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Welcome

The committee of the Liquids and Complex Fluids Group are pleased to welcome you to the 2007 group newsletter. This newsletter outlines the nature of the group, its interests and relevant activities across the country.

What is the Liquids and Complex Fluids Group?

The Liquids and Complex Fluids Group, was formed in 2006 from the union of the Liquids and Complex Fluids Groups of the IOP. It aims to advance research on the liquid state of matter by fostering collaborations between experimentalists, theorists and computer simulators. Topics range from the structure and dynamics of pure liquids of all kinds to complex fluids such as emulsions, gels, foams, colloids, and liquid crystals, a scope that encompasses both microscopic and mesoscopic length scales from 'simple' liquids to soft condensed matter. The group also has strong interests in synthetic and bio-polymers, with close collaboration with the Polymer Physics and the Biophysics groups. There are also strong ties with other liquid matter researchers through the Royal Society of Chemistry and the European Physical Society. Other topics covered include liquid mixtures and solvation phenomena, liquids and glasses under extreme conditions, confined liquids and fluids at interfaces, the glass transition and arrested states of matter (including the structure of glasses and amorphous solids), crystal growth in liquids, and self-assembly from solution. The field also has strong links with biologically-inspired physics and nanotechnology.

A distinctive aim of the group is postgraduate education, particularly via our own graduate school, aimed at underpinning the education of the next generation of workers in the field. Another aim is the development of new instrumentation and

analysis tools for work on liquids and complex fluids at UK x-ray and neutron sources.

The Liquids and Complex Fluids group is now approximately one year old. I am pleased to report that the group committee members have been active in providing a significant number of activities that we hope will be of interest to our members: conferences, one-day meetings, workshops and the post graduate winter school (see 'Forthcoming activities' below) stretching to 2009. These events have been aimed to cover all the major areas of interest to our membership, experiment, theory and simulation: from biological aspects to chemistry and physics. We hope you will enjoy attending as many as you can. As chair, I send my warmest thanks to all those on the committee, and others, who have given their time and energy in organising these activities. If members have ideas for new activities for the group, can I encourage them to contact any committee member to raise them in good time for inclusion in the programme.

I am pleased to report that group membership has increased significantly over this first year of the combined group (growing by over 25%) and we hope that new members will continue to join and enhance the life of the group. Partly our membership has been given a boost by the success of the initial postgraduate 'Winter school', held at Cosners House in Abingdon Jan 2007. Can I encourage all graduate students to come to the next school in January 2008...don't forget that students who's work falls under the EPSRC remit can apply for a free place and group members can also apply for travel funding support... places are already going fast.

I would also draw members attention to the AGM to be held at Coseners House, on Friday 11th Jan 2008. This short meeting is the ideal opportunity for members to comment on present activities of the group and make suggestions for future events or improvements in the group. Can I encourage as many of you as possible to attend both the AGM and the meeting on *Confined Fluids* that coincides with it.

I would also like to send congratulations to our honorary secretary Cait MacPhee, who has been particularly productive and recently given birth to a baby son, Iain Clifford Williams, weighing in at 9lb 7oz.

*Stuart Clarke, Chair,
Liquids and Complex Fluids Group*

Committee Membership

Chair:**Dr Stuart Clarke**

The University Chemical Laboratory
University of Cambridge

E-mail: stuart@bpi.cam.ac.uk

Honorary Treasurer:**Prof Philip S Salmon**

Department of Physics
University of Bath

E-mail: p.s.salmon@bath.ac.uk

Committee:**Dr Daniel Bowron**

ISIS

Rutherford Appleton Laboratory

E-mail: d.t.bowron@rl.ac.uk

Dr Jason Crain

School of Physics

The University of Edinburgh

E-mail: j.crain@ed.ac.uk

Dr Neal Skipper

Department of Physics and Astronomy
University College London

E-mail: n.skipper@ucl.ac.uk

Prof Chris Care

Department of Applied Physics
Sheffield Hallam University

E-mail: c.m.care@shu.ac.uk

Prof Wilson Poon

Department of Physics and Astronomy
University of Edinburgh

E-mail: w.poon@ed.ac.uk

Prof Robert Evans

HH Wills Physics Laboratory
University of Bristol

E-mail: Bob.Evans@bristol.ac.uk

Prof Alan K Soper

ISIS Rutherford Appleton Laboratory

E-mail: a.k.soper@rl.ac.uk

Honorary Secretary:**Dr Cait MacPhee**

Department of Physics and Astronomy
University of Edinburgh

E-mail: cait.macphee@ed.ac.uk

Dr Rammile Ettelaie

Department of Food Science

University of Leeds

E-mail: r.ettelaie@food.leeds.ac.uk

Dr Daniel Read,

Department of Applied Mathematics,
University of Leeds

E-mail: d.j.read@leeds.ac.uk

Prof George Jackson

Chemical Engineering and Chemical
Technology, Imperial College London

E-Mail: g.jackson@imperial.ac.uk

Dr Patrick Warren

Unilever Research
Port Sunlight

E-mail: patrick.warren@unilever.com

Prof Peter Olmsted

School of Physics and Astronomy
University of Leeds

E-mail: p.d.olmsted@leeds.ac.uk

Dr Paul Bartlett

School of Chemistry
University of Bristol

Bristol

E-mail: p.bartlett@bris.ac.uk

Members of the committee welcome suggestions and comments from group members to help facilitate the running and development of the group at any time.

Events

Reports on recent group events

LCFG/EPSRC Winter School 2007



Cosener's House

The Groups Winter Postgraduate School, 'Solutions in the Snow' was held at The Cosener's House, Abingdon, Oxon from 7th – 10th January 2007. We thank everyone who came and who made this such a successful event, particularly the 40 students and lecturers, who brought the event to life.

This School was the first in a three-year rolling programme to enable students in the field to get a firm grounding in all the key topics that underpin research in liquids and complex fluids (theoretical, experimental and computer simulation) through a series of lectures given by established specialists in the relevant field.

Feedback on the 2007 school has been very positive indeed and all eligible students who replied have indicated that they intend to come to the next school (which will be held at Jesus College, Cambridge, Jan 6th – 9th 2008). The school was oversubscribed, even with some students sharing rooms. The larger venue for 2008 will mean that all students who wish to come can be accommodated.

As well as complementary comments about the lecturers, the attendees particularly enjoyed meeting and networking with each other. Another highlight was the visit to the DIAMOND and ISIS site, and we thank Alan Soper and colleagues for arranging and funding this enjoyable aspect of the school.



Attendees at the 2007 Winter school

The winner of the poster prize, part sponsored by 'Soft Matter', was Kevin Mutch from the School of Chemistry, Bristol University. Well Done Kevin.

PhD students with appropriate interests are strongly encouraged to come to the 2008 school in Cambridge. We are pleased to be able to offer a limited number of free places to students with research interests falling under the EPSRC remit, arising from EPSRC support for the school. In addition members of the LCFG are also encouraged to apply for student travel bursaries. More details of the school, grants and application forms are on the group website.

*Stuart Clarke
Cambridge*

Current Challenges in Liquid and Glass Science



Attendees at the Workshop on Challenges in Liquids and Glass Science, 2007. Spencer Howells is in the middle in the front row, fourth from left

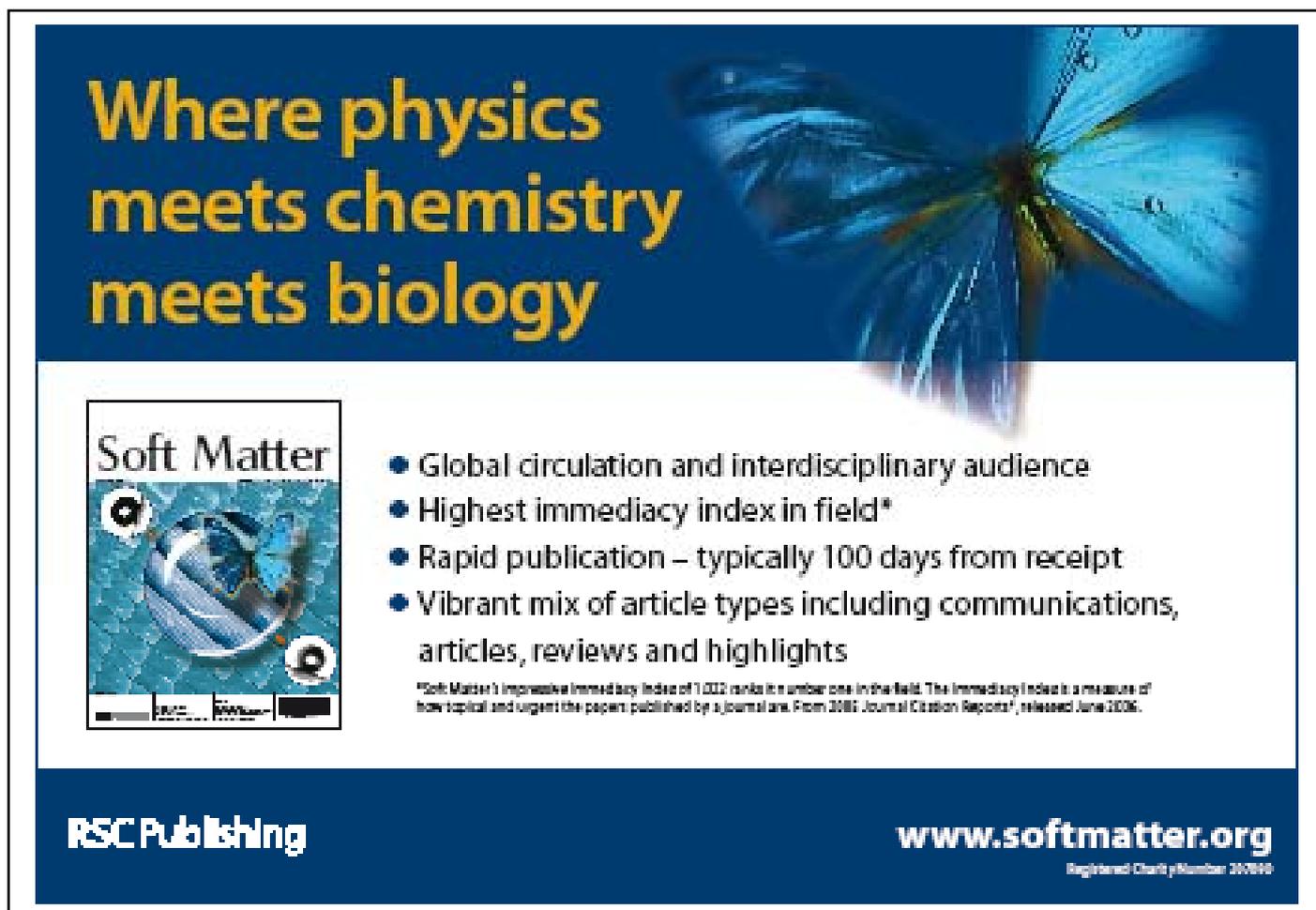
International Workshop on Current Challenges in Liquid and Glass Science, The Cosener's House, Abingdon 10 - 12 January 2007

The workshop was held to discuss current experimental and theoretical challenges in liquid and glass science and to honour the contribution made by Spencer Howells (ISIS) to the field of neutron scattering from liquids and glasses. The meeting was attended by 70 experimentalists, theorists and computer simulators from Europe, Japan and North America and comprised 34 oral presentations together with two lively poster sessions. Three major themes were discussed, namely (i) the glass transition and properties of liquids and glasses under extreme conditions; (ii) the complementarity of neutron and x-ray scattering techniques with other experimental methods; and (iii) the modelling of liquid and glass structure. These themes served to highlight (a) recent advances in neutron and x-ray instrumentation used to investigate liquid and glassy materials under extreme conditions; (b) the relationship between the results obtained from different experimental and theoretical/computational methods; and (c) the modern methods used to interpret experimental results.

The presentations ranged from polyamorphism in liquids and glasses to protein folding in aqueous solution and included the dynamics of fresh and freeze-dried strawberries and red onions. The properties of liquid phosphorus were also memorably demonstrated! The formal highlight was the “Spencerfest” dinner where Neil Cowlam (Sheffield) gave an excellent after dinner speech. The meeting was organised by Alex Hannon (ISIS), Philip Salmon (Bath) and Alan Soper (ISIS) and benefited tremendously from the skills of Carole Denning (ISIS). The financial support of the Council for the Central Laboratory of the Research Councils (CCLRC), the Liquids and Complex Fluids Group of the Institute of Physics, The ISIS Disordered Materials Group, the CCLRC Centre for Materials Physics and Chemistry and the CCLRC Centre for Molecular Structure and Dynamics is gratefully acknowledged. Some of papers presented at the workshop will appear as a Special Issue of the Journal of Physics: Condensed Matter.

*Phil Salmon
Bath*

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Meeting Reports

Report of the NCM 10 conference in Prague 2006

Due to the generous support by the Institute of Physics Liquids and Complex Fluids Group travel bursary I was able to attend the conference on Non-Crystalline Materials 10 held in Prague/Czech Republic from September 18th until September 22nd 2006.

At this conference about 70 talks and about the same number of posters were presented. Topics of the presentations ranged from the structure and dynamics of glasses and liquids, to the magnetic behaviour of glasses and to the properties of amorphous organic materials and thin films.

I presented a poster on “Partial Structure Factors of Three Distinct Forms of Amorphous Ice”. This work is an essential part of my PhD thesis. My poster attracted many people working in the field of non-crystalline materials and I benefited largely from the discussions I had with some of the conference participants about the structure of the different forms of amorphous ice and their relations. It was an interesting experience to present my work to an audience that consisted of experts and non-experts in the subject. I could also get an overview of the enormous variety of research topics studied in the field of non-crystalline materials.

One highlight outside the scientific program was for me the concert given by the “Prague Chamber Orchestra VIRTUOSI PRAGENSES” at the Klementinum’s Mirror Chapel. I was impressed by the virtuosity of the musicians. Until then I did not know most of the pieces played there.

The conference dinner was held in the restaurant “U Kalicha” where a part of the story of “The Good Soldier Švejk” takes place. I was lucky to have seen the film in German before and it was interesting to see the original setting.

All in all, I really enjoyed attending this conference and would like to thank the Institute of Physics Liquids and Complex Fluids Group for their support.

Anita Zeidler

4th Workshop on Non-Equilibrium Phenomena in Supercooled Fluids, Glasses and Amorphous Materials, Pisa, 17th-22nd September 2006

This year the 4th Workshop on Non-Equilibrium Phenomena in Supercooled Fluids, Glasses and Amorphous Materials was held between the 17th and 22nd September 2006 in Pisa, Italy. The conference was held at the Scuola Normale Superiore, a setting steeped in history converted to an academic institution by Napoleon in 1813. The workshop covered a wide range of glassy materials including those found in polymers, colloidal suspensions, proteins as well as molecular glasses and spin glasses and the formation of glassy states in confined systems. In particular, glassy dynamics were covered at length with fast and slow relaxation timescales identified both experimentally and theoretically over the range of systems. Also the influence of external factors such as surface effects, pressure and temperature on the timescales and fragility of glasses were presented.

Over 140 delegates attended this conference presenting recent results in the forms of oral presentations and poster sessions. Two round table meetings, at which all delegates could attend, allowed topics to be reviewed in succession and discussed with the main objective being to reach a universal understanding of glasses that could be applied to all systems. Further discussions were continued at the conference dinner held in the Museo dell'Opera with a beautiful view overlooking the Leaning Tower.

Attending this conference was important as I gained a broader and more complete understanding of glass dynamics. As an experimentalist, using optical tweezer techniques to probe colloidal glasses, I gathered ideas as to how further information on glass dynamics might be collected by applying our rather novel techniques. From the Soft Matter group at Bristol University, Dr Paul Bartlett presented a talk on recent measurements of the onset of elasticity and increase in the effective temperature of a glass forming colloidal fluid. I presented a poster reporting recent active microrheology measurements carried out by applying optical torque to rotate a probe within a glass forming fluid. Interesting and fruitful discussions followed and useful connections with researchers working in this field were made. I am very grateful to the conference organisers for their efforts and the Liquids and Complex Fluids Group for kindly supporting my attendance at this conference.

*Tiffany Wood
Soft Matter Group, School of Chemistry, University of Bristol*

Forthcoming Meetings

Group Meetings

- **UNDERSTANDING OF CONFINED FLUIDS: FROM SUPERFLUIDS TO OIL RESERVOIRS, 9th - 11th January 2008, The Cosener's House, Abingdon, Oxon, UK.**

In this workshop we will address a number of important contemporary questions concerning the fundamental properties of classical and quantum fluids in confinement, building on recent advances in experiment, theory and computer simulation. In addition to established figures from industry and academia, we will also encourage participation from young researchers, through open poster sessions and discussion periods together with international experts in the field.

Scientific topics to be addressed include: *Quantum Fluids, Simple Classical Fluids, Molecular and Complex Fluids, Solid-Liquid Interfaces, Phase Transitions, Crossing Length- and Time-Scales.*

Contact: Dr. Neal Skipper, Department of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT. Email: n.skipper@ucl.ac.uk, **Details** will be posted on the Liquids and Complex Fluids web site at: <http://www.iop.org/activity/groups/subject/lcf/index.html>

- Members and colleagues are warmly invited to a meeting on 'Phase Separation and Mixing', jointly organised by the LCFG, the Colloid and Interface Science Group of the RSC and the Colloid and Surface Chemistry Group of the Society of Chemical Industry, to be held at Trinity College, Cambridge from 3rd to 5th September 2008.

This meeting aims to address the important area of phase separation and mixing in its many forms and to bring together workers interested in a wide range of systems, including polymers, colloids, emulsions, gels and lipid membranes, and those workers using a variety of novel techniques, such as optical tweezers and microrheology.

Confirmed speakers include:

Biological Systems, Dr Sarah Keller, University of Washington, USA.

Theory of Colloid Behaviour, Professor Jean-Pierre Hansen, Cambridge University, UK

Phase Separation in Thin Films, Professor Richard Jones, Sheffield University, UK

Experimental Studies of Colloid Phase Behaviour, Dr Paul Bartlett, Bristol University, UK

Morphological Control Using Phase Separation, Professor Ian Norton,
Birmingham University, UK

Call for Abstracts

We encourage applications for speakers and poster presentations.

On-line submission of your abstract is the preferred method and is available via www.iop.org/Conferences by following the link from 'Forthcoming Institute Conferences'. The recommended alternative approach is by email to claire.garland@iop.org.

Key Dates

Abstract Submission Deadline	31 January 2008
Notification of Acceptance	3 March 2008
Early Registration Deadline	31 July 2008
Registration Deadline	22 August 2008

One Day Group Meetings

- A meeting on '*Recent Advances in Mixed and Active Membranes*' will be held on 23 - 24 July 2007 at the Institute of Physics, London, jointly organised by the Biological Physics and the Complex Fluids Group of the Institute of Physics. Invited Speakers include:

P Bassereau, Institut Curie, Paris, France

M Deserno, MPI fur Polymerforschung, Germany

H G Dobreiner, University of Bremen, Germany

F Gallet, Paris IV, France

P O'Shea, University of Nottingham, UK

P Petrov, University of Exeter, UK

P Sens, ESPCI, Paris, France

For full details on the submission of abstracts and how to register on-line, please visit the website via www.iop.org/Conferences following the link from 'Forthcoming Institute Conferences'.

- A one day workshop on '*Structuring Colloidal Dispersions by External Fields*' will be held at the IOP, London on Wednesday 21st November 2007. Details of the meeting and registration can be found on the IOP website. Confirmed speakers include Jan Dhont and Christos Likos. Applications for oral and poster presentations are warmly welcomed. Please visit the group website via www.iop.org/Conferences following the link from 'Forthcoming Institute Conferences'. Further details are available from Claire Garland, claire.garland@iop.org.

- One day meeting on simulation approaches in liquids/soft solids is provisionally planned: *Bio-inspired Self Assembly*, Spring 2008, Sheffield Hallam University.

This one-day workshop will explore developments in the field of bio-inspired self assembly. The meeting will bring together simulators and experimentalists working on, for example, bio-mineralisation, self-assembly of complex structures, nano-structured materials and templating. It is planned to invite a speakers from the UK and Europe.

If you have an interest in attending the meeting, please contact Chris Care (c.m.care@shu.ac.uk) or Doug Cleaver (d.j.cleaver@shu.ac.uk).

See outline details below. More information to follow.

The committee encourages members to attend the variety of group conferences, workshops and schools organised by the group. In addition we welcome members suggestions for further meetings or other activities. Please contact any member of the committee.

Other meetings of interest to group members

2007

Meeting in Honour of Jean-Pierre Hansen, July 23-25 2007, Trinity College, Cambridge. Website:

<http://www.theor.ch.cam.ac.uk/people/sprikgroup/jeanpierre/jptop.htm>

CCP5 2007 annual meeting, New Hall, Cambridge, 29th-31st August, The theme of this year's meeting is "Multiscale Modelling: simulation methods and applications spanning time and length scales". Register via the conference website: http://www.srcf.ucam.org/~jae1001/ccp5_2007

Shear-banding phenomena in entangled systems, 3-5 September, 2007. University College London, London, UK.

<http://www.euromech.org/colloquia/2007/492>

UK Polymer Showcase Meeting, 6-7 September, London College of Fashion,

<http://www.polymerirc.org/pages/PolymerShowcase>

Biennial meeting of the Polymer Physics Group of the IOP, 10-12th September, 2007, Grey College, Durham University.

Thermodynamics 2007, 26 - 28 September 2007, IFP - Rueil-Malmaison (France): <http://thermo2007.ifp.fr>

Polymer Colloids Forum, 16-18 Sept 2007, Warwick. Organised by the Colloid and Interface Science Group, RSC.

Novel Applications of Surface Modification, 18-20 September 2007, University of Southampton. Polymer Physics Group of the IOP. www.iop.org.

5th International Workshop on Complex Systems, 26-28 September, 2007. A satellite meeting of the 4th International Conference on Flow Dynamics together with the 5th International Symposium on Water Dynamics. Workshop web page: <http://www.ifs.tohoku.ac.jp/tokuyama-lab/IWCS2007/>

Networks, Excitability and Motility, 2 day conference/training event organised by the Biological Physics group of the IOP, 17-18th September at the Manchester Institute of Biotechnology. Contact Claire Garland at the IOP: claire.garland@iop.org.

International Soft Matter Conference 2007, 1 - 4 October 2007 Eurogress, Aachen, Germany. <http://www.fz-juelich.de/iff/ismc2007>

Franco-Israeli Trends in soft matter, biophysics and microfluidics - October 7th-10th, 2007, Biarritz – France: <http://fit2007.crpp-bordeaux.cnrs.fr/>

2008

Nanoparticles, Feb 2008, Organised by the Colloid and Interface Science Group, RSC.

The Importance of Polymer Science for Biological Systems, Faraday Discussion 139, 26-28th March 2008, University of York: www.rsc.org/FD139

7th Liquid Matter Meeting, 27 June - 1 July, 2008, Lund, Sweden (Eur. Phys. Soc).

New Frontiers in Colloid Science, A conference to celebrate the Career of Professor Brian Vincent, 1st –2nd April, 2008, Lords Cricket Ground, London: Contact Emily Moss: Emily.moss@soci.org.

Surfaces and Interfaces in Soft Matter and Biology; The Impact and Future of Neutron Reflectivity, Symposium in honour of Robert K. Thomas FRS, 21st-23rd May 2008, Institute Laue Langevin, Grenoble, France. Webpages: www.ill.eu/Events/rktsymposium/ Email: refsymp2008.ill.eu

Polymer interactions in solution and at interfaces, July 2008 Cardiff. Organised by the Colloid and Interface Science Group, RSC.

**LIQUIDS AND COMPLEX FLUIDS
WINTER SCHOOL****'Solutions in the Snow'****6th – 9th January 2008, Jesus College, Cambridge, UK**

Applications are invited for the 2nd Institute of Physics Liquids and Complex Fluids/EPSRC Winter School. The aim of this School is to provide a comprehensive foundation for researchers in the field of liquids and complex fluids. The lectures will introduce key topics of current interest together with the theoretical, experimental and computer simulation approaches used to address them. The School is directed towards postgraduate students from a wide range of backgrounds including physics, chemistry, chemical engineering and biophysics.

The School is built around a rolling programme of lectures, which will ensure that the majority of PhD students can cover the full programme over a three year period. Each School will consist of a series of lectures presented by active members of the community. In 2008 these include Eugene Terentjev (University of Cambridge), Peter Olmsted (University of Leeds), Bob Evans (University of Bristol) and Stefan Egelhaaf (University of Duesseldorf).

The School is organised by the Institute of Physics Liquids and Complex Fluids Group (LCFG) and supported by the EPSRC. The cost of attending, accommodation and meals (but excluding travel) is £300 for academic and £500 for industrial participants. A limited number of free places are available to UK students whose work is covered by the EPSRC remit. A limited number of IOP LCFG travel bursaries are also available for LCFG group student members. To join the group see the IoP web site: www.iop.org.

Further details (including an application form) on the Winter School web site: <http://www.iop.org/activity/groups/subject/lcf/index.html>

Alternatively, contact: Dr Stuart Clarke, c/o Jane Snaith, IOP Liquids and Complex Fluids Group, Department of Chemistry, University of Cambridge, Cambridge, CB2 1EW, UK. js115@cam.ac.uk

UNDERSTANDING OF CONFINED FLUIDS: FROM SUPERFLUIDS TO OIL RESERVOIRS

9th - 11th January 2008

The Cosener's House, Abingdon, Oxon, UK

The Liquids and Complex Fluids Group of the Institute of Physics announces an International Workshop to discuss recent advances in the understanding of Confined Fluids.

Fluids confined in small spaces are ubiquitous in the natural and industrial world, and are of great interest both for their fundamental physical properties and their practical importance. For example, understanding the mechanisms of surface phase transitions such as superfluidity, wetting, layering, roughening and freezing remains a major challenge. Moreover, the properties of confined fluids are directly relevant to many natural systems, from biological cells to oil reservoirs. As a result, confined fluids are very topical, and are being studied extensively by a broad range of physicists, chemists, biologists, geologists and engineers. Such research crosses many disciplines, length-scales and time-scales, and therefore uses very many different techniques, both experimental and theoretical.

In this workshop we will address a number of important contemporary questions concerning the fundamental properties of classical and quantum fluids in confinement, building on recent advances in experiment, theory and computer simulation. In addition to established figures from industry and academia, we will also encourage participation from young researchers, through open poster sessions and discussion periods together with international experts in the field.

Scientific topics to be addressed include: *Quantum Fluids, Simple Classical Fluids, Molecular and Complex Fluids, Solid-Liquid Interfaces, Phase Transitions, Crossing Length- and Time-Scales.*

Application and programme details will be posted during July 2007 on the Liquids and Complex Fluids web site at:

<http://www.iop.org/activity/groups/subject/lcf/index.html>

Contact: Dr. Neal Skipper, Department of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT.
Email: n.skipper@ucl.ac.uk

The 2007 IOP Polymer Physics Group Biennial

10th – 12th September 2007
Grey College
Durham University

The conference meal will be held in the unique
setting of Durham Castle
Registration and poster abstracts still accepted:
contact m.i.harries@durham.ac.uk

IOP | Institute of Physics **Biological Physics Group**

THE IOP BIOLOGICAL PHYSICS GROUP

Conference and Training Course in Emergent Themes in Biophysics

Networks, Excitability, and Motility

Manchester Institute of Biotechnology, University of Manchester

17-18th September, 2007

We present a one-day *research meeting* on emerging themes in biological physics combined with a one day *training course* intended for students and PDRAs who are considering a career in biophysical research. Programs will be based on invited talks from leading UK researchers and will include poster sessions. They will highlight a series of emergent themes in biological physics.

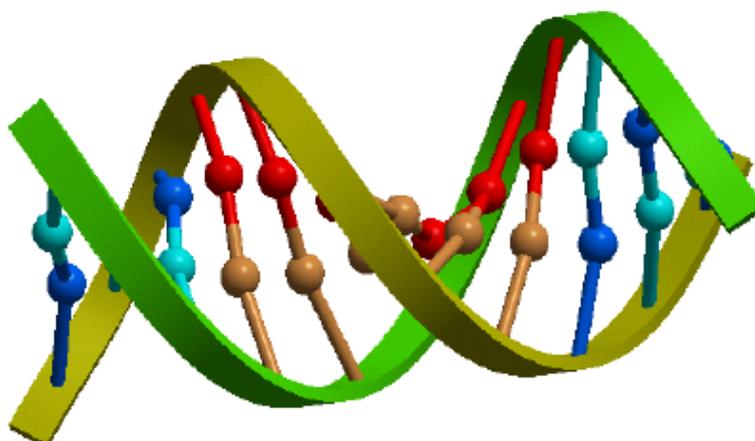
Registration deadline: 30th July, 2007

For accommodation contact:

<http://www.accommodation.manchester.ac.uk/currentstudents-adviceandinformation/hotels/hostels/>

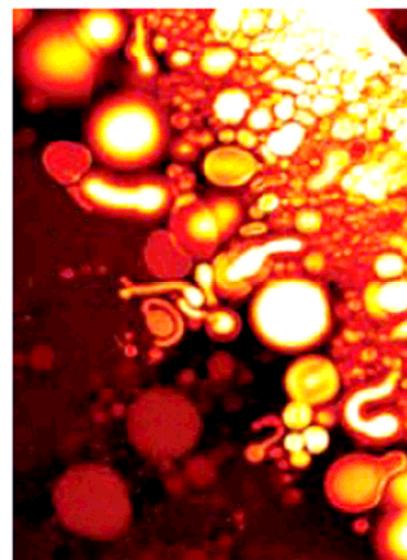
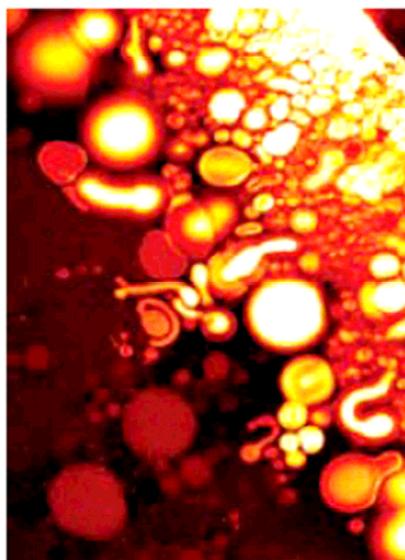
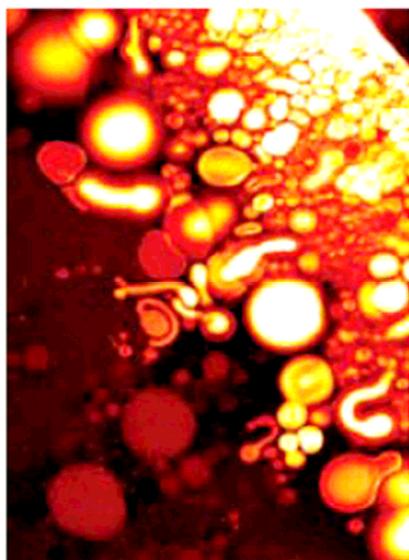
Conference contact e-mail: claire.garland@iop.org

Address: Claire Garland, Acting Conferences Manager, Institute of Physics, 76 Portland Place, London, W1B 1NT, UK.



Faraday Discussion 139: The Importance of Polymer Science for Biological Systems

26 – 28 March 2008
University of York, UK



RSC | Advancing the
Chemical Sciences

www.rsc.org/FD139

Annual General Meeting Notification

It is intended to hold the AGM at 12.30 on Friday Jan 11th 2008 at Cosener's House, Abingdon, Oxon. This coincides with the end of the 'Confined Fluids' Workshop and we hope that members will take the opportunity to attend both events. Please put these dates into your schedules.

Student bursaries

Student Travel Bursaries are available to enable students, who are members of the group, to attend relevant meetings. Bursaries are typically of the order of £50 for UK meetings and £100 for international meetings. They can be used to attend meetings organised by the group and are available to students for other meetings with appropriate content. Anyone receiving a bursary will be expected to write a short meeting report for inclusion in the group newsletter as a condition of funding. Application forms can be found on the group web-site and should be submitted to the group secretary.

It is important that potential applicants should be aware that after March 2008 a new system for administering Student Bursary applications may come into place where applications should be made to the IOP centrally prior to assessment by the Liquids and Complex Fluids Group. Please see the IOP web site for more details.

Prizes

Nominations for the biannual 2007/8 Liquids and Complex Fluids Group Young Scientist Award are invited. The winner will receive £200, a certificate, and will give a lecture at a general meeting. Those eligible for awards should be members of the Group and work in the UK or Ireland, be UK or Irish citizens or have strong UK or Irish connections. The Liquids and Complex Fluids Committee defined "Young Scientists" as those individuals with no more than 5 years postdoctoral experience (allowing for career breaks) following the award of a PhD. Those who are currently paid employees of the Institute, members of Council and those under contract to the Institute are not eligible for awards. Nomination forms are available on-line from the group web-site and the closing date for receipt of nominations is **2nd April 2008**.

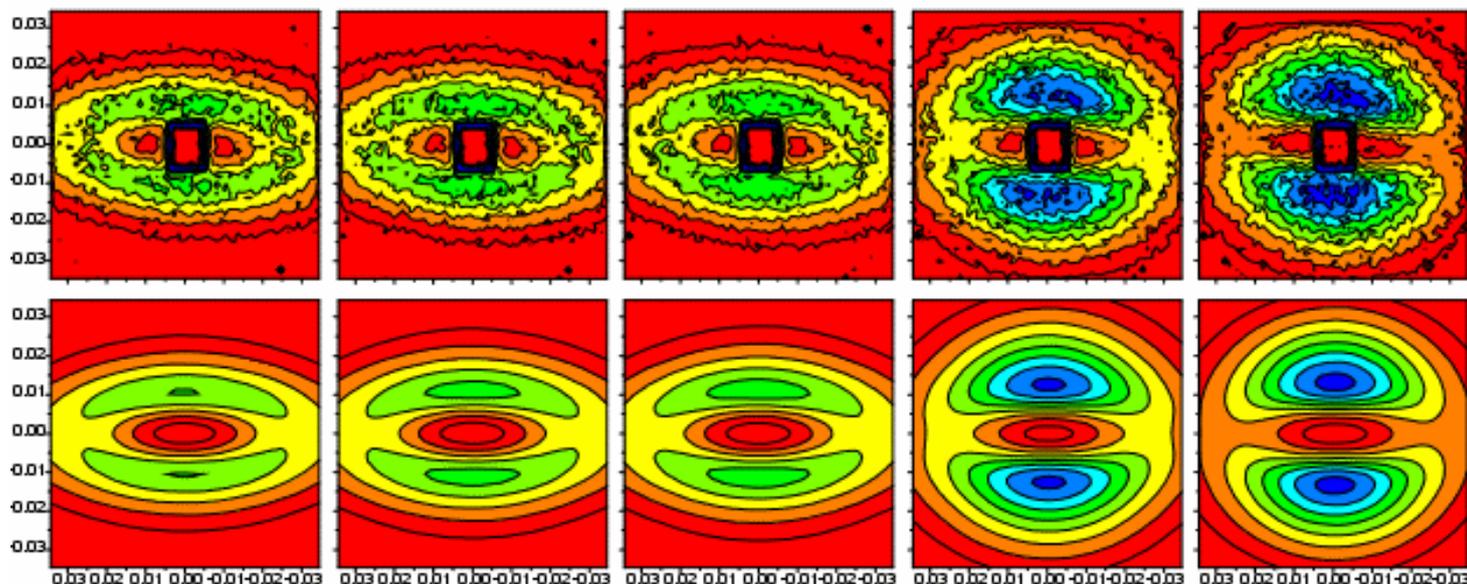
Web Pages

The committee are extremely grateful to Phil Salmon and Daniel Read for their work in establishing and maintaining the group website. This site contains many useful pages covering activities of the group and related matters, application forms for bursaries and other information. Any suggestions for material to include etc. please contact the group chair, Stuart Clarke. Please see:

www.iop.org/activity/groups/subject/lcf/index.html

Liquids and Complex Fluids Across the UK

Focus on Leeds



Experimental and theoretically predicted neutron scattering patterns from a melt of partially-labelled H-shaped polybutadienes during relaxation following a step-strain. From the group of D. Read, Leeds in collaboration with scatterers from KFA Juelich.

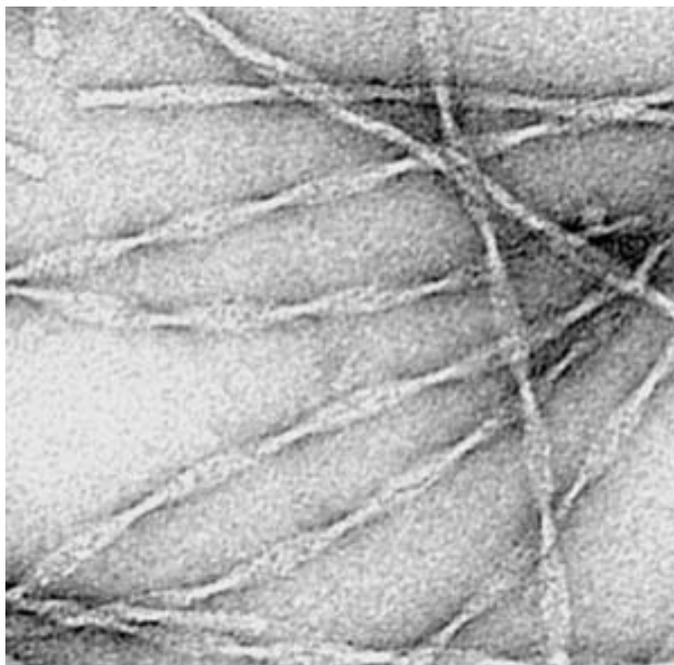
In trying to summarise work on liquids and complex fluids at the University of Leeds, the difficulty is knowing where to set the boundaries of the subject with the danger of missing out some good work: there is very significant activity, over several departments (including physics, maths, chemistry, food science, the life sciences, computing) and covering everything from fundamental science at the molecular level to engineering applications. No doubt in this short review I will miss something; I apologise in advance.

A particular area of strength at Leeds is the large concentration of theoreticians and simulators with experimentalists, especially in the fields of polymer and soft matter physics and statistical mechanics. It is a dangerous business doing theory in a vacuum, so the many experimental groups, both on site and in numerous outside collaborations, form a perfect synergy. Experimental techniques such as microscopy (atomic force, confocal, electron), rheology, microrheology, Brewster angle spectroscopy, ultrasound and scattering (light, X-rays and neutrons) are all used to investigate a variety of different systems.

Highlights of recent research:

An area receiving a lot of attention at Leeds is that of membranes: two-dimensional objects living in a three dimensional world. Biological membranes comprise many different molecules that regulate shape and function. The statistical mechanics, thermodynamics, and dynamics of these complex membranes is intrinsically interesting for its fundamental physics, such as phase

separation within membranes, coupling between composition and shape (curvature), dynamics of shape transformations, and the interplay with embedded protein dynamics. Wider afield, biologists at Leeds have a programme of structural and functional studies on several classes of membrane proteins, including membrane transporters and ion channels. One technological application being explored is the coupling of biomembranes to conducting (electrodeic) and non-conducting solid surfaces - for example to be able to convert biological signals to electronic ones.



TEM micrograph of designed peptide P11-2 fibrils with width ~ 10 nm. Group of The peptide aggregation work is mostly due to Dr Amalia Aggeli from the SOMS centre.

Self-assembly is another subject with strong biological and technological importance. Peptide molecules can assemble into a hierarchy of structures: tapes, ribbons, fibrils and fibres. Research at Leeds is exploring how these can act as building blocks for materials in diverse areas such as dentistry, catalysis, tissue scaffolds and surface coatings. Other work is focussed on block-copolymers, in particular aiming to increase the long-range order of the phase separated state for improvements in their practical application.

Leeds is the co-ordinating university for the "Microscale Polymer Processing" project, which brings together over 30 scientists from ten major UK and international Universities with industrial collaborators from BASF, Dow, DSM, Dupont, ICI, Ineos, Lucite International and Mitsubishi, to understand how molecular variables influence polymer processing. Activities specific to Leeds include theoretical modelling of polymer melt dynamics (addressing how does molecular structure such as the inclusion of branch points affect flow), polymer crystallisation, prediction of neutron scattering patterns from labelled polymers, finite element calculation of flow in complex geometries, a large effort in

experimental polymer rheology, and the study of flow and properties of two-phase polymeric systems.

Some of the most frequently encountered complex fluids in everyday life occur in food systems. The Food colloid group at the Food Science department at Leeds has a long-standing interest in understanding and manipulation of the rheological behaviour of such fluids in order to achieve novel textures and structures in food products. The group is particularly active in exploring the relation between emerging structures in food dispersions, emulsions and foams, interfacial rheology and the underlying colloidal interactions in these systems. A major focus is how these colloidal interactions are tailored by adsorption of proteins and other food grade amphiphilic biopolymers to the surface of the emulsion droplets.

All this gives me little space to mention the significant research effort in Leeds on fundamental studies of the statistical mechanics of liquids at surfaces; the statistical mechanics of driven systems at steady state; liquid crystals; flow-induced phase transitions and shear-banding; physical properties of glassy polymers.

Some useful links:

Self-Organising Molecular Systems: <http://www.soms.leeds.ac.uk/>

Astbury Centre for structural molecular biology: <http://www.astbury.leeds.ac.uk/>

Microscale Polymer Processing: <http://www.mupp2.com>

Physics department: <http://www.physics.leeds.ac.uk>

Maths department: <http://www.maths.leeds.ac.uk>

Food science: <http://www.food.leeds.ac.uk>

Daniel Read

Dept. of Applied Mathematics, University of Leeds

EPSRC Portfolio partnership, Swansea.

Portfolio Partnership in Complex Fluids and Complex Flows

The Portfolio Partnership (PP) was formed to provide the requisite scale and intensity of collaborative effort to study the behaviour of complex fluids in complex flows at the *meso*-scale (50nm to 10 m). From its inception, our principal objective has been to combine expertise in theory and experiments. The benefits of this approach have manifested themselves in areas which were planned at the PP's establishment, and in new activities which, although unforeseen at the outset, have grown in significance to become major aspects of our future research directions. Those activities are described in outline in this commentary.

Rheometry

Rheometry is a key area of our work and a principal objective of our research has been to create 'next-generation' instrumentation for the study of complex fluids, including bio-fluids (such as blood). Blood clotting abnormalities cause significant morbidity and mortality and are associated with changes in blood viscoelasticity. A

full understanding of the relationships between the microstructure of clots and their viscoelastic properties has been sought for more than 60 years but progress has required a conjunction of advances in rheometry and an appropriate quantification of the disordered microstructure of clots. We have made substantive progress towards their resolution, including the establishment of a new approach to coagulation monitoring based on an adaptation of Fourier transform mechanical spectroscopy (FTMS). We have shown how FTMS can be used to detect the establishment of incipient clots in blood. A comparison of our technique with conventional coagulation monitors indicate that the latter are not capable of detecting the incipient clot, whose establishment occurs *several minutes* prior to conventional assessments of clot formation time. The significance of our findings is that the incipient clot provides the 'template' for ensuing clot development. No adequate means has previously been available to detect this aspect of coagulation.

This aspect of our work received significant impetus with a Royal Society 'Brian Mercer' Feasibility Award (2007) to Prof. PR Williams to exploit our clot detection work in a point-of-care instrument. We are collaborating with Prof. John Weisel at the School of Medicine, University of Pennsylvania, in joint studies of fibrin network elasticity. These studies involve Dr K Hawkins, a new RCUK Research Fellow in Nanomedicine in the group.

NMR Diffusometry: Experimental and Simulation studies

Our NMR Diffusometry work is complementary to our haemorheological studies of pathological influences on clot structure. We are attempting to exploit measurements of the anomalous diffusion of protons within blood clots by studying deviations from normal diffusion, as a probe of the hindrance of free diffusion by barriers which do not involve a specific length and time scale but a *range of self-similar scales*. The NMR experiments are linked to simulations in which the variation of structural parameters is accomplished by randomly choosing points on the sample-spanning cluster of the incipient clot backbone to launch both random and self-avoiding random walkers. We are incorporating a kinetic model to influence the stochastic process which involves calculation of the various enzyme reactions using the diffusion and reaction equations pertinent to clotting factors. The simulations explore mechanisms by which diseases interfere with clot assembly. Prof. P Rees and Dr M Brown are implementing these 3D simulations on IBM's 'Blue C' (2.7 teraflop) supercomputer. A related study considers nanostructural 'templating' material within biogels. Our collaboration with Cardiff Institute of Tissue Engineering and Repair (CITER), has resulted in the *first* studies of collagen to be conducted at physiological concentrations and near-physiological temperatures. The results form the basis of new simulation studies with Dr R Daniels, an RCUK Research Fellow in Nanomedicine.

Developments in Scanning Probe Microscope (SPM) Instrumentation

A new collaboration with Dr C Wright and Dr S Conlan has developed a hybrid AFM/LSCM instrument to study the mechanical properties of cells & their interactions. This instrument will be used by other UK Groups through the EPSRC

Engineering Equipment Loan Pool, and forms the basis of work by Dr S Doak, one of our four RCUK Fellowships in Nanomedicine (2006). It also stimulated a new collaboration with Dr S Doerr (NERC Research Fellow) leading to a new NERC grant to study soil hydrophobicity and is providing the *first* ultra high resolution images of protein structures and DNA wrapping. This work is closely linked to our device fabrication/characterisation using SPM, which was instrumental in Dr O Guy obtaining an RCUK Fellowship in Nanomedicine. A highlight of this work has emerged from investigations of the fundamental interaction of gases with a surface formed from SnO₂ single crystal 8nm particles (using STM). This has allowed the electronic properties of the nanoparticles and their interaction with gases under real working conditions to be probed to for the first time. This work underpins the discovery that individual electrons may be stored for weeks within the particles on the surface by injection from an STM tip, permitting surface charge patterning on the nm scale. We have shown selective adsorption and Coulomb blockade effects at room temperature, with potential applications in molecular docking and novel electronic devices respectively, paving the way for new fabrication methods and new device architectures. We have also modelled the nanoparticle self-consistently as a charged quantum dot, taking into account exchange and correlation for the first time using a modified Kohn-Sham approximation. This work was instrumental in Dr Maffeis, a PP post-doc, obtaining a Royal Society Research Fellowship.

2. CAVITATION AND STRUCTURAL STUDIES OF STRETCHED LIQUIDS

A major component of the PP's activities involves theoretical and experimental investigations of the structural and dynamic characteristics of 'stretched' liquids and cavitation phenomena. In this work the nucleation and transformation of transient ice states after cavitation collapse of simultaneously superheated and supercooled (d-m) water are being studied for the first time. We are collaborating with Prof. J. Dore (U. of KenT) and Dr. M-Claire Bellissent at the Laboratoire Leon Brillouin, CEA Orphee, Saclay, and are adapting our cavitation techniques for use in neutron diffraction experiments. The results constitute new information concerning the complex properties of water and ice. A significant finding to date is that the ice which forms from d-m water is not the normal form of ice-I. A tentative assignment of ice VIII has been made prior to more extensive studies. A key objective is to determine the spatial correlations for 'constant density' water over an intermediate length-scale and the dynamical characteristics of the molecular motion over a range of time-scales, and to investigate their variation as a function of temperature and density. Under tension the connectivity of water's H-bond network may become disrupted, with the creation of micro-voids.

3. COMPUTATIONAL AND NUMERICAL WORK

In addition to experimental work, our activities involve complementary efforts in the development of numerical simulation tools with the predictive capabilities required to underpin experimental advances. The key challenges are the development of physically realistic models, and the design of efficient computational models for solving complex flow problems, including multiphase

flows. Our key achievements on Multiphase Flows include an interface capturing algorithm using a marker-particle method which has been developed to study the full break-up of a hexane droplet in a gas flow. A multiphase lattice Boltzmann method has been developed for immiscible binary fluids with variable viscosities and density ratio using a single relaxation time for each fluid and the spinodal decomposition of two fluids and the rising bubble problem have been simulated. Our work on the extended pom-pom (XPP) model for Branched Polymer Melts has shown that it possesses some disconcerting attributes - multiple solutions are found in simple steady shear and uniaxial extensional flow, and it predicts positive and negative values for the second normal stress difference. The predictive capability of the pom-pom model and the accuracy of the spectral element method have also been investigated for a well-characterised LDPE, and Graphical User Interface software has been written to fit rheometrical data in order to predict the shear and extensional rheology of different models.

Experimental and Computational Studies of Lubricant Flows link our simulations to cavitation measurements. A new model has been derived which treats the lubricant as a compressible fluid. The model includes different equations of state, and temperature and pressure dependent viscosity. For speeds of sound in the region of those of multigrade oils, compressibility is shown to enhance load bearing capacity and this effect is amplified as the eccentricity ratio approaches unity. Elasticity has been incorporated into a compressible model, which has involved a review of the principle of objectivity. Using techniques from differential geometry we have shown the need to work with the relative left Cauchy-Green tensor (and not the relative right Cauchy-Green tensor) when working with integral constitutive relations. In our work on **Computational Tools for Kinetic Theory Models**, efficient spectral methods have been developed for solving the Fokker-Planck equation that will allow treatment of multi-bead spring models. Numerical methods for solving the Fokker-Planck equation have suffered from the so-called 'curse of dimension'. However, efficiency has been established using a reduced basis function method that requires far fewer degrees of freedom than traditional tensor product methods. This approach has been used to solve models such as the FENE model, for which no closed form differential constitutive equation exists, and is therefore applicable to a wider class of constitutive models.

We are also engaged in the prediction of contraction flows, a topic of wide industrial application e.g. for process design and control. This entails the prediction of vortex development, pressure-drop and stress build-up and includes studies of kinetic-based and worm-like micellar systems. Breakthroughs have been achieved in the capture of enhanced excess pressure drops for strain-hardening fluids relevant to the industrial processes of enhanced oil-recovery; and in establishing predictive capability for branched polymer melts (pom-pom models) and viscoelastic surfactants. A related study has focussed on the exploitation of viscoelastic secondary flows in contraction geometries for the production of high-value products. A significant discovery is that radically different flow phenomena

arise within complex transient flows, depending on boundary condition type. *Substantial sweeping vortices* may be generated through flow-rate control and specific rheological settings. This indicates the need for *strong strain-hardening properties*, and new pom-pom predictions reveal *molecular backbone stretch* at the periphery of vortices. In a further study, compressibility has been successfully incorporated into our incompressible flow solvers of pressure-correction form, for complex flow problems at low to vanishing Mach numbers. Our simulation efforts are closely linked to experiments in extensional rheometry.

Rhodri Williams, Swansea

Newsletter Contributions

The newsletter editor, Stuart Clarke, welcomes any comments or additional material that members would like to submit for consideration for future editions.

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The Institute of Physics, 76 Portland Place, W1B 1NT, UK.

Tel: 020 7470 4800

Fax: 020 7470 4848