Presentations of PhD students financed by UNCE during last (at least) three months

11th January 2021, 8:30–10:50, Zoom

Schedule

Time	Speaker	Title
8:25		Opening
8:30	Jakub Fara	Introduction to an Eulerian-Lagrangean method for solving material interactions
8:45	Mark Dostalík	Local well-posedness for compressible heat-conducting Maxwell viscoelastic fluid
9:00	Hana Turčinová	Fine properties of Sobolev functions in the context of rearrangement-invariant spaces
9:15	Anna Doležalová	INV condition for weak limits of $W^{1,n-1}$-homeomorphisms
9:30	Martin Sýkora	Binary Mixtures in between Frameworks
9:45	Jiří Malík	Thermomechanical interaction of ice shells and subsurface oceans on icy moons
10:00	Emil Skříšovský	Weak solutions for compressible Navier–Stokes–Fourier system in two space dimensions with adiabatic exponent almost one
10:15	Tomáš Los	TBA
10:30		Concluding remarks

Abstracts

Jakub Fara, Introduction to an Eulerian-Lagrangean method for solving material interactions. We introduce a new simple method for solving the interaction between different materials. It combines the Eulerian and Lagrangian description and its main concept is based on the time integration of points spread out on the material boundary. This enables to track the interface in time. We observe that this relatively simple method allows for computing finite deformations in a very efficient way. Finally, we demonstrate the strength of this method on a 2D benchmark.

Mark Dostalík, Local well-posedness for compressible heat-conducting Maxwell viscoelastic fluid. To model viscous fluid flows which propagate disturbances with finite speed we propose a hyperbolic system of balance laws governing the thermomechanical evolution of compressible heat-conducting Maxwell fluid. We construct a mathematical entropy of the system which yields its symmetrizability and in turn local well-posedness of the corresponding Cauchy problem.

Hana Turčinová, Fine properties of Sobolev functions in the context of rearrangement-invariant spaces. Let Ω be a domain in the Euclidean space $\mathbb{R}^n$ having the outer cone property and let $d(x) = \operatorname{dist}(x, \partial\Omega)$. Given $p \in (1, \infty)$ and a scalar function u of several variables, we seek minimal requirements on the regularity of the function u/d in order that u belongs to the Sobolev space $W_0^{1,p}$ sheltering functions with zero boundary traces. We present a new such condition in terms of Lorentz spaces. We will further present another recent collection of results, originally also motivated by investigation of fine properties of traces of Sobolev functions. Considered in a broader perspective of Sobolev embeddings into spaces furnished with Frostman measures (that is, measures characterized by the rate of their decay on shrinking balls), the trace problem leads to interesting questions concerning certain new scale of function spaces. Such spaces are determined by the functional

$$\|f\|_{X^{\langle\alpha\rangle}} = \|((|f|^\alpha)^{**})^{\frac{1}{\alpha}}\|_{\overline{X}},$$

defined on measurable functions, in which α is a positive real parameter, and $\overline{X}$ is the representation space of certain rearrangement-invariant space X. We will survey a variety of results concerning these spaces including their relations to customary function spaces, their mutual embeddings and duality properties. We discover a new one-parameter path of function spaces leading from a Lebesgue space to a Zygmund class independent of the classical one.

Anna Doležalová, INV condition for weak limits of $W^{1,n-1}$-homeomorphisms. The INV condition is a desired property for admissible deformations in nonlinear elasticity models. However, this property is not always preserved under weak limits in Sobolev spaces when the integrability of the weak derivative is not high enough. We study the weak closedness of a subclass of mappings with INV and additional assumptions on regularity of the inverse function.

Martin Sýkora, Binary Mixtures in between Frameworks. Binary mixtures are a wide range of materials ranging from water with sand to superfluids. They can be approached from many points of view, each of them having its positives and negatives. In our work, we compare the SHTC and GENERIC approach. The first one boasts the property of being a set of fist order hyperbolic equations, thus having chracteristics that may help construct numerical solutions, while the latter is generated by a theory applicable to many more materials in a unified way.

Jiří Malík, Thermomechanical interaction of ice shells and subsurface oceans on icy moons. Mathematically formulated, the thermomechanical interaction of ice shells and liquid oceans constitutes a heat convection problem with phase change on a domain with a free surface. The talk addresses the first two of the difficulties and introduces tools used to overcome them. The efficacy of the tools is assessed in the form of a comparison with an analytical, purely conductive, benchmark problem and experimental data for a convection problem with phase change.

Emil Skříšovský, Weak solutions for compressible Navier–Stokes–Fourier system in two space dimensions with adiabatic exponent almost one. In this talk I will focus on the Navier–Stokes–Fourier system, which is a model describing the flow of a compressible viscous heat-conducting fluid. The system is studied in a bounded two-dimensional domain with the pressure law given by $p(\varrho, \theta) \sim \varrho\theta + \varrho \log^{\alpha}(1 + \varrho) + \theta^4$. This pressure law can be understood as a very close approximation of the pressure law $\varrho\theta$, which makes it interesting from a physical viewpoint. The weak solutions with entropy inequality and total energy balance are considered and the existence of this type of weak solutions without any restriction on the size of the initial conditions or the right-hand sides is shown provided $\alpha > \frac{17+\sqrt{417}}{16} \cong 2.34$.

Tomáš Los, TBA.