Institute of Mathematics and Physics, Aberystwyth University, Seminar Programme, Autumn 2010

January 17, 2011

- Wednesday 25th August, 14:10, Room 231
- Dr Chris Nicklin
  Diamond Light Source
- Science at grazing incidence on beamline *I*07

- Wednesday 1st September, 16:30, Room 231
- Prof. Bob Newport
  University of Kent, Canterbury
- Total scattering of bioactive ceramics

- Wednesday 15th September, 15:10, Room 319
- Christina Cerny

  University of Nottingham
- Title:

  A six-term cyclic sequence in KK-theory for the Toeplitz extension of higher rank Cuntz-Pimsner algebras
  (no KK-theory required)

- Friday 5th November, 10am, Room 321

- Dr Benjamin Dollet

  Institut de Physique de Rennes, CNRS/Université Rennes

- Title:

  DYNAMICS OF BUBBLES, FILMS AND FOAMS: ROLE OF INTERFACIAL RHEOLOGY

Interfacial phenomena at air/water interfaces are fundamental to understand the physics and fluid mechanics associated with bubbles, soap films, and foams. The surfactant molecules (soap, phospholipids, proteins) generally covering these interfaces not only lower surface tension, but also often give rise to an interfacial viscoelasticity. We show the crucial influence of surface rheology through three series of experiments: oscillations of ultrasound contrast agent microbubbles, fast dynamics of soap films, and 2D flows of foam.

Ultrasound contrast agents are microbubbles which are encapsulated by a phospholipid monolayer, both to prevent them from too fast dissolution and to carry therapeutic molecules for targeted drug delivery. In medical applications, once injected in the blood pool, they constitute very efficient ultrasound scatterers, which enables to image organ perfusion or to detect tumors. We have developed an optical spectroscopy method, and showed that the resonance properties of the contrast agents shows that the viscoelasticity of the phospholipid monolayer modifies drastically their response compared to uncoated gas bubbles [1].

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Fast and/or confined film and foam flows are of great practical interest, because of the use of foams in porous media for enhanced oil recovery, and of the development of microfluidics with bubble assemblies. We first present an elementary experiment at the scale of single soap films pushed through tubes. Varying their velocity, we observe that SDS films get curved downstream, and we show that film rupture occurs as the film curvature exceeds that of the tube [2]. With another solution (SLES/CAPB/myristic acid) giving strongly viscoelastic interfaces, the behaviour is totally different; soap films are deformed at much lower velocity, with a strong dependence on the amount of liquid. We identify an intermittent flow regime, reminiscent of stick-slip in solid friction.

Moreover, we show by tracer-tracking that the moving film has a long-range influence on the wetting film ahead of it. We also present measurements of the 2D flow of foam through a contraction [3] or blown by a localised overpressure, where we can measure the full elastic, plastic and viscous response by image analysis. We evidence again a dramatic influence of the interfacial viscoelasticity, which controls a transition from quasistatic behaviour up to total rupture of the foam through a rich variety of intermediate out-of-equilibrium configurations.

[1] S. M. van der Meer et al., J. Acoust. Soc. Am. 121, 648 (2007).

[2] B. Dollet, I. Cantat, J. Fluid Mech. 652, 529 (2010).

[3] B. Dollet, J. Rheol. 54, 741 (2010).