

# Institute of Mathematics and Physics, Aberystwyth University, Seminar Programme, Autumn 2008

November 25, 2008

- Friday 3rd October, 9:30, Room 231 (SEL/Data Room)
- Dr. A.C. Barnes
- H.H.Wills Physics Laboratory
- University of Bristol
- Title: The structures of Rare Earth Aluminate liquids and glasses and their relation to polyamorphism and the liquid-liquid phase transition.

- Thursday 9th October, 15:10, Room 321
- Prof. Davide Bigoni
- University of Trento (Italy)
- Title: The perturbative approach to material instability
- Abstract: The perturbative approach to material instability proposed by Bigoni and Capuani (J. Mech. Phys. Solids, 2002; 2005) consists in the analysis of the response to an incremental perturbation of a uniformly deformed infinite body subject to remote, finite strain. The approach is shown to reveal features which remain undetected using conventional methods based on local stability criteria, for instance, it provides a mechanical interpretation to flutter instability in a continuum. Different perturbing agents can be employed, namely, concentrated forces and dipoles, fractures and rigid inclusions. These agents can also be randomly distributed and may simulate long-range effects of a dislocation distribution. Finally, the perturbative approach permits analytical solution for a finite-length shear band in an infinite prestressed material subject to Mode II loading, providing justification of the experimental observation that shear bands are preferred failure modes in ductile materials.

- Friday 17th October, 16:00, Room 319
- Dr. Anne Juel
- Manchester Centre for Nonlinear Dynamics
- School of Mathematics, University of Manchester
- Title: Anomalous bubble propagation in elastic tubes
- Abstract: Airway reopening is an important physiological event, as exemplified by the first breath of an infant that inflates highly collapsed airways by driving a finger of air through its fluid-filled lungs. Whereas fundamental models of airway reopening predict the steady propagation of only one type of bubble with a characteristic rounded tip, our experiments reveal a surprising selection of novel bubbles with counter-intuitive shapes that reopen strongly collapsed, liquid-filled elastic tubes. We characterise these bubbles in terms of their dimensionless speed and the initial level of tube collapse, and find sub-critical exchanges of stability between them. Moreover, our multiple bubbles are associated with a discontinuous relationship between bubble pressure and speed that sets exciting challenges for modellers.

- Thursday 23rd October, 15:10, Room 321
- Prof. Vitali Liskevich
- Department of Mathematics, University of Wales Swansea
- Title: On positive solutions of semilinear and quasilinear equations with measurable coefficients in unbounded domains
- Abstract: We will discuss the problem of existence and nonexistence of positive solutions to semilinear and quasilinear elliptic equations on unbounded domains. The main emphasis is on the stability of the critical exponent under perturbations by lower order terms. The domains to be considered are mainly exterior domains and cone-like domains. Examples demonstrating sharpness of the results will be presented

- Wednesday 29th October, 2pm, Room 502
- Dr John E. Snyder
- Senior Lecturer

Wolfson Centre for Magnetics, School of Engineering  
Cardiff University, Cardiff, Wales, UK

- Title: Tailoring the Properties of Cobalt Ferrite-Based Magnetoelastic Materials to Enable Advanced Sensing and Actuating Applications
- Cobalt ferrite-based magnetoelastic materials show considerable promise for the development of advanced noncontact stress sensors and actuators, and for integration with oxide ferroelectric/piezoelectric materials to form two-phase nanocomposite multiferroics. In sensor and actuator applications, signals can be coupled out or external stimulus coupled in through a magnetic field, thus enabling "wireless" modes of operation. In multiferroic applications, a magnetic field can directly produce an output voltage, or an electric field switch the magnetization.

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Cobalt ferrite-based materials have some major advantages over metallic magnetoelastic materials for either type of applications: The high resistivity enables high-frequency actuator or sensor application. It also prevents shorting out the piezoelectric voltage in nanocomposite multiferroics. And the composition and structure of these oxides makes them compatible with oxidizing environment applications, and desirable for integration with oxide electronics for enhanced functionality devices. In order to enable such applications, we need to understand how to control and tailor the magnetic and magnetoelastic properties of these materials. To that end, we have developed "families" of cation-substituted cobalt ferrites with enhanced properties. This talk will review progress in our ongoing research program: investigations of how substitutions of  $Mn^{3+}$ ,  $Cr^{3+}$ ,  $Ga^{3+}$  or  $Ge^{4+}/Co^{2+}$  for  $Fe^{3+}$  affect the magnetic and magnetoelastic properties of cobalt ferrite, and our understanding of how these substitutions affect the cation site occupancies, and they, in turn, determine the magnetic and magnetoelastic properties. The talk will include discussion of Mossbauer spectroscopy results, planned EXAFS investigations, and proposed future work on pulsed laser deposition (PLD) of cobalt ferrite and cobalt ferrite-based nanocomposite thin films.

- Thursday 30th October, 15:10, Room 321
- Dr Christakis Pallikaros
- Title: On root subsystems and involutions in the symmetric group
- Abstract: We investigate root subsystems which have a given involution in the symmetric group as their longest element. We relate such root subsystems to decreasing subsequences appearing in the row- form representation of the involution and to the shape of the pair of tableaux corresponding to the involution under the Robinson-Schensted-Knuth process. Finally, we link the above with the representation theory of the symmetric group.

- Monday 3rd November, 14:00, Room 231 (SEL)
- Dr. Justin Wells
- University of Trondheim, Norway
- Title: Conductivity measurements on molecular layers, ultra-thin metal films and semiconductor surfaces.
- Abstract: Measurements of conductivity play a central role in macro-scale solid state physics. However, only very recently have nano-scale measurements been possible. By performing measurements on such small scales, surface-sensitive measurements can be made, and due to the changed symmetry conditions at surfaces, this facilitates the study of 2D phenomena. In the first part of this presentation the method and instrumentation will be described. This will be followed by some examples; the surface of clean and adsorbate covered Si(111).

- Thursday 13th November, 15:10, Room 321
- Dr Alexander Plakhov (IMAPS)
- Title: Billiards and applications to optimal mass transport and aerodynamics of rarefied media
- Minicourse I
- It is planned to tell about billiard scattering in the exterior of a bounded set. The following questions will be addressed:
  - ① Newton's problem of minimal resistance.
  - ② Bodies of zero resistance and bodies invisible in one direction.
  - ③ Scattering on rough surfaces.
  - ④ Minimal and maximal resistance problems for some vaulting bodies and optimal mass transport.
  - ⑤ Magnus effect, that is, deflection of the trajectory of a spinning ball.
  - ⑥ Retroreflectors: optical devices that reverse the direction of light beams.

- Thursday 20th November, 15:10, Room 321
- Dr Alexander Plakhov (IMAPS)
- Title: Billiards and applications to optimal mass transport and aerodynamics of rarefied media
- Minicourse II
- It is planned to tell about billiard scattering in the exterior of a bounded set. The following questions will be addressed:
  - ① Newton's problem of minimal resistance.
  - ② Bodies of zero resistance and bodies invisible in one direction.
  - ③ Scattering on rough surfaces.
  - ④ Minimal and maximal resistance problems for some vaulting bodies and optimal mass transport.
  - ⑤ Magnus effect, that is, deflection of the trajectory of a spinning ball.
  - ⑥ Retroreflectors: optical devices that reverse the direction of light beams.

- Thursday 27th November, 15:10, Room 321
- Dr Sonia Schirmer
- Department of Applied Mathematics & Theoretical Physics
- University of Cambridge
- Title: Control Paradigms for Quantum Engineering & Applications

Many different paradigms for quantum control from open-loop Hamiltonian (and sometimes reservoir) engineering to feedback control, either based on a measurement record or coherent feedback, have been proposed. All of these have useful applications but also limitations, and in practice a combination of different control paradigms will be necessary. I will start with a brief overview of the main paradigms for quantum control and then focus in particular on optimal control techniques and related applications in quantum information processing such as quantum gate engineering. I will briefly review standard gradient-based techniques for optimization based on approximating the fields by piecewise constant functions and show how this parametrization can lead to theoretically 'optimal' control solutions that are far from optimal in practice. I will then show how these results can be improved using an alternative frequency-domain optimization approach inspired by spectral pulse shaping.

- Friday 28th November, 15:30, Room 231 (SEL)
- Dr Alexander Plakhov (IMAPS)
- Title: Billiards and applications to optimal mass transport and aerodynamics of rarefied media
- Minicourse III
- It is planned to tell about billiard scattering in the exterior of a bounded set. The following questions will be addressed:
  - ① Newton's problem of minimal resistance.
  - ② Bodies of zero resistance and bodies invisible in one direction.
  - ③ Scattering on rough surfaces.
  - ④ Minimal and maximal resistance problems for some vaulting bodies and optimal mass transport.
  - ⑤ Magnus effect, that is, deflection of the trajectory of a spinning ball.
  - ⑥ Retroreflectors: optical devices that reverse the direction of light beams.

- Thursday 11th December, 15:10, Room 321
- Vu Hoang
- Department of Mathematics, University of Karlsruhe
- Title: Spectral Floquet-Bloch theory with discontinuous coefficients
- Numerous applications require the study of PDEs with spatially periodic coefficients, such as the propagation of electromagnetic waves in (possibly artificial) crystals. Floquet-Bloch theory characterises the spectrum of periodic differential operators by considering certain spectral problems on a single periodicity cell. We show how to deal with discontinuous material coefficients (dielectric permittivity, etc.) which can create mathematical difficulties on the operator theoretic level (joint work with M.Brown, M.Plum and I.Wood).