Foreword

Gert Lube

Institut für Numerische und Angewandte Mathematik (NAM),
Georg-August-Universität, Göttingen,
Lotzestrasse 16-18, D-37083 Göttingen, Germany
E-mail: lube@math.uni-goettingen.de

Martin Stynes

Department of Mathematics,
National University of Ireland, Cork, Ireland
E-mail: m.stynes@ucc.ie

Wolfgang A. Wall

Lehrstuhl für Numerische Mechanik,
Technische Universität München,
Boltzmannstrasse 15, D-85747 Garching, Germany
E-mail: wall@lnm.mw.tum.de

Biographical notes: Gert Lube is Professor for Numerical and Applied Mathematics at the Georg-August University of Goettingen, Germany since 1993. His research interests are in numerical methods for partial differential equations with an emphasis on multiscale problems in fluid dynamics.

Martin Stynes is a Professor in the School of Mathematical Sciences at the National University of Ireland, Cork. He has worked on the numerical analysis of singularly perturbed differential equations for over 20 years and is a co-author of the leading reference textbook in this area.

Wolfgang A. Wall is Professor and Director of the Chair for Computational Mechanics at the Technical University of Munich, Germany since 2003. His research interests are in computational fluid and solid mechanics with an emphasis on computational modelling of multiscale and multiphysics problems and a current focus on applications in bio- and aerospace engineering.

This Special Issue of IJCSM contains 19 engineering and mathematics papers that consider differential equations whose solutions have boundary and/or interior layers. These papers were invited by the Guest Editors based on the research results presented at the BAIL 2006 conference, which was held in Göttingen in July 2006.

BAIL 2006 is the latest in a series of BAIL conferences that have been held in various international centres since the 1980s. This approximately biennial event has become an established forum where members of the mathematics and engineering community come together to discuss topics of mutual interest. At BAIL 2006 there were four invited lectures – three of which appear as papers here – and 72 contributed talks, some of which were given in mini-symposia that focused on specific aspects of boundary and interior layers. The original conference Proceedings on CD-ROM contained 55 papers. (The papers appearing in this Special Issue are not identical to the corresponding papers in the Proceedings.)

The papers of this Special Issue constitute a broad interdisciplinary view of current research activity into problems whose solutions exhibit layers, as we now outline.

The three invited lectures by Houston, Stynes and Wall are reproduced here as papers: that of Georgoulis, Hall and Houston considers the error analysis of the discontinuous Galerkin finite element method while Stynes gives a survey of the streamline-diffusion finite element method – both these papers are mathematical in nature – then the paper by Gravemeier, Lenz and Wall reviews the use of the variational multiscale method in the simulation of incompressible turbulent flows.

The remaining papers can be grouped as follows. Finite element methods are discussed by several authors: Al-Lawatia, Wang, Telyakovskiy and Wang (an Eulerian-Lagrangian method for time-dependent transport equations in porous media), Hartmann (discontinuous Galerkin FEM for the compressible Euler equations), John and Knobloch (the reduction of layer-induced oscillations in SUPG solutions), Kuzmin, Mierka and Turek (implementation of a $k-\varepsilon$ turbulence model in an FEM), Linß (analysis of an FEM for time-dependent reaction-diffusion problems) and Matthies and Tobiska (mass conservation in coupled flow-transport problems). Finite difference methods appear in the papers by Dunne, O'Riordan and Turner (numerical analysis of a coupled system of ODEs that model plasma sheaths), Maubach (preconditioning in convection-diffusion problems), Shishkin (analysis of a finite difference method for a singularly perturbed semilinear parabolic problem) and Tolstykh, Lipavskii and Chigarev (construction of arbitrary-order difference schemes with an application to nonlinear conservation laws). Shishkina and Wagner use a finite volume method to simulate turbulent Raleigh-Bénard convection. Alrutz and Knopp examine near-wall grid adaptation for turbulent flows. Asymptotic analyses are the main topic in the papers by Mauss, Dechaume and Cousteix (laminar flow in a channel) and Scheichl and Kluwick (turbulent boundary layers in incompressible flows). Finally, modelling is the main focus of Buschmann and Gad-el-Hak (boundary layers in turbulent flows) and Layton and Stanculescu (approximate deconvolution operators for three-dimensional turbulence in the Navier-Stokes equations).

We hope that this selection of papers gives the reader an appreciation of the current high level and variety of research activity concerned with problems whose solutions have boundary and interior layers.