UK and Republic of Ireland SIAM Section Annual Meeting

11th January, 2002

A taste of the diversity of industrial and applied mathematics activity in the UK and the Republic of Ireland was provided by the 6th annual meeting of the UKIE section of SIAM which was held at Leeds University on January 11th. Organised by the section officers - David Parker (President), Ivan Graham (Vice-President) and Peter Jimack (Secretary) - the meeting saw over 50 people gather to hear talks on subjects ranging from mathematical biology to quantum chaos.

The academic part of the conference was opened by Brian Sleeman (University of Leeds) who discussed mathematical modelling of tumour angiogenesis. Beginning with the question `What is a tumour?', he outlined the basic biology of vascular tumours and the mechanism by which their growth is stimulated by blood flow from nearby capillaries. He then presented a mathematical model based on reinforced random walks which modelled first the creation of a capillary sprout caused by penetration of a growth factor through the capillary wall, and then the growth of this sprout through the extra cellular matrix to join with the tumour and enhance its blood supply. Finally, he briefly explained how the use of angiostatins to cut off this blood supply to the tumour holds the promise of developing an alternative to cancer treatments such as chaemotherapy.

The second talk was scheduled to have been presented by SIAM president Tom Manteuffel, who sadly had to withdraw at short notice due to illness. Fortunately, the organisers obtained the services of an excellent late replacement in Nick Higham (University of Manchester), who gave a talk about structured eigenvalue problems. The theme of the talk was how to test for the presence of a particular type of structure in a matrix problem, and how close the given problem was to one without this structure. He began with the idea of testing for definiteness in a generalised eigenvalue problem, introducing the notion of the Crawford number which can be used to characterise definite pairs of matrices. He then presented two methods for calculating the Crawford number of a given matrix pair, first a simple bisection algorithm and then a more sophisticated level set method. His talk finished with a discussion of hyperbolic and elliptic structure in the quadratic eigenvalue problem, which can also be identified by means of the Crawford number.

The morning session was concluded by Jens Marklof (University of Bristol), who again had kindly agreed to speak at short notice after a late cancellation. His presentation, entitled "Pseudo-Random Numbers, Spectra and Waves", was concerned with aspects of quantum chaos relating to the statistical properties of the eigenstates of quantum systems. After demonstrating numerically the pseudo-random nature of the eigenmodes of the Helmholtz equation in a rectangular domain with a circular hole, Marklof introduced the concept of

quantum ergodicity and explained that it is generally not understood whether all (and not just almost all) highly excited eigenfunctions of an ergodic quantum system will become equidistributed in the classical limit on the available classical phase space. He then considered the question of whether or not random properties of ray dynamics can be seen via properties of the eigenvalues, and described the Berry-Tabor conjecture which states that the eigenvalues have a spacing distribution of independent random variables from a Poisson process. This has been proved for some special cases.

After lunch, John Willis (University of cambridge) talked about problems involving the propagation of a crack through a three-dimensional solid and, in particular, what happens when such a crack hits an obstacle and a disturbance is created which does not disperse with time. After setting up an equation for the crack surface, he showed how a model can be formulated and solved for the unperturbed problem, with perturbation techniques then used to model the effects caused by the obstacle. Willis then illustrated how a dispersion relation can be obtained for a crack front wave, that is, a disturbance associated with a constant energy release rate. He ended his presentation with another application of this technique, this time to asses the stability of a crack to an out-of-plane disturbance for an elastic medium in two dimensions.

The mathematical part of the day was completed by John Gibbon (Imperial College, London) who spoke about singularity formation in stretched three-dimensional solutions of the Euler equations. After introducing the incompressible Navier-Stokes and Euler equations, the speaker raised the question of when there are alignments of vorticity with eigenvectors of the strain matrix in the vortex stretching term: this phenomenon would not be expected from `random' turbulence, but is observed in practice, for example with a Burgers' vortex tube. He then introduced the idea of `stretching' a two-dimensional Navier-Stokes solution with a linear z-dependence to obtain a vortex tube with more space dependence, and described how to characterise its horizontal and axial variation. Which of these two spatial variations dominates depends on a particular parameter whose dynamics can be studied to give insight into the fluid behaviour. To finish, Gibbon briefly described the application of these ideas to the incompressible ideal MHD equations.

The official proceedings concluded with a brief business meeting. Section president David Parker commented on the continuing high standard of talks and good attendance at the annual meetings, although he expressed disappointment at the number of postgraduate attendees: members were encouraged to be more vigorous about promoting the event with graduate students. He also asked for nominations for the post of secretary which will become vacant in the spring. President of the London Mathematical Society Trevor Stuart (Imperial College, London) intimated that he had not made progress with enquiries that he had made over obtaining a reciprocal

LMS/SIAM membership deal, but that he will continue to pursue this. Current secretary Peter Jimack gave a report of section activities throughout the year and asked for suggestions from members for future projects. The issue of the possibility of hosting a mainstream SIAM conference in the UK or Republic of Ireland was again raised, and is something that UKIE members are very keen to see happen.

The day was rounded off by a splendid meal for those whose travel arrangements permitted. Overall, this was another well-organised and well-attended meeting in a series which reflects the continuing high standards and range of applied mathematics currently studied in the UK and Republic of Ireland.

Further details about the UKIE SIAM section can be found at http://www.comp.leeds.ac.uk/siam/.

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