Institut für Angewandte Mathematik

Leibniz Universität Hannover

Workshop

„ Recent trends in Applied Mathematics“

Ort: Raum c311, Gebäude 1101, Welfengarten 1, 30167 Hannover

Datum: Mittwoch 08.08.2018

13:00 „Nonlocal shallow-water wave equations”

Dr. Gabriele Brüll (KIT, Karlsruhe)

Abstract: I am going to present some recent results in the context of nonlocal shallow-water model equations. Probably the most famous nonlinear water-wave model equation is the Korteweg-de Vries equation (KdV), which appears in the context of irrotational, small-amplitude, shallow-water waves. The KdV equation displays a strong balance between nonlinearity and dispersion, which leads to the existence of solitary solutions. However, when it comes to other typical water-wave phenomena the KdV equation displays some shortcomings. It lacks for instance the ability to describe wave breaking or nonsmooth traveling-wave solutions. In 1967 Whitham proposed to study the KdV equation when replacing its dispersion relation by the exact dispersion relation of the linearized Euler equations. The resulting equation is genuinely nonlocal and its dispersion much weaker (2.5 orders) than that of the KdV equation. Whithams conjectures that this equation forms wave breaking in finite time and admits steady solutions which are not smooth were recently answered affirmatively. In this talk, I give a short introduction to the Whitham equation and present a joint work with M. Ehrnström and L. Pei, where we proved that any solitary solution of the Whitham equation decays exponentially, is symmetric and has exactly one crest. Thereby they capture precisely the properties of the corresponding solutions to the Euler equations. In a second part, I am going to discuss briefly an ongoing work with R. Dhara on the existence and regularity of highest waves for the fractional KdV equation.

•14:30 „ Advance numerical methods for solving stochastic and deterministic equations“

Dr. Amirreza Khodadadia (Universität Wien)

Abstract: In this presentation, we deal with the numerical challenges in stochastic and deterministic PDEs and present advanced numerical techniques for solving the equations efficiently. We first consider the error analysis and provide the a-priori and a-posteriori error estimates for different elliptic, parabolic and hyperbolic equations. We also show that the obtained convergence rates for both time and space discretization are optimal. One of the desirable numerical methods considered here is the adaptive finite element method (FEM). The technique enables us to provide the error indicator for the coupled system of equations. Furthermore, mixed finite element methods are employed to convert fourth and second order PDEs to a system of equations (using auxiliary variables). Both techniques have been used for deterministic and stochastic equations. For stochastic parabolic and elliptic equations, in order to decrease the computational effort noticeably, several numerical techniques such as optimal multilevel (quasi-) Monte Carlo finite element method (MLMC-FEM) and adaptive FEM have been developed. The numerical results indicate the efficiency of the methods where the computational complexity decreased by orders of magnitude (compared to standard MC-FEM). Bayesian inference and Markov chain Monte Carlo used for parameter estimation in inverse problems as well. For deterministic equations, to decrease the cost of calculation (CPU time) in fourth-order time-dependent problems, we introduce a new numerical technique by combining proper orthogonal decomposition method with local discontinuous Galerkin and exponential time differencing. Furthermore, in order to solve the Boltzmann-transport equation with small computational effort, we reduced the (6 +1)-dimensional Boltzmann equation to a (2 + 1)-dimensional diffusion-type equation. Therefore the ionic current can be calculated immediately. The developed numerical methods have been applied to solve different scientific computing problems. Here, we consider the current fluctuation of transistors (stochastic drift-diffusion model), modeling of ion diffusion through transmembrane proteins (Boltzmann-transport equation), phase segregation of binary alloys and polymers (stochastic Cahn-Hilliard-Cook model), detection of specific biological species, e.g., cancer cells and viruses (stochastic Poisson-Boltzmann model), tumor growth simulation (Cahn-Hilliard-Navier-Stokes model), material science (stochastic homogenization and interface elliptic problems) and parameter estimation in psychical systems (Bayesian inversion).

Alle Interessierten sind herzlich eingeladen

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