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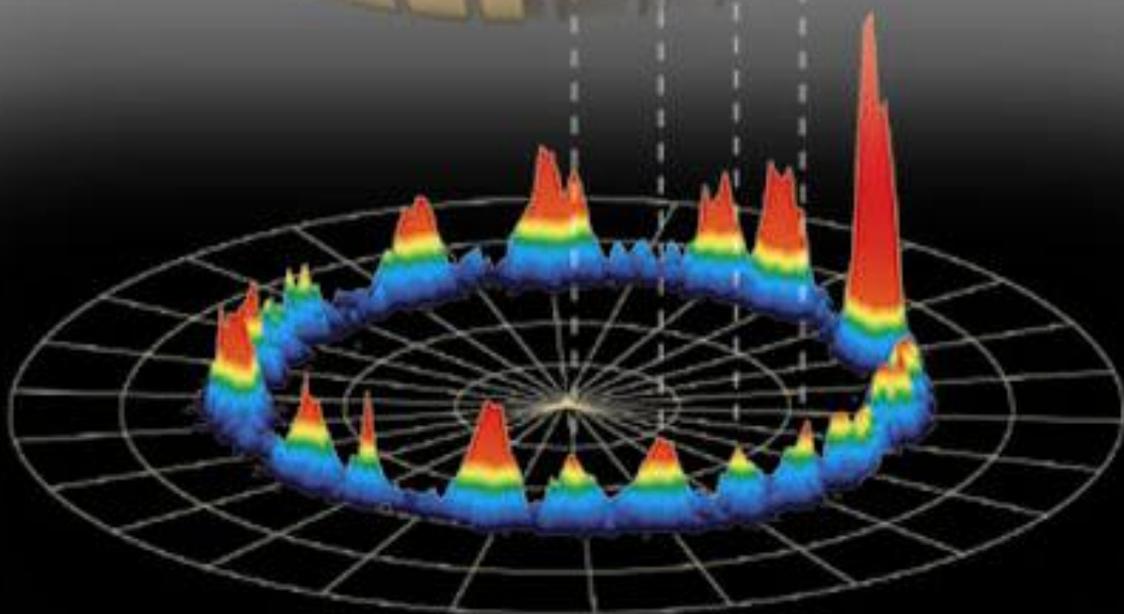
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Editorial

This newsletter continues the theme of the last one with opinion pieces from the Network Chairs in the new EPSRC Grand Challenge networks that are of particular relevance to our community. After this issue I will be stepping down as Newsletter editor, to be replaced by Robert Endres, as I have now become group Secretary. I hope you have enjoyed these irregular instalments and please give your continued support to Robert.

Items for the newsletter should be e-mailed to
r.endres@imperial.ac.uk

*Prof Jamie Hobbs
Newsletter Editor*



The Committee

Chair

Prof Andrew Turberfield

Honorary Secretary

Prof Jamie Hobbs

Honorary Treasurer

Prof Beppe Battaglia

Members

Dr Rosalind Allen

Dr Jose Brandao-Neto

Dr Pietro Cicuta

Dr Robert Endres

Dr Mark Leake

Prof Timothy Newman

Prof Paul O'Shea

Prof Peter Weightman



*Prof Andrew Turberfield,
Chair*

The Chair's commentary

Since the last newsletter in March 2012, the Group has held three significant meetings.

Physics Meets Biology (3-5 Sept 2012) is an international conference series that covers a very wide spectrum of biological physics. This year, a total of 27 plenary, invited and contributed talks ranged from super-resolution microscopy, diffraction from exploding nanocrystals and the mechanics of membranes and hearing to the statistical physics of decision making by insects and stem cells. Three of the talks, and many excellent posters, were

contributed by students. We also had thought-provoking personal views, from Professor Douglas Kell, Chief Executive of BBSRC, on 'what Physics can do for Biology' and from Professor Dame Athene Donald on how to strengthen interest in interdisciplinary research by winking biology into the physics curriculum, 'sharing the excitement'. This is our third PMB: each time we worry whether the programme is too broad, and each time we are reassured that this is precisely what makes it attractive. I should like to thank Jamie Hobbs, Sarah Harris, Jose Brandao-Neto and Mark Leake for their help in running this conference.

Biomolecular Thermodynamics (26-27 Nov 2012) is surely even broader - it underpins everything discussed in Physics Meets Biology and the whole of

the rest of life besides. Sarah Harris has provided a separate report – we are grateful to her for running this fundamentally important topical meeting.

Advanced Photonics Techniques in Soft Matter and Biology was held on the 14th January 2013. This is latest of a successful series of biennial one day meetings that highlight new developments in photonics relevant to soft matter and biology. Mark Leake has provided a separate report.

Our 2012 AGM was held at Physics Meets Biology. We thanked departing committee members Sarah Harris (who has served valiantly as Secretary), Aline Miller and Ray Goldstein and are pleased to welcome Jamie Hobbs as Honorary Secretary and newly elected members Rosalind Allen (Edinburgh) and Tim Newman (Dundee) (wiping out any hint of a southern bias). New Group-organized meetings include The Physics of Behaviour (Brighton, 24-26 June 2013) – see the Group calendar for details for this and keep an eye open for more to come.

Something else to look out for is the launch of the Physics of Life Grand Challenge Network ‘From Molecules to Systems: Towards an Integrated Heuristic for Understanding the Physics of Life’ (8 April 2013 at the Institute of Physics). After the launch meeting, network chair Graham Leggett and co-chair Jamie Hobbs and their steering group are planning a series of Plenary Events and Focused Workshops to explore the challenges and opportunities of engagement between physics and biology. Please see the article in this issue and www.physicsoflife.org.uk for more details.

I should like to thank Jamie Hobbs for producing excellent newsletters and Robert Endres for taking on the job of editor.

Do make use of the Group – if there are things that you would like us to do, please contact a committee member.

Opinion Pieces

The EPSRC Physics Grand Challenge Networks

Recently EPSRC has launched a number of “Grand Challenges” in the area of its “Physics” activity. Two of these are directly relevant to the Biological Physics community, “Understanding the Physics of Life” and “Emergence and Physics Far from Equilibrium”. EPSRC has launched two “Networkplus” activities to help to define the areas of science covered by these broad themes, and in this issue we have an introduction to the two networks from the network Chairs.

Understanding the Physics of Life.

The launch of an EPSRC Grand Challenge Network on “Understanding the Physics of Life” is a significant one for the biological physics community, because it marks the explicit recognition, for the first time, that biological physics is a central component of EPSRC’s Physics Programme. I am delighted to have the privilege of leading this Network, and I hope that it will provide a valuable service to the community. I am fortunate to have the assistance of my colleague Jamie Hobbs and a Steering Committee of extremely talented and dedicated colleagues.

Choosing a theme for the Network was a much easier job than one might have expected, because as I talked to people the idea of integrating understanding across the length scales came up repeatedly – hence the title of our Network, “From Molecules to Systems”. Biochemists apply reductionist methodology to develop highly detailed understanding of biological systems at the molecular level, and systems biologists are trying to develop approaches to modeling whole systems, but there is no framework to bring the two together in an integrated fashion.

Physicists have an important contribution to make to this, because they have many years experience of tackling similarly difficult cross-length-scale challenges: the integration of quantum theory and general relativity was one of the grand challenges of 20th century science, and statistical mechanics provides a link from molecular scale phenomena to the behavior of large ensembles of molecules. The insights springing from these accomplishments, together with new tools, both experimental and theoretical, can help to solve the problem of integration biological understanding from the molecular to the systems level.

We hope that as many as possible of you will get involved in the Network. The majority of its funding is to support meetings. There will be three plenary meetings to get things off to a flying start, addressing broad cross-length-scale challenges (The Living Cell, Synthetic Biology and Multicellularity), and there will be a larger number of focused workshops, whose themes will be defined by the community. The objective of these events is not to define a field, but to identify major cross-length-scale challenges and provide opportunities for new partnerships to be formed between physicists and biologists to tackle them. We expect that this will lead to the submission of research proposals to EPSRC. The involvement of biologists is critical to the success of the venture, and it is pleasing in this regard that BBSRC has made a contribution to the funding for the Network.

Importantly, EPSRC sees the submission of high quality research proposals as a key goal for the network – by working together we thus hope to be able

to ensure that biological physics continues to be adequately funded by EPSRC and, indeed, that its funding position is improved. To support the building of partnerships, we have small reserves of funds (for example, to support travel). We will also be organizing summer schools and other activities designed to train and inspire the next generation of biological physicists.

Prof Graham Leggett, Dept Chemistry, University of Sheffield.

Towards consensus on a unifying treatment of emergence and systems far from equilibrium.

In contrast to closed physical systems, which can be described using traditional statistical mechanics, the world around us is far from equilibrium. Indeed, the Earth continuously receives energy from the Sun, plants and animals grow, while man-made structures tend to degrade and decay. Often, the near equilibrium approach can be applied to selected temporal and spatial scales, for example, when a time-varying driving force temporarily vanishes, a system may evolve towards the equilibrium, for a short period of time. In general, however, equilibrium statistical mechanics is inapplicable to systems, which are subject to strong external driving forces, shocks, instabilities or change. A non-exhaustive list of such phenomena includes: far from equilibrium hydrodynamics, magnetically confined plasmas, quantum systems and man-made networks with relevance to power supply grid or spreading of infections. At the same time, spontaneous emergence of long lasting correlations, flows, structures and patterns is one of the hallmarks of non-equilibrium systems. Understanding this behaviour is not only important for their theoretical description but has practical industrial implications, where there is often a need to control the flow of materials and also to change their states, forming useful and stable structures. Non-physical systems and models, in which subtle collective mechanisms can be monitored or prescribed, offer an alternative route to studying such behaviour.

In March 2012, the EPSRC awarded funding for two Physics Grand Challenge networks on Physics of Life and on Emergence and Physics Far From Equilibrium. The latter network will be coordinated by Dr. Bogdan Hnat from the Physics Department of the University of Warwick and Dr. Tobias Galla from the University of Manchester. The funded network aims to prepare the UK community to meet the challenge of unifying various approaches to systems far from equilibrium and to ensure international competitiveness of UK scientific community as a collective. No discipline alone can address, let alone answer, the open questions related to emergence and physics of systems far from equilibrium. Non-equilibrium systems represent diverse fields of science, which are often separated by their unique terminology,

methodology as well as by different practical applications they may lead to. This is one of many barriers towards progress, which this network will help to overcome. At the same time the diversity of the theme and the broad base of this network are our strengths: analogies between very different phenomena will be used for addressing specific problems and for building general principles that can be exploited in theory and experiment.

The network will build upon an existing repertory of techniques and methods for analysing non-equilibrium processes and will attempt to utilize existing methodologies in fields different from those for which they were originally devised. A strong emphasis will be placed on work with our industrial partners finding areas where we can exploit both new and existing results for non-equilibrium systems, in the context of a clear "user requirement" of industrial research. For more information, please visit the network website located at http://www2.warwick.ac.uk/fac/sci/physics/research/cfsa/people/hnat/epsrc_networkplus/.

Dr Hnat Bogden, Dept of Physics, University of Warwick.

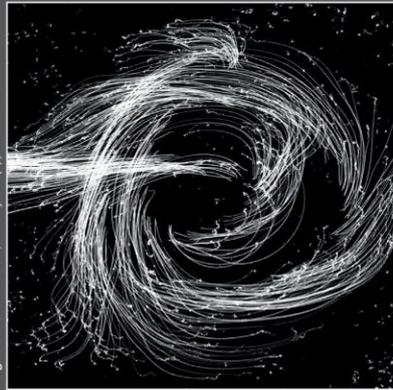
Conference Calendar

Physics Emergent of Behaviour

24-26 June 2013
The Grand, Brighton

<http://bio13.iopconfs.org/>

The aim of this multidisciplinary meeting is to bring together physicists and biologists to discuss experimental and theoretical approaches for studying behaviour in living systems. Speakers will combine an introduction aimed at a broad audience with results from their latest research. Topics covered will include search strategies and foraging, simplicity underlying complexity, sensing and migration, and decision-making. These topics span multiple scales from single cells and individuals to collectives.



Physics of Emergent Behaviour

From single cells to groups of individuals

24–26 June 2013, The Grand, Brighton, UK

Organised by the IOP Biological Physics Group

This conference will provide an opportunity to discuss current research on the various aspects of emergent behaviour in living organisms, covering a multi-scale spectrum from intracellular domain and multicellular collectives up to large groups of organisms.

Conference themes

- Search strategies and foraging
- Simplicity underlying complexity
- Sensing and migration
- Collective decision-making

Confirmed speakers

- **Dante Chialvo**, CONICET (National Research Council), Argentina
- **Lucilla de Arcangelis**, Seconda Università degli Studi di Napoli, Italy
- **Ben Fabry**, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
- **Nigel Franks**, University of Bristol, UK
- **Raymond E Goldstein**, University of Cambridge, UK
- **Thomas Gregor**, Princeton University, US

- **Patrick M Hogan**, University of Sheffield, UK
- **Henrik Jeldtoft Jensen**, Imperial College London, UK
- **Jens Krause**, Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB), Germany
- **Stefano Mancuso**, Università degli Studi di Firenze, Italy
- **Alfonso Martinez Arias**, University of Cambridge, UK
- **David Peak**, Utah State University, US
- **Peter Swain**, University of Edinburgh, UK
- **Massimo Vergassola**, Institut Pasteur, France
- **Tamás Vicsek**, Hungarian Academy of Sciences and Eötvös University, Hungary

Key dates

Abstract submission deadline:	4 April 2013
Early registration deadline:	22 May 2013
Registration deadline:	17 June 2013

Sponsored by European Science Foundation,
Institute for Complex Adaptive Matter (ICAM)/US National Science Foundation (NSF) and Society of Biology



<http://bio13.iopconfs.org>

IOP Institute of Physics

Conference reports

“Biomolecular Thermodynamics”

26-27 November, Institute of Physics, London

This meeting was the first on the theme of the thermodynamics of biomolecules organised by the Biological Physics Group. We were delighted to have 75 delegates at the meeting from disciplines as broad as biochemistry, pharmacy, physics and maths, who all discussed their recent experimental and theoretical work using language accessible to a multidisciplinary audience. The poster session held over an extended lunch break was particularly lively, and offered an ideal opportunity for researchers from diverse disciplines to discuss their work on a one to one basis.

The focus of the first day was on the equilibrium thermodynamics of biomolecules. Presentations by Geoff Holdgate (AstraZeneca) and Anne Imberty (CERMAV-CNRS France) highlighted the importance of understanding biomolecular thermodynamics in the design of new drugs and the treatment of disease. Alan Cooper (Glasgow) discussed the contribution heat capacity measurements have made to our fundamental understanding of biomolecular interactions, and Babis Kalodimos (Rutgers) described how advances in NMR techniques have shown that protein dynamics and entropy can regulate biomolecular recognition and protein activity. The important role of computer simulation in understanding the complex interactions that govern the thermodynamics of molecular recognition was emphasised by Rebecca Wade (Heidelberg).

The theme of non-equilibrium biomolecular thermodynamics was discussed on the second day. Adrian Mulholland (Bristol) described recent insights into enzyme catalysis provided computer simulations at the quantum mechanical level. The use of novel nanomechanical devices to probe the mechanism of action of antibiotics that attack bacterial cell walls was described by Rachel McKendry (UCL), and Lorna Dougan (Leeds) showed how single molecule manipulation experiments are contributing to our understanding of the stability of proteins extracted from organisms that live in extreme environments. Following presentations on protein self-assembly into amyloid fibrils from both experimentalists and theoreticians, Andy Bates (Liverpool) closed the meeting with an overview of energy flow in living organisms, and recent insights into the thermodynamics of the topoisomerase molecular motors that control the supercoiling and packaging of DNA.

All of the presenters were gently encouraged to avoid discipline specific language by the “Jargon Jamboree”, in which delegates were requested to record their own scientific area alongside any terminology used by speakers that they did not understand. The results of the jamboree were fed back to the conference at the end of the meeting. This survey revealed that the units in which quantities are described can erect undesirable barriers between the different scientific communities; for example physicists describe energy in units of the thermal energy $k_B T$, whereas the chemists prefer the more conventional kJ/mol, and the biochemists use the old fashioned but often more convenient kCal/mol.

Feedback from delegates showed that the broad range of disciplines present at the meeting “had the potential to be genuinely useful”, and suggestions for future engagement between the different communities included discussion groups during such meetings to address, for example developments in the key experimental techniques, such as Isothermal Titration Calorimetry and Surface Plasmon Resonance. Delegates were enthusiastic about the IOP as a conference venue and had particular praise for the catering. The organisers would like to say a big “Thank You” to the IOP conference team,

especially Joanne Hemstock who did a wonderful job as IOP conference co-ordinator. We would also like to thank GE Healthcare, who kindly provided funding to support the meeting, and who made a valuable scientific contribution by exhibiting their most recent technology for measuring biomolecular thermodynamics and their active engagement with the other delegates.

Conference organisers:

Dr Sarah Harris (School of Physics and Astronomy, University of Leeds)

Dr Bruce Turnbull (School of Chemistry, University of Leeds)

Dr Martin Cann (School of Biological and Biomedical Sciences, Durham University)

“Advanced photonics techniques in soft matter and biology”

14 January 2013 at the Institute of Physics, London, UK

Co-organized by Dr. Tom Waigh (Manchester University), Prof Peter Winlove (Exeter University) and Prof Mark Leake (York University), co-sponsored by the Biological Physics Group and Polymer Physics Group of the IoP

This was the fourth incarnation of the increasingly popular biennial one day event in which leaders in the field of advanced photonics techniques gathered to highlight new developments in photonics relevant to soft-matter and biological physics. The meeting kicked off with a description of a novel dual polarization interferometry technique to measure heterogeneities in molecular films (P. Coffey, Manchester University), followed by a description of the new use of polarization light microscopy to characterize the structure of giant amyloid spherulites, relevant to diseases such as CJD involving protein prion amyloid formation in the brain (J. Sharp, Nottingham University). After morning coffee the theme switched to Raman imaging, involving first a comprehensive description of the current state-of-the-art for coherent Raman imaging (H. Offerhaus, Twente University, The Netherlands), followed by an application based talk for coherent Raman imaging using a multiphoton approach on live cells (P. Borri, Cardiff University). Over lunch was a well-received poster session demonstrating significant diversity in this increasingly emergent advanced photonics field.

In the afternoon we then had an entertaining description of 3D holographic microscopy and its application in measuring the dynamics of flagellar filaments in living eukaryotic cells (L. Wilson, Harvard University, US), most importantly necessitating the wearing of retro red/blue 3D glasses by the audience (which was a first for me!) We then followed the theme of focussed light with a talk on the use of near infrared optical tweezers to measure the piconewton-level forces involved in immune cell interactions (A. Wright, Nottingham University), and finished the session with a thorough treatment from one of the stalwarts of electron microscopy development into the use of structural imaging using ‘ptychography’, which allows measurement from only very weakly scattering objects (J. Rodenburg, Sheffield University). After coffee we resumed with a discussion of ultrabroadband tetrahertz spectroscopies enabling a unique signature for water and biomolecules to be measured (K. Wynne, Glasgow University), followed by a talk on the use of optical tweezers to measure microrheological properties of polymers, and finally closing the meeting with a comprehensive description of new advances in plasmonic evanescent field techniques for biomolecule sensing on optical surfaces.

In closing, it was agreed that a fantastic and insightful time had been had by all, thanking Kirsty Orr from the IoP for her exemplary conference organization efforts and the various

industrial sponsors of the meeting who kindly subsidised our sandwiches, and agreed to look forward to the fifth incarnation of this successful event in two years' time!
Professor Mark Leake, York University (mark.leake@york.ac.uk)

“Physics Meets Biology 2012”

3-5th September 2012, University of Oxford

This was the third in the series of biennial “Physics Meets Biology” meetings and continued the theme of well attended meetings covering an exceptionally broad range of areas in Biological Physics. The first day started with a focus on the new techniques that are poised to revolutionise biophysics, with Stefan Hell and Achilles Kapanidis introducing super-resolution optical techniques and applications, and Thomas Barends on biological imaging with free-electron lasers. After lunch there was a switch in direction towards theory, with invited talks from Robert Endres and Chris Brackley sandwiching a high quality contributed talk from Patrick Hogan. Before an excellent poster session the EPSRC Physics of Life Network was introduced by Graham Leggett. The day was rounded off by Douglas Kell from BBSRC and the University of Manchester who’s talk on “what physics can do for biology” was the subject of animated discussion over dinner.

The second day saw more biology coming to meet physics, with talks from Sandra Schmid and Daniel Robert that underlined the quantitative rigour that is now common in the biological community. There were also excellent invited talks from Viola Vogel and Rhoda Hawkins backed up by contributions from Andrew Harrison, Maximiliano Giuliani and Jorn Dunkel. The afternoon broadened out the scope of the conference even further, with Hendrik Dietz setting the benchmark for DNA nanostructures, followed by contributions from Julien Gautrot, Nicholas Bell and Emyr MacDonald. Following another busy poster session, Athene Donald led a discussion on teaching biological physics at undergraduate level. The day was rounded off by some delicious food at the conference dinner.

The final day started with another fascinating and varied theoretical session with invited talks by Ben Simons and Martin Howard and contributions from Clive Bowsher and Jens Karschau. The final session of the conference jumped from physical biochemistry with Dek Woolfson to dynamic light microscopy with John Girkin, with further contributions from Stephen Wells and Mark Leake.

Feedback on the conference from delegates supported our impression that the conference was a great success, spanning the breadth of biological physics and reflecting the vitality of the area.

Report by Jamie Hobbs. Conference organising committee: Andrew Turberfield, Sarah Harris, Mark Leake, Jamie Hobbs and Jose Brandao-Neto.