Commun. Comput. Phys.
10.4208/cicp.2018.hh80.preface

Vol. **24**, No. 4, pp. i-iii
October 2018

Preface

Special Issue Dedicated to Professor Houde Han's 80th Birthday

With great joy and enthusiasm, we are proud to present this special issue of the journal of *Communications in Computational Physics* (CiCP), in honor of Professor Houde Han on the occasion of his eightieth birthday.

Professor Han received his B.S. degree in Mathematics from Peking University in 1960. He began his scientific career as an Assistant Lecturer, 1960–1979, then as a Lecturer, 1979–1982, and then as an Associate Professor, 1982–1986, at Peking University. He moved to Tsinghua University as an Associate Professor in 1986 and was promoted to Professor in 1987 and retired from there in 2005. He had held a Visiting Professorship at the University of Science and Technology of China in Hefei during 2004–2010. Professor Han has made significant contributions in scientific computing and numerical analysis, especially on the development and analysis for the artificial boundary method, infinite element method and finite element method for solving partial differential equations (PDEs).

A main aspect of Professor Han's work focused on the artificial boundary method for PDEs on unbounded domains. Based on the mode expansion technique for exterior problems and adapting proper transmission conditions at the chosen artificial boundary, he together with his collaborators has designed and analyzed high order artificial boundary conditions (ABCs) for many important time-independent problems and initial-boundary value problems which are arising from physics, fluid mechanics, linear elasticity, etc. In particular, he established the optimal error bound of the artificial boundary method for the exterior problem of Poisson equation, involving a few asymptotic parameters, such as mesh size, location of the artificial boundary, and the number of terms used in the approximate artificial boundary conditions. In addition, his work on the time-dependent problems on unbounded domains has resulted in new special functions which were not introduced previously. With his collaborator, Professor Han published a monograph titled *Artificial Boundary Method*.

Another research topic closely related to the artificial boundary method is the boundary integral equation method. Professor Han studied carefully the derivatives of double-layer potentials, and derived new formulations for them. These new formulations maintain the self-adjointness of the boundary integro-differential equations which are equivalent to the original boundary value problem with Neumann boundary condition. He also developed symmetric and skew-symmetric coupling methods between finite element method and boundary element method. A remarkable advantage of the symmetric coupling method over the non-symmetric method is that the resulting linear algebraic system is symmetric, while its equivalent skew-symmetric formulation admits the coercive property of the coupling problem for the given symmetric coercive problem. This property can be directly applied to prove the optimal error estimate of the numerical solutions.

Singular perturbation problem appears in various disciplines and dates back to the boundary layer problem presented by Prandt in 1904. A common feature of this kind of problems is that one or more small parameters are getting involved. The key ingredient of a successful numerical method is to determine the correct solution ansatz. Together with his collaborators, Professor Han studied the singular perturbation problem of elliptic type, and derived its high-order asymptotic solution expansions. He proposed tailored finite point method, which is able to capture the boundary or interior layers of solutions of singularly perturbed problems on a given coarse grid. Furthermore, for the convection-dominated diffusion problems, he developed an iteration method along the convection direction. It turns out that this method demonstrated an efficient numerical convergence.

Professor Han has also made significant contributions to some other research topics, such as the numerical method for ill-posed problems, the lower-order rectangular nonconforming finite element, and the fast iteration method for infinite element method. In 1982, he proposed the energy regularization method to overcome the numerical instability of the ill-posed problems. In 1984, he developed the lowest-order nonconforming rectangular finite element by using the cell center and the edge centers as the degrees of