University Center for Mathematical Modeling, Applied Analysis and Computational Mathematics

Semester Seminar, 2nd December 2013, 8:30–12:10, Room K4

Schedule

Time	Speaker	Title
8:30		Opening
8:35	Václav Kučera	Numerical solution of a new hydrodynamic model of flocking
8:47	Ondřej Souček	Water transport in partially-molten ice: A multiphase theory approach
8:59	Václav Vlasák	Collections of sets of uniqueness
9:11	Iveta Hnětynková	Analysis of TLS problems with multiple right-hand sides
9:23		Discussion
9:30		Coffee break
9:40	Miloslav Vlasák	Optimal test spaces
9:52	Tomáš Bárta	Lojasiewicz type convergence results and applications
10:04	Petr Honzík	Singular integral operators with rough kernel
10:16	Vít Průša	On the natural structure of thermodynamic potentials and fluxes in the theory of chemically non-reacting binary mixtures
10:28		Discussion
10:40		Coffee break
10:50	Karel Tůma	Oldroyd-B – linear or non-linear thermodynamically compatible rate-type fluid model?
11:02	Ondřej Kurka	Notes on the trace problem
11:14	Martin Lanzendörfer	Hydrodynamic lubrication: the thin film approximation and a couple of questions
11:26	Miroslav Bulíček	Analysis and approximation of a strain-limiting nonlinear elastic model
11:40		Discussion
11:55		Concluding remarks

Abstracts

Tomáš Bárta, Lojasiewicz type convergence results and applications. We formulate an abstract convergence result for solutions of differential equations (or any function defined on R_+) based on Lojasiewicz type estimates. We apply this result to a wave equation with nonlinear damping and show for a large class of damping functions that solutions converge to an equilibrium.

Miroslav Bulíček, Analysis and approximation of a strain-limiting nonlinear elastic model. Elastic solids with strain-limiting response to external loading represent an interesting class of material models, capable of describing stress concentration at strains with small magnitude. A theoretical justification of this class of models comes naturally from implicit constitutive theory. We investigate mathematical properties of static deformations for such strain-limiting nonlinear models and we obtain results concerning existence, uniqueness and regularity of weak solutions, and existence of renormalized solutions for the full range of the positive scalar parameter featuring in the model for spatially periodic setting.

Iveta Hnětynková, Analysis of TLS problems with multiple right-hand sides. Consider a linear approximation problem $AX \approx B$, where A is a real m by n matrix and B is a real m by d matrix. In *total least squares* (TLS) we seek a minimal correction to B and A such that the corrected system is compatible, i.e.

$$\min_{G,E,X} \|[G,E]\|_F \quad \text{subject to} \quad (A+E)X = B+G.$$

The previous analysis of existence and uniqueness of a TLS solution did not cover all possible situations. A new full classification of TLS problems presented in *I. Hnětynková, M. Plešinger, D. M. Sima, Z. Strakoš, and S. Van Huffel: The total least squares problem in $AX \approx B$: a new classification with the relationship to the classical works, SIAM J. on Matrix Anal. and Appl., 32 (2011), pp. 748–777* revisits and refines previous results. We summarize the classification with emphasize on problematic classes of TLS problems revealed by the new analysis. Outputs of the *classical TLS algorithm* usually used to solve TLS problems will be studied.

Petr Honzík, Singular integral operators with rough kernel. We present some recent results in the theory of singular integrals operators with rough kernel. In particular, we discuss the p-dependent boundedness of the operators and we present the state of the theory for the bilinear operators.

Václav Kučera, Numerical solution of a new hydrodynamic model of flocking. This work is devoted to the numerical solution of equations describing the dynamics of flocks of birds or other individual entities forming herds or swarms. We will consider the model of Fornasier et al. (2010), which is a hydrodynamic limit of the well known Cucker-Smale model. The resulting equations consist of the Euler equations for compressible flow with an additional nonlinear nonlocal right-hand side term. Due to the complexity of the model, we focus only on the one-dimensional case. For the numerical solution we use a semi-implicit discontinuous Galerkin method. This work represents the first thorough attempt to solve these equations numerically.

Ondřej Kurka, Notes on the trace problem. We discuss the following question: For a function f of two variables which is convex in the directions x and y, how can its trace $g(x) = f(x, x)$ look like? We provide some necessary and sufficient conditions, as well as some examples illustrating that our approach does not seem to be appropriate for finding a full characterization. The lecture is based on a joint work with Dušan Pokorný.

Martin Lanzendörfer, Hydrodynamic lubrication: the thin film approximation and a couple of questions. The model reduction due to the thin film flow assumptions, leading to the Reynolds equation and all its variants, is fundamental to the hydrodynamic lubrication theory and computations. We will briefly review the classical concepts and some recent results, focusing on the question how safe it is to use the thin film approximation, and whether it is inevitable.

Vít Průša, On the natural structure of thermodynamic potentials and fluxes in the theory of chemically non-reacting binary mixtures. A theory describing the behaviour of chemically non-reacting binary mixtures can be based on a detailed formulation of the governing equations for the individual components of the mixture or on treating the mixture as a single homogenized continuous medium. We argue that if we accept that both approaches can be used to describe the behaviour of the given mixture, then the requirement on the equivalence of these approaches places restrictions on the possible structure of the internal energy, entropy, Helmholtz potential and also of the diffusive, energy and entropy fluxes.

The restrictions can be further exploited in the specification of thermodynamically consistent constitutive relations for quantities such as the interaction (drag) force or the Cauchy stress tensor. As an example of the application of the current framework, we derive, amongst others, a generalisation of the Fick's law, and we recover several non-trivial results obtained by other techniques.

Ondřej Souček, Water transport in partially-molten ice: A multiphase theory approach. We present a two-phase model for thermo-mechanical evolution of partially molten ice and gravity-driven water extraction in the physical setting relevant for conditions in the ice layers of moons of outer planets in the solar system (Europa, Enceladus). We discuss development of a compressible extension of the traditional incompressible model.

Karel Tůma, Oldroyd-B – linear or non-linear thermodynamically compatible rate-type fluid model? In 2000 Rajagopal and Srinivasa proposed a new way how to obtain viscoelastic models using the thermodynamic framework and they derived a model that after the linearization reduces to standard Oldroyd-B model. In this talk we show that the precise standard Oldroyd-B model can be derived using this thermodynamic approach under the assumption that elastic response corresponds to compressible neo-Hookean solid. Thus, we show that the linear Oldroyd-B model is obtained as a thermodynamically compatible viscoelastic model with the non-linear elastic response.

Miloslav Vlasák, Optimal test spaces. Idea of better test spaces for Galerkin (Petrov–Galerkin) finite element method will be presented and some interesting relations and applications will be discussed.

Václav Vlasák, Collections of sets of uniqueness. We introduce the Collection of sets of uniqueness and some of its interesting subcollections. We also mention some known results and open problems concerning these collections.