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Preface

Sino-German Computational and Applied Mathematics

This short article is the epilog of the 11 preceding papers in this issue of JCM. All contributions are authored by participants of the 6th Sino–German Workshop on Computational and Applied Mathematics at Shanghai.

The 6th Sino–German Workshop on Computational and Applied Mathematics was held at the Tongji University, Shanghai, from October 9th to 13rd, 2017. The symposium enhanced the mutual understanding of the state of the art of current research on both sides and stimulated future bilateral cooperation of various topics on scientific computing; it was kindly funded by the Sino–German Center for Research Promotion (Grant No. GZ1420). The bilateral workshop followed previous ones in Berlin (2005), Hangzhou (2007), Heidelberg (2009), Guangzhou (2011), and Augsburg (2015). The Shanghai workshop brought 25 invited speakers from Chinese institutions, 13 invited speakers from German universities and 1 invited speaker from the Netherlands universities (oriented from German universities).

In the preceding 11 papers in the journal JCM, leading numerical and applied mathematicians of both sides demonstrate the remarkable advances in computational and applied mathematics.

Three papers are concerned with finite element methods of fourth–order problems. The paper by Hu and Zhang under two sparse hypotheses of nonconforming finite elements of fourth–order elliptic problems presents a new and universal a priori error analysis method which only assumes the H^2 basic regularity of exact solutions and does not use the bubble function technique in the recent medius error analysis method. A sufficient condition for these hypotheses is proposed by imposing a set of in some sense necessary degrees of freedom of the shape function spaces, and a new second order nonconforming element is designed on both triangular and tetrahedral grids. The paper by Li, Ming and Shi, by making use of the bubble function method, proposes a class of 12 degrees of freedom second order plate bending elements on triangular grids with quadratic rate of convergence. They may be viewed as the second order Specht triangle element, while the Specht triangle element is one of the best first order plate bending element. The convergence result is proved under minimal smoothness assumption on the solution. The paper by Huang, Wei, Yang and Yi designs a recovery based linear finite element method for solving the biharmonic equation. The main idea is to replace the gradient of continuous piecewise linear functions on triangular grids by recovered gradients. One relevant problem for the fourth–order problems is the Reissner–Mindlin plate model which is considered in the paper by Gallistl and Schedensack. In particular, a new numerical scheme is constructed, which is based on a discrete Helmholtz decomposition and is a generalization of the Arnold–Falk element [SIAM J. Numer. Anal., 26(6):1276–1290, 1989]. A robust best-approximation result is showed with respect to the thickness parameter t. Another relevant problem is the Stokes equations. The paper by Braack and Kaya presents a new pressure correction of the rotational incremental pressure-correction splitting method of the time-dependent Stokes equations, where the global Poisson problem for the pressure update in the original scheme is replaced by a number of smaller non-overlapping Poisson problems that are completely decoupled. The accuracy of the resulting scheme is comparable to that of the original scheme.

Two papers are related to adaptive algorithms. The paper by Carstensen and Puttkammer gives a unifying analysis of the discrete reliability of the a posteriori error estimates for nonconforming finite elements which satisfy seven hypotheses. Besides a crucial commuting property and a Poincare type inequality with explicit multiplicative constants of the error of the canonical interpolation, the main ingredient of the analysis is conforming companions which help to circumvent the non-nestedness of the nonconforming schemes. The paper by Du, Wu and Zhang analyzes the superconvergence property of the linear finite element method based on the polynomial preserving recovery (PPR) for Robin boundary elliptic problems. The superconvergence of the recovered gradients post-processed by PPR is proved and an asymptotically exact a posteriori error estimator is proposed.

Two papers consider numerical methods of multiscale problems. The paper by Altmann, Chung, Maier, Peterseim and Pun investigates a strongly heterogeneous medium saturated by an incompressible viscous fluid. A method is proposed which is based on the local orthogonal decomposition technique where local corrector problems are constructed in line with the static equations. The optimal first-order convergence of this method is proved. The paper by Helzel and Schneiders is about radial basis function methods for the Smoluchowski equation, a drift–diffusion equation on the sphere, arising in the modelling of particle dynamics. It is showed, by numerical examples, that the radial basis function methods reach an accuracy, using relatively few degrees of freedom, which is comparable with the accuracy of spectral methods.

The remaining papers cover further important topics of numerical analysis. The paper by Daniels and Hinze studies a control-constrained parabolic optimal control problem without Tikhonov term in the tracking functional. A variational discretization of its Tikhonov regularization is used and robust a-priori estimates are established depending on the problem's regularity for the error between the discretized regularized problem and the limit problem; while the paper by Duan and Tang constructs a discontinuous Galerkin (DG) one stage scheme for the Hamilton–Jacobi equation. Instead of the usual Cauchy-Kovalewski procedure, the new scheme makes use of a local continuous space time Galerkin predictor to achieve high order accuracy both in space and time.

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