University Center for Mathematical Modeling, Applied Analysis and Computational Mathematics

Semester Seminar, 15th December 2014, 8:30–12:10, Room K2

Schedule

Time	Speaker	Title
8:30	Vít Průša	Solving nonlinear ordinary differential equations with jump discontinuities using Colombeau algebra formalism
8:45	Benjamin Vejnar	A strange Sobolev homeomorphism in four dimensions
9:00	Iveta Hnětynková	Image processing in quality analysis of jewelry stones
9:15		Coffee break
9:45	Ondřej Souček	Dynamic boundary conditions for Korteweg fluids – physical modeling and numerical simulations
10:00	Miroslav Bulíček	Minimizers to varitational integrals with linear growth
10:15	Václav Vlasák	Symmetric sets and sets of uniqueness
10:30	Dušan Pokorný	Curvature measures and kinematic formulas for WDC sets
10:45		Coffee break
11:10	Ondřej Kurka	Amalgamation of classes of Banach spaces with a monotone basis
11:25	Václav Kučera	Surface area, the Schwartz lantern and convergence of the finite element method
11:40	Martin Lanzendörfer	On some numerical simulations in the slider bearing lubrication
11:55	Miloslav Vlasák	A posteriori error estimates for DG

Abstracts

Vít Průša, Solving nonlinear ordinary differential equations with jump discontinuities using Colombeau algebra formalism. Spring-dashpot systems and resistor-inductor-capacitor systems are the prominent examples of physical systems that are modelled using systems of ordinary differential equations. The response of such systems to abrupt changes is frequently of eminent interest in engineering practice. If the corresponding system of differential equations is linear, then the standard theory of distributions and Laplace transform techniques can be applied to solve the problem. However, if the underlying system of ordinary differential equations is nonlinear, none of these techniques can be applied. The key issue is that the standard theory of distributions (generalized functions) does not provide us tools for multiplication of distributions. Nevertheless, the nonlinear operations on distributions (generalized functions) can be defined in the framework of so-called Colombeau algebra. It will be shown how to use this formalism in solving the key problem — the response of nonlinear systems to step or impulsive forcing.

Benjamin Vejnar, A strange Sobolev homeomorphism in four dimensions. For $n \geq 4$, we sketch a construction of a homeomorphims f in the Sobolev space $W^{1,1}((0,1)^n, \mathbb{R}^n)$ whose Jacobian is positive on a set of positive measure and also negative on a set of positive measure. This solves a problem of Hajlasz. It is known that such a homeomorphism can not exists in dimension $n \leq 3$. It follows by the properties of f that it can not be approximated by diffeomorphisms (or by piecewise affine homeomorphisms) in $W^{1,1}_{\mathrm{loc}}$. This is a joint work with S. Hencl.

Iveta Hnětýnková, Image processing in quality analysis of jewelry stones. In jewelry industry there is a need to detect automatically possible defects in produced stones. Such process is complex and relies strongly on image processing methods. In this talk, we describe problems appearing during the quality analysis. We present some ideas that led to improvements in the performance of the underlying algorithm.

Ondřej Souček, Dynamic boundary conditions for Korteweg fluids – physical modeling and numerical simulations. We present a derivation of certain class of natural boundary conditions for a material model of Korteweg fluid. By construction, these boundary conditions automatically ensure non-negativity of associated local entropy production, and are therefore thermodynamically consistent. We present first numerical simulations for a compressible Navier-Stokes-Korteweg model with these novel boundary conditions.

Miroslav Bulíček, Minimizers to varitational integrals with linear growth. In the calculus of variations, a very difficult task is to minimize functionals that involve only linear growth and therefore provides only L^1 coercivity. Such problem is in general unsolvable and in fact lead to minimization problems in the space of the Radon measures. Such problem can be nowadays solved by using the weak-lower semicontinuity of the convex functionals and one obtains a solution - a Radon measure. However, it is a natural question whether such a generalized notion is really neccesary. We show that for a very general class of functionals (having assympotically the Uhlenbeck structure), the minima are attained in the space L^1 and that no measure theory is in fact needed. Moreover, we show the relevance of such problems to the continuum mechanics setting.

Václav Vlasák, Symmetric sets and sets of uniqueness. We will present the notion of symmetric sets. We will discuss which symmetric sets are sets of uniqueness. We will also discuss some relations between symmetric sets, H^N sets and σ-porous sets.

Dušan Pokorný, Curvature measures and kinematic formulas for WDC sets. I will introduce the class of WDC (weakly delta-convex) sets and discuss how we can define the notion of curvature (i.e. second order differentiable structure) for this class and what are its main properties. I will then concentrate on some recent results about kinematic formulas for WDC sets. The presented results are a joint work with Jan Rataj and Joseph Fu.

Ondřej Kurka, Amalgamation of classes of Banach spaces with a monotone basis. It was proved by Argyros and Dodos that, for many classes of separable Banach spaces, there exists an isomorphically universal space with nice properties. For example, if every member of the class is reflexive, then the universal space is also reflexive. We will show that, in the case that the class consists of spaces with a monotone Schauder basis, it is possible to provide an isometrically universal space.

Václav Kučera, Surface area, the Schwartz lantern and convergence of the finite element method. Several sufficient conditions for the convergence of the finite element method are known. The most general is the assumption that the angles in the triangulations used are bounded away from π (maximum angle condition). Recently, it was shown by counterexample that this condition is not necessary for O(h) convergence. The necessary and sufficient condition remains unknown and in fact, no necessary conditions have ever been proposed. In this talk, we generalize the maximum angle condition and show a simple link to the problem of approximation of surface area and the classical counterexample known as the Schwartz lantern.

Martin Lanzendörfer, On some numerical simulations in the slider bearing lubrication. This time, our brief visit to the hydrodynamic lubrication problems will be more focused on the numerical results. We will examine a selection of flow simulations (by means of the 2D finite element approximation of the planar flow) and discuss its setting, artificial boundary conditions and the sensitivity on relevant parameters.

Miloslav Vlasák, A posteriori error estimates for DG. A known result connecting discontinuous Galerkin (DG) and Runge- Kutta methods (RK) will be discussed and used for deriving a posteriori error estimates. Still, there are many questions to answer. The main question arises from unnatural choice of spaces and norms in the estimate.