Workshop on Computational Mathematics

10 May (Friday) 2013

Room: 118

Graduate School of Mathematical Sciences, The University of Tokyo

10:15-11:00

Professor Eric Chung
(Chinese University of Hong Kong)

"Multiscale simulation of waves"

Abstract:
Numerical simulation of elastic and acoustic wave propagation utilizes increasingly large and complex models, providing more realistic and useful results. However, significant challenges remain as direct simulations on fine grid are computationally prohibitive. While in some cases, effective medium theories may be useful, in other situations the distribution of heterogeneities may have more complex effects on waves. We present our results of a new multiscale finite element algorithm for simulating acoustic wave propagation in heterogeneous media. The wave equation is solved on a coarse grid using multiscale basis functions. These multiscale basis functions are chosen as the most dominant modes among the set of all fine grid basis functions, and thus allowing a coarse representation of complex wave structures. Numerical results demonstrate the performance of the method. Long term developments have strong potential to enhance inversion algorithms, since the basis functions need not be regenerated, allowing faster simulations for repeated calculations needed for inversion.

11:00-11:45

Professor Zhonghua Qiao
(The Hong Kong Polytechnic University)

"Energy stability analysis and adaptive time-stepping strategy for nonlinear diffusion equations"

Abstract:
In this talk, I will review our recent works on some nonlinear diffusion equations, which have the dissipative mechanism in energy laws, such as, the dynamics of the molecular beam epitaxy (MBE) model, the Cahn-Hilliard model, the phase-field crystal model, etc. The numerical simulations of these models require very long time computations to reach the steady state. In our research, we have developed some unconditionally energy stable schemes which can preserve the discretized energy decay properties for these models. By using the energy stable schemes, an adaptive time-stepping strategy has been introduced. The energy is used to monitor the change of the time steps. Large time steps are used when the energy decays rapidly and small time steps are adopted otherwise. The numerical experiments demonstrated that the CPU time is significantly saved for long time simulations, and both the steady states and the dynamical behaviors are resolved accurately.

13:30-14:15

Professor Manabu Machida
(University of Michigan)

"Recursion algorithm for the inverse Born series"

14:30-15:15

Professor Leevan Ling
(Hong Kong Baptist University)

“On method of fundamental solutions for solving Cauchy problems”

Abstract:
The method of fundamental solutions (MFS) introduced by Kupradze and Aleksidze in 1964 has become a popular meshless method for solving various PDEs of practical importance. As a boundary-type meshless method, MFS is computationally cheaper than other domain-type meshless methods. More importantly, the accuracy of some MFS approximations can approach the order of machine epsilon, or so it is claimed. Users simply provide the location of the boundary of the domain of the problem. It is unnecessary to create a mesh over the entire region or its boundary, which turns out to be extremely helpful in solving inverse problems of various types. To investigate the applicability of the MFS in solving Cauchy problems, a series of carefully designed numerical experiments, on both direct and inverse problems, is carried out. In this talk, the true approximation power of MFS will be revealed. (This project was supported by the CERG Grant of the Hong Kong Research Grant Council and the FRG Grant of the Hong Kong Baptist University.)

15:15-16:00

Professor Kazufumi Ito
(North Carolina State University)

“Control of Variational Inequalities”

Abstract:
We discuss the optimal control problem for parabolic variational inequality and Cahn-Hillard Navier Stokes system. The Lagrange multiplier formulation is discussed and the necessary optimality is derived.