bilbao, Spain — [2]Institute of Natural Sciences and Mathematics, Ural Federal University, Ekaterinburg 620002, Russia

Magnetic materials are at the leading edge of the rapidly growing field of biomedical applications. This work summarises recent developments of our groups in the area of magnetic nanomaterials potentially applicable in biomedicine. The main focus of the discussion is the magnetic biodetection. Magnetic biosensor is a compact analytical device incorporating a biological or biologically derived sensitive element, integrated in the physicochemical transducer employing a magnetic field and magnetic materials. Although existing devices allow a quantified evaluation of small changes in the magnetic susceptibility in the living system, or in magnetic field values created by the extracellular electric currents, there is a need to improve their sensitivity and specificity and further develop their design up to miniaturized analytical systems. Fabrication and characterization techniques for following magnetic nanomaterials used in biosensing devices will be discussed and examples of particular detection given: iron oxide nanoparticles obtained by electrophysical techniques and water-based ferrofluids and ferrogels on their basis, amorphous ribbons and thin film multilayered structures with high giant magnetoimpedance responses. This work was supported by the RSF grant 18-19-00090.

Invited Talk AKjDPG 2.4 Wed 11:35 H38
From synthetic to biological magnetic microswimmers — •Damien Faivre — Aix Marseille Univ, CEA, CNRS, BIAM, 13108 Saint Paul-Lez-Durance, France — MPI Colloids and Interfaces, 14424 Potsdam, Germany

Microswimmers have numerous applications varying from environmental remediation to medical work. One of the most promising design encompasses the use of magnetic components to obtain sustainable propulsion mechanisms and external controllability. These components can be of biological or synthetic origin. In my group, we have worked with both type: with magnetotactic bacteria on the one hand and with synthetic aggregate of random shape on the other hand. The bacteria typically form magnetic chain inside their body but are motile by means of rotation of their flagellar apparatus. I will show how these bacteria use their chain to orient. I will also show how given bacteria can reach unprecedented speed by a surprising mechanism. In turn, synthetic swimmers are typically inspired from bacterial flagella and therefore are formed via complicated and expensive route to obtained helical shapes. In my group, we went another line and studied random-shape microswimmers. I will show how these shapes can be chosen to obtain swimming behaviors barely possible otherwise, and how studying such microswimmers permit a better understanding of how shape and magnetic properties influence swimming.

Discussion (11:55 - 12:10)

Panel discussion Moderated by Michael Farle (U Duisburg-Essen) (12:10 - 12:40)

AKjDPG 3: PhD Focus Session: Theory of Stochastic Processes with Applications in Biology (joint session SOE/BP/DY/AKjDPG)

Session initiated and organized by Rosalba Garcia Millan, Johannes Pausch and Ignacio Bordeu Weldt (Imperial College, UK), in cooperation with divisions DY, BP, SOE and the jDPG.

Time: Thursday 15:00–18:45 Location: H17

Invited Talk AKjDPG 3.1 Thu 15:00 H17
Ecosystem stability and altruistic advantage — •Nick Jones — Imperial College Mathematics, London, UK

In this talk I consider why many, empirically observed, directed networks might contain a lack of feedback loops. An answer might be network growth mechanisms that favour clear trophic levels and which generate assymetries between the in degrees and out degrees of nodes. This is a partial answer to May's (Complexity-Stability) Paradox. Finally I will outline an, ageing relevant, concrete biological example of spatial demographic stochasticity where altruists can dominate a system even when actively selected against.

AKjDPG 3.2 Thu 15:45 H17
Thermodynamics of steady-state switching — •Jacob Cook[1,2] and Robert G. Endres[1,2] — [1]Department of Life Sciences, Imperial College, London, UK — [2]Centre for Integrative Systems Biology and Bioinformatics, Imperial College, London, UK

Entropy production is a hallmark of nonequilibrium processes in stochastic thermodynamics. Multistable nonequilibrium systems are abundant outcomes of nonlinear dynamics with feedback yet relatively little is known about what determines the stability of the steady states and their switching rates in terms of entropy and entropy production. Here, we will link the fluctuation theorem for the entropy production along trajectories and the large-deviation approach of minimum-action-path theory to elucidate the thermodynamics of steady-state switching. Interestingly, we find that the entropy production at steady state plays no explicit role, but the entropy production along switching trajectories is key. Alternative stabilising and destabilising mechanisms such as steady-state entropy and diffusive noise are also investigated.

AKjDPG 3.3 Thu 16:00 H17
Dynamical phase transition in assemblies of chemotactic cells — •Charlie Duclut — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

We consider a large number of chemotactic cells that diffuse, die, divide and interact at long range via the release of chemicals. We investigate the dynamics at long time and focus on the phase transition that occurs between a dilute and a dense phase using a renormalization group analysis. If we consider only interactions that conserve the particles number, exact scaling exponents can even be obtained; this analysis predicts in particular a superdiffusive behaviour of the cells close to the phase transition.

Invited Talk AKjDPG 3.4 Thu 16:15 H17
Topological Hindrance and Jamming Transitions in Multi-Species Transport — •Erwin Frey — Arnold-Sommerfeld-Center for Theoretical Physics, Ludwig-Maximilians-Universität München, München, Germany

Motivated by recent experimental studies that have addressed the stepping behavior of kinesins, we investigate a lattice gas model for simultaneous transport of two species of active particles on a microtubule. The species are distinguished by their different gaits: While the first species moves straight ahead, the second follows a helical path. We show that the collective properties of such systems critically differ from those of one-species transport as described by generalised totally asymmetric exclusion processes. This is most evident in a jamming transition far below full occupation, as well as in nonequilibrium pattern formation. The altered behavior arises because - unlike the case in single-species transport - any given position may be targeted by two particles from different directions at the same time. However, a particle can leave a given position only in one direction. This simple change in connectivity significantly amplifies the impact of steric interactions and thus becomes a key determinant of mixed species transport. We computationally characterize this type of hindrance and develop a comprehensive stochastic theory for collective two-species transport along a cylinder. Our observations show high robustness against model extensions that account for additional biomolecular features which suggests relevance also in a biological context.

15 min. break

Invited Talk AKjDPG 3.5 Thu 17:00 H17
Seeing and believing at super-resolution — •Susan Cox — Randall Centre for Cell and Molecular Biophysics, King's College London

Super-resolution microscopy is a powerful tool for imaging structures at a lengthscale of tens of nm, but its utility for live cell imaging is limited by the time it takes to acquire the data needed for an image. For localisation microscopy the acquisition time can be cut by more than two orders of magnitude by using advanced algorithms which can analyse dense data, trading off acquisition and processing time. Information can be traded for resolution: for example, the whole dataset can by modelled as arising from blinking and bleaching fluorophores (Bayesian analysis of Blinking and Bleaching), although at a high computational cost. However, all these approaches will come with a risk of artefacts, which can mean that the image does not resemble the underlying sample. We have recently developed Harr Wavelet Kernel Analysis, a multi-timescale prefiltering technique which enables high density imaging without artefacts. The results of benchmarking with other techniques reveal that at high activation densities many analysis approaches may achieve high apparent precision (very sharp images), but poor accuracy (the images don't look like the sample). I will discuss the relationship between precision, accuracy and information content in super-resolution microscopy images.

AKjDPG 3.6 Thu 17:45 H17
Filament flexibility enhances power transduction of F-actin bundles — •Alessia Perilli[1], Carlo Pierleoni[2], Giovanni Ciccotti[1], and Jena-Paul Ryckaert[3] — [1]Dept. of Physics, Sapienza University of Rome, Italy — [2]Dept. of Physical and Chemical Sciences, University of L'Aquila, Italy — [3]Dept. of Physics, Free University of Brussels, Belgium

In different biophysical cellular processes, semiflexible biofilaments like Factin and F-tubulin are known to exploit chemical free energy, associated to their growth by polymerization, to perform mechanical work against an external load. In vitro experiments have recently been set up to measure the force-velocity relationship of an actin bundle or to equilibrate the bundle polymerizing force by an optical trap restoring force. Theoretical interpretation is usually based on multi filament brownian ratchet models assuming perfectly rigid filaments (Mogilner-Oster). In this talk, we will exploit statistical mechanics tools and a coarse grained stochastic dynamic approach based on the discrete Wormlike Chain (WLC) model, to study the influence of filament flexibility on the non-equilibrium velocity-load relationship for a bundle of parallel un-crosslinked actin filaments pressing against a mobile wall. Using a realistic value of the actin persistence length, we show that flexibility enhances the power developed by the polymerizing force against the load in a way which increases with the length of the bundle, as long as the pushing filaments remain in the nonescaping regime.

Topical Talk AKjDPG 3.7 Thu 18:00 H17
Reconstructing the topographic landscape of epithelial-mesenchymal plasticity — •Francesc Font-Clos, Stefano Zapperi, and Caterina A. M. La Porta — Center for Complexity and Biosystems, University of Milan, Italy

We construct a topographic map underlying epithelial-mesenchymal plasticity by combining numerical simulations, statistical physics methods and analysis of bulk and single-cell gene expression data. The map reveals a multitude of metastable hybrid phenotypic states, separating stable epithelial and mesenchymal states, and is reminiscent of the free energy measured in glassy materials and disordered solids.

Topography of epithelial-mesenchymal plasticity, Francesc Font-Clos, Stefano Zapperi, Caterina A. M. La Porta, Proceedings of the National Academy of Sciences Jun 2018, 115 (23) 5902-5907; DOI:

10.1073/pnas.1722609115

AKjDPG 3.8 Thu 18:30 H17

Beating cancer 'escape room': let's use mathematical modelling to unlock cells! — •Núria Folguera-Blasco — The Francis Crick Institute, London, UK

The inherent capacity of differentiated cells to switch their phenotype in vivo in response to damage stimuli might have a pivotal role in ageing and cancer. However, how the mechanisms of phenotype reprogramming are established remains poorly understood. In order to elucidate such mechanisms, we present a stochastic model of combined epigenetic regulation (ER)-gene regulatory network (GRN) to study the plastic phenotypic behaviours driven by ER heterogeneity. Our analysis of the coupled system reveals the existence of pluripotent stem-like and differentiated steady-states. Crucially, ER heterogeneity is responsible for conferring abnormal robustness to pluripotent stem-like states, which cause the locking of the cells in a stem cell-like state prone to cancer development. By analysing the ER heterogeneity, we formulate epigenetic heterogeneity-based strategies capable of unlocking and facilitating the transit from differentiation-refractory (pluripotent stem-like) to differentiation-primed epistates. Our results suggest that epigenetic heterogeneity regulates the mechanisms and kinetics of phenotypic robustness of cell fate reprogramming. The occurrence of tunable switches capable of modifying the nature of cell fate reprogramming from pathological to physiological might pave the way for new therapeutic strategies to regulate reparative reprogramming in ageing and cancer.