

# Report on the 13th Scottish Computational Mathematics Symposium

September 9-10th, 2004

The Scottish Computational Mathematics Symposium (SCMS)

(see <http://www.ma.hw.ac.uk/scms/>)

has been held every year since 1992, with the aim of bringing together mathematicians and others who develop computer algorithms to solve mathematical problems. Each meeting features invited speakers from across the spectrum of theoretical and practical numerical analysis.

The 2004 meeting, under the title *Numerical Analysis of Differential Equations*, was used as an opportunity to mark the retirement of Professor David Sloan from the 1825 Chair of Mathematics after 39 years of service to the University of Strathclyde. David Sloan has contributed to the numerical analysis and applied mathematics communities in the UK and beyond in a number of ways: through high-quality research, supervision of PhD students and guidance of younger researchers, co-organisation of the SCMS, and his service on many external committees, including numerous roles for the UK's Engineering and Physical Sciences Research Council (EPSRC) and panel membership of the 2001 Research Assessment Exercise.

The  $1\frac{1}{2}$  day meeting in September 2004 at the University of Strathclyde focussed on areas of strength of the UK numerical differential equations community, with invited presentations by leaders in the field. Key themes of the meeting were *adaptivity* and *structure preservation* for *nonlinear* problems.

The meeting attracted over 60 participants, including 14 postgraduate students, with many others joining in the conference dinner.

The opening speaker, Nick Trefethen (Oxford University), gave a wide-ranging overview of interpolation in Chebyshev points. Developed around five theorems that “ought to be well known”, his talk finished with an interactive demonstration of a system that overloads MATLAB in order to work on continuous “chebfun” objects. Nick Trefethen's predecessor at Oxford, Bill Morton, gave a talk that emphasized the need to reproduce key properties when approximating PDEs. Taking groundwater flow and wave equations as examples, he mentioned some widely-used properties—maximum principle, variational principle, characteristic properties, conservation laws—and a

more modern one—symplecticness. It was perhaps encouraging to at least one member of the audience that Bill’s talk covered work undertaken while in very active “semi-retirement” at the University of Bath. David Griffiths (University of Dundee) continued the hyperbolic theme by considering the numerical simulation of advection equations through irregular grids. Dispersion and group velocity were studied on (a) smoothly varying grids and (b) mapped grids. In particular, results from the literature on sensitivity to grid perturbations were explained. The first morning session was completed by Bengt Fornberg (University of Colorado), who described a new fictitious point method for implementing boundary conditions with spectral methods. Results were presented for the Kuramoto-Savishinsky equation, and the importance of accurately resolving time-space corner singularities was illustrated.

After lunch, Andrew Stuart (University of Warwick) discussed a stochastic PDE approach for sampling paths of stochastic differential equations, conditional on observations; work motivated by applications in smoothing and filtering. He made the point that this area offers a range of technical and practical challenges to numerical analysts. Alastair Spence (University of Bath) then talked about issues in large scale nonsymmetric eigenvalue computations. He developed a convergence theory for inexact inverse iteration and for a useful reformulation called “inverse correction”. Experiments on large scale finite element systems illustrated the theory. Bob Russell (Simon Fraser University), stepped off a plane and gave a talk that surveyed the use of moving mesh methods for solving time-dependent parabolic PDEs. He discussed connections between seemingly different approaches and suggested a number of directions for future research in this area. The final speaker of the first day was Bill Sloan, a civil engineer at the University of Glasgow. After an amusing, illustrated mini-biography of his father (David Sloan), Bill talked about his own research on the mathematical modelling of engineered biological systems. His work deals with small-scale waste treatment facilities in developing countries; a topic that has a direct effect on the health and wealth of individuals and populations.

An evening dinner followed, during which Alistair Watson (University of Dundee) gave a highly entertaining speech, to which David Sloan responded admirably.

On the Friday morning, Weizhang Huang (University of Kansas) continued the theme discussed by Bob Russell, focusing on the equidistribution principle. A key challenge here is to develop an approach that is suitable

for PDEs in more than one space dimension. Endre Süli (Oxford University) talked about discontinuous Galerkin methods, which were introduced in the early 1970s and have seen a recent upsurge of interest because of their computational convenience and their ability to perform successfully without excessive numerical stabilization. He discussed stability, accuracy and adaptivity issues for problems in computational continuum mechanics. Following a short coffee break, Arieh Iserles (University of Cambridge) reviewed recent advances in quadrature methods in the presence of highly oscillatory kernels. As in the opening talk by Nick Trefethen, the material ranged from little-known classical results to new algorithms and applications. The final speaker, Mark Ainsworth (University of Strathclyde), looked at dispersive and dissipative behavior of high order Galerkin schemes for wave propagation. One of the key themes of the talk was that simply increasing the degrees of freedom and using extra processing power is no substitute for a careful analysis of a method's underlying properties.

Overall, a packed program of 12 high-quality, topical talks in  $1\frac{1}{2}$  days produced an intensive but friendly scientific meeting. The opportunity to mark the retirement of David Sloan was welcomed by all concerned, with many tributes being paid to his achievements: notably, his important contributions to research topics described at the meeting and his leadership role of building up a thriving research group in numerical analysis at Strathclyde.

The meeting was organised by Stuart Bramley (University of Strathclyde), Dugald Duncan (Heriot-Watt University) and Des Higham (University of Strathclyde). Funding, including support for postgraduate attendees, was provided by The Engineering and Physical Sciences Research Council (EPSRC) of the UK, The ICIAM '99 Fund, The Glasgow Mathematical Journal Trust Fund, The Edinburgh Mathematical Society and The London Mathematical Society.

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September, 2004