University Center for Mathematical Modeling, Applied Analysis and Computational Mathematics

Junior and Student Members Seminar 2026/2027, hybrid form (in person and via Zoom), Room K3, Wednesdays, November 18 and 25, December 9 and 18, and January 6, 09:00-10:30

Schedule

Guest and Junior Members.

Time	Speaker	Title
Nov 18		
9:00–9:30	Umberto Zerbinati	Material robustness and the discretization of the angular momentum balance law
9:30–9:45	Petr Pelech	Piling twinning disconnections up
9:45–10:00	Alexei Gazca	Pressure-robust and quasioptimal DG discretisations of the p-Stokes problem
10:00–10:15	Malte Kampschulte	Limit models in fluid structure interaction
Nov 25		
9:00–9:15	Vojtěch Patočka	Effusive cryovolcanism on icy worlds: experiments with large volumes of water in near-vacuum environment
9:15–9:30	Ritesh Khan	Hybrid Hierarchical Matrices with Adaptive Precision Storage
9:30–9:45	Ondřej Chrenko	The structure of envelopes of forming super-Earths in eccentric and gap-opening regimes
9:45–10:00	Jelena Radovič	Meter-scale radiative transfer process modelling in complex urban environments: a PALM model validation study
10:00–10:15	Yuxin Ma	Mixed precision thin SVD algorithms based on Gram matrix
Dec 9		
9:00–9:15	Jan Blechta	Adaptivity for implicitly constituted Stokes flow
9:15–9:30	Marc Fehling	Variational numerical methods for nonlinear elasticity
9:30–9:45	Laëtitia Lebec	Cracking Europa: Formation of the dilational bands
9:45–10:00	Santolo Leveque	Parallel-in-time solver for the Runge–Kutta discretization of the heat equation
10:00–10:15	Michal Outrata	On direct multilevel solvers induced by AMG

Student Members.

Time	Speaker	Title
Dec 16		
9:00–9:10	Adam Dvořák	Phase-field simulation of the β-to-ω transformation in Ti–Mo alloys
9:10–9:20	Anna Kneselová	Properties of classical operators on discrete classical Lorentz spaces
9:20–9:30	Martin Vejvoda	Numerical simulations of metamaterials
9:40–9:50	Andrew Haar	Shifted Maximal Functions and the Boundedness of Rough Singular Integral Operators
9:50–10:00	Lucie Wintrová	A Multiscale Mixture Model for Brain Tissue Clearance
10:00–10:10	David Kubíček	Properties of a certain functional generated by two rearrangement-invariant spaces
10:00–10:20	Tobiáš Krupa	Chemically reacting mixtures: entropy method for asymptotic stability
Jan 6		
9:00–9:10	Jiří Puček	On the Existence of a Weak Martingale Solution for a Stochastic MHD System
9:10–9:20	Vít Beran	Microstructural record of crystal settling dynamics in magma reservoirs
9:20–9:30	Jakub Cach	Predictive theory of recirculation onset in expanding pipe flow
9:40–9:50	Lenka Košárková	Multicomponent flow in domains with moving boundary
9:50–10:00	Jovi Koikkara	Beyond Poisson–Boltzmann: Classical Density Functional Theory of Electrolytes at Charged Interfaces
10:00–10:10	Jaromír Mielec	(Inv) condition in fractional Sobolev spaces

Guest Speaker

Umberto Zerbinati: Material robustness and the discretization of the angular momentum balance law. Material robustness is the ideal property of a discretization in continuum mechanics whereby its error estimates do not depend on the nature of the constitutive law employed. This generalizes the notion of pressure robustness in incompressible fluid mechanics, where we demand that the error estimates do not depend on the magnitude of the pressure, the spherical component of the constitutive law. While it is not known how to achieve material robustness in general, prior work has developed discretizations with specific kinds of material robustness for specific kinds of materials. For example, for stress–velocity discretizations of the one-constant Leslie–Ericksen equations, certain methods enjoy error estimates for the stress that are independent of the Frank constant. In this work we consider the discretization of more complex polar fluids with nonsymmetric stress tensors, which require the additional solution of the angular momentum balance law. We employ extensions of the mass-conserving mixed stress formulation, with the aim of achieving both pressure robustness in the symmetric part of the stress and viscosity robustness in the antisymmetric part. We show that these properties do not hold with the standard weak enforcement of the symmetry of the stress tensor, but that they do when the method is applied on Powell–Sabin or Worsey–Farin splits. We explain this by proving that, on these splits, the inf-sup stability constant is independent of the constitutive law and the error estimates decouple.

Abstracts of Junior Members

Jan Blechta: Adaptivity for implicitly constituted Stokes flow. The framework of implicit constitutive relations between the Cauchy stress and the velocity gradient allows to capture the most common non-Newtonian fluid models, including those which are traditionally treated using variational inequalities, such as the Bingham fluid. In this talk I will present an adaptive method

based on the method of equilibrated fluxes. The method builds on the velocity–pressure–extra-stress formulation, estimates for localized error components, such as discretization, regularization, linearization, etc., and provides balancing and stopping criteria for the algorithm components, such as local mesh refinement, the Newton solver, etc. We support our findings with numerical experiments. This is a joint work with A. Gazca, J. Málek, and M. Vohralík.

Ondřej Chrenko: The structure of envelopes of forming super-Earths in eccentric and gap-opening regimes. As planets grow in gas-dust protoplanetary disks, they can accrete gas and build up their primordial envelopes. Understanding the structure of these envelopes is essential for connecting the process of planet formation with the population of (exo)planets we observe today. One long-standing puzzle is the ubiquity of super-Earths among exoplanets: these planets can contain enough solid material to trigger substantial gas accretion, yet their growth often appears to have stopped before they developed into sub-Neptunes or even gas giants. Why? In this talk, I will present 3D radiation hydrodynamic simulations of super-Earths embedded in protoplanetary disks. Using non-uniform computational meshes, we can resolve the region around the planet in detail and investigate how it delivers gas to the envelope. I will focus on two important but relatively unexplored regimes of super-Earth evolution: eccentric planetary orbits driven by the planet's own luminosity, and gaps carved in the surrounding disk. The eccentric regime leads to efficient recycling of envelope material, while gap opening controls the cooling rate of the envelope.

Marc Fehling: Variational numerical methods for nonlinear elasticity. We investigate the uniqueness of energy minimizers in nonlinear elasticity from a numerical perspective. We compare two computational approaches: direct minimization of the discrete energy functional and the numerical solution of the associated Euler-Lagrange equations. While direct energy minimization offers greater flexibility, the Euler-Lagrange formulation can be combined with a deflated continuation method to systematically explore multiple solution branches. The stability of computed equilibria is assessed by examining the positive definiteness of the Hessian of the energy functional.

We consider two model problems: beam buckling and cross compression. The former is analyzed in terms of bifurcation theory, while the latter focuses on the uniqueness of energy minimizers. We present preliminary numerical results illustrating the potential of these approaches for investigating solution multiplicity, stability, and uniqueness.

Alexei Gazca: Pressure-robust and quasioptimal DG discretisations of the p-Stokes problem. Pressure-robustness of a numerical discretisation in the context of incompressible fluids refers to the fact that the convergence of the velocity field is not affected by the quality of the pressure approximation. This is a topic that has received much attention in recent years, mostly pertaining to the linear Stokes problem. It is a very desirable property of discrete approximations of incompressible flow, since non-robust discretisations may produce larger errors for small viscosities, and even unphysical behaviour; In the non-Newtonian setting the situation is potentially worse, since non-pressure-robust discretisations lead in general to suboptimal rates for the velocity. Drawing from recent results dealing with the p-Laplacian, we show that by introducing a so-called smoothing operator, which maps non-conforming discrete functions into conforming ones, it is possible to derive quasioptimal discretisations with minimal regularity assumptions that are in addition pressure-robust. Unlike non-pressure-robust discretisations, these lead to the optimal linear rate with piecewise linear approximations.

Malte Kampschulte: Limit models in fluid structure interaction. Continuum mechanics has a long tradition of simplifying complicated equations e.g. by looking at certain (scaling) limits, such as small deformations. This has been studied both formally as well as rigorously both for solid and for fluid-mechanics. However when studying coupled problems between the two, often different limit and non-limit models are coupled directly, without paying attention to any of the assumptions under which they were originally obtained. This talk will discuss why that can be a bad idea.

Ritesh Khan: Hybrid Hierarchical Matrices with Adaptive Precision Storage. Hierarchical matrices are multilevel block low-rank representations of matrices that are widely used for fast matrix computations. Hierarchical matrices are built using a tree data structure with low-rank blocks identified using various admissibility conditions, such as standard/strong admissibility and weak admissibility. In this talk, we introduce a novel hierarchical matrix framework, namely $\mathcal{H}_h$, based on a *hybrid* admissibility condition: we use strong admissibility at the coarser levels (larger blocks) and weak admissibility at the finer levels (smaller blocks). We carry out a rounding error analysis of $\mathcal{H}_h$-matrices and show that the low-rank blocks of $\mathcal{H}_h$-matrices can be represented in low precision without degrading the overall approximation quality. We provide an explicit rule for choosing the precision for a particular low-rank block. We propose an adaptive mixed precision algorithm for constructing and storing $\mathcal{H}_h$-matrices. Our numerical results illustrate that the proposed adaptive mixed precision $\mathcal{H}_h$-matrices can achieve significant storage reductions (up to $11\times$) compared to uniform double precision $\mathcal{H}$-matrices, without compromising accuracy.

Laëtitia Lebec: Cracking Europa: Formation of the dilational bands. Key aspects of the formation of dilational bands crisscrossing Europa's surface remain unclear. These widespread linear features are hundreds of kilometers long and are characterized by a complete opening of the surface with exposure of subsurface material. The main mechanism identified for their formation is the tectonic extension that occurs during the thickening of Europa's ice shell. Dilational bands exhibit a wide range of characteristics, from smooth, hummocky, or lineated texture to a high- or low-relative albedo when compared with those of the surrounding. In this work, we unravel the conditions under which these bands are formed in order to predict their morphology and composition from the rheological and physical properties of the ice shell at the time of their formation.

Santolo Leveque: Parallel-in-time solver for the Runge–Kutta discretization of the heat equation. Time-dependent PDEs arise quite often in many scientific areas, such as mechanics, biology, economics, or chemistry, just to name a few. Of late, researchers have devoted their effort in devising parallel-in-time methods for the numerical solution of time-dependent PDEs, adding a new dimension of parallelism and allowing to speed-up the solution process on modern supercomputers.

In this talk, we present a parallel-in-time preconditioner for the space-time discretization of the heat equation arising when employing a Runge–Kutta method in time. The resulting system is solved iteratively for the numerical solution and for the stages of the method. The proposed preconditioner results in a block-diagonal solve for the stages, and a Schur complement obtained by solving again systems for the stages. A range of numerical experiments validate the robustness of the preconditioner with respect to the discretization parameters and to the number of stages, showing the speed-up achieved on a parallel architecture.

Yuxin Ma: Mixed precision thin SVD algorithms based on Gram matrix. We present a mixed precision algorithm that leverages the Gram matrix and Jacobi methods to compute the singular value decomposition (SVD) of tall-and-skinny matrices. By constructing the Gram matrix in higher precision and coupling it with a Jacobi algorithm, our theoretical analysis and numerical experiments both indicate that the singular values computed by this mixed precision thin SVD algorithm attain high relative accuracy. In practice, our mixed precision thin SVD algorithm yields speedups of over 10x on a single CPU and about 2x on distributed memory systems when compared with traditional thin SVD methods.

Michal Outrata: On direct multilevel solvers induced by AMG. We consider an algebraic multigrid (AMG) scheme for the direct solution of complex-valued square linear systems based on a recursive 2×2 block partitioning of the coefficient matrix and study the optimal choices of its components. In particular, we complement existing results that characterize optimal choices for nonsymmetric-cycle methods [1,2] by analyzing the spectral behavior of the symmetrized variant. We analyze the error propagation operator of the two-level symmetric-cycle method by calculating its invariant subspaces and its nonzero eigenvalues that govern the behavior of the error after a single cycle. We show that the error propagation operator can be studied separately for pairs

of modes, working as bases of the invariant subspaces. The main result is an explicit choice of smoothing parameters that makes all the pairs of modes respond identically, forcing the nontrivial eigenvalues of the error propagation operator to collapse to a single, a priori known value, i.e., we give an explicit choice for the smoothing parameters so that the nonzero part of the spectrum of the error propagation operator collapses to a single, a priori known point on the real line. As a consequence, we give a closed-form formula for the inverse of a general square matrix that, to the best of our knowledge, is new in the literature. Additionally, the framework provides a clear, self-contained description of an ideal AMG W-cycle, offering a concrete target for the design of related schemes. We illustrate the theory with direct applications to general matrices and with analyses of representative matrices arising in numerical methods.

[1] S. MacLachlan, T. Manteuffel, and S. F. McCormick. Adaptive reduction- based AMG. Numerical Linear Algebra with Applications, volume 13(8): 599–620, 2006.

[2] J. P. Lucero Lorca. Towards a multigrid preconditioner interpretation of Hierarchical Poincar´e-Steklov solvers. arXiv:2511.00735, 2026.

Vojtěch Patočka: Effusive cryovolcanism on icy worlds: experiments with large volumes of water in near-vacuum environment. Icy bodies of the outer Solar System display evidence of remarkable surface activities, including explosive and potentially effusive cryovolcanism. When water is released into their extremely low-pressure surface environments, or when the surface ice melts in response to an impact, the liquid water has traditionally been expected to form solid ice with a porous outer layer. Here, we expose 40 kg of low-salinity water in a specialist chamber at The Open University, UK, and show that freezing under near-vacuum conditions is a complex, dynamic process during which vapor puffs through the growing ice sheets, building previously unobserved ice structures.

Petr Pelech: Piling twinning disconnections up. In SMAs, two pure energy-minimising martensitic phases are separated by a twinning interface whose orientation is fixed by the relation of a rank-one connection [1]. For an interface to be inclined, the phases are no longer energy-minimising. At the nanoscale, a mechanism for achieving this is provided by something known as a twinning disconnection, where two parallel twinning planes of the 'preferred' orientation are separated by a step where some residual stress/strain must lie [2]. Our goal is to investigate the transition between the nano- and microscale using rigorous mathematical tools, in particular Γ-convergence. Further understanding should shed light on the evolution of twin boundaries when the material is subject to external stresses. This is a joint work with William Sumners, Barbora Benešová, Malte Kampschulte, Petr Sedlák, Miroslav Frost, Jaroš Petr and Hanuš Seiner.

[1] Pitteri M., Zanzotto G. - Continuum Models for Phase Transitions and Twinning in Crystals. Chapman & Hall (2002), ISBN 9780849303272

[2] J.P. Hirth, R.C. Pond. Steps, dislocations and disconnections as interface defects relating to structure and phase transformations. Acta Materialia, Volume 44, Issue 12, 1996, Pages 4749-4763, ISSN 1359-6454, https://doi.org/10.1016/S1359-6454(96)00132-2

Jelena Radovič: Meter-scale radiative transfer process modelling in complex urban environments: a PALM model validation study. Ongoing climate change, insufficient urban resilience, and the ever-increasing exposure of city dwellers to environmental hazards such as urban heat stress require carefully tailored mitigation strategies supported by high-fidelity urban climate modelling tools. Urban boundary layer processes are strongly affected by urban morphology, vegetation, and the dynamic nature of human activities. Moreover, the complex structure of cities and their properties exacerbate an already complex process of modelling urban areas and climate; as spatial resolution increases, the complexity of radiative processes also increases.

Radiative transfer modelling in microscale urban environments remains challenging due to the highly complex interactions between buildings, vegetation, and dense urban morphology. These interactions include multiple reflections, scattering, shading, and thermal emission. Key factors, such as the sky view factor, the fractions of sunlit and shaded surfaces, and the spatial variability of surface properties, are also considered bottlenecks for numerical models. Despite considerable

progress, uncertainties related to radiative transfer parameterisations and input data persist in street-scale simulations.

This study evaluates the Parallelized Large Eddy Simulation Model (PALM) and its Radiative Transfer Model (RTM) in representing shortwave radiation processes within a realistic urban environment. PALM simulations were conducted in spin-up mode at 1 m spatial resolution for a densely built and vegetated area in Prague, Czech Republic, and validated against measurements collected during observational campaigns in 2017 and 2018. Incoming and outgoing shortwave radiation were assessed across a series of selected episodes at four urban locations characterised by contrasting surface properties and urban morphology.

The results demonstrate that PALM reproduces the incoming shortwave radiation with high fidelity, particularly when driven by carefully selected mesoscale forcing. Larger discrepancies are observed for outgoing shortwave radiation, highlighting its sensitivity to surface representation, vegetation structure, and urban geometry. The analysis identifies inaccuracies in static urban input data, such as building geometry and vegetation parameters, as a dominant source of error. Overall, the findings emphasise the high importance of accurate mesoscale forcing and high-quality urban static datasets for reliable street-scale radiative transfer modelling. Furthermore, this study provides a comprehensive validation of PALM's shortwave radiation modelling, advancing the understanding of uncertainties in microscale urban radiative transfer simulations and supporting the improved modelling of urban heat exposure and mitigation strategies development.

Abstracts of Student Members

Vít Beran: Microstructural record of crystal settling dynamics in magma reservoirs. Many processes involved in the formation of plutonic bodies are currently unresolved or poorly constrained, due to the inherent complexity of igneous systems. In particular, only limited quantitative tools are available to address the extent to which the settling of crystals within magma affects the microstructure of igneous rocks. Here, a parameterized model of a convecting and solidifying magma reservoir is presented, based on experimentally supported kinetics of crystal nucleation and growth, in which crystals nucleate in the upper thermal boundary layer, undergo growth while suspended in the convecting magma, and are eventually deposited on the floor. Coupling the reservoir to a 1D heat equation model of the host rock to control the thermal evolution of the reservoir, a probabilistic framework is introduced for the settling of size-evolving particles to quantify the crystal size distributions in the cumulate pile and in the convecting bulk interior. The vigor of convection controls the crystal size distributions in the cumulate: weak convection results in rapid sinking and a narrowing of the resultant size distribution, whereas vigorous convection results in a broadening of the size distribution. In contrast, the mean crystal size is relatively unaffected by variation in the settling regime. Stratigraphic (temporal) evolution of the mean crystal size is controlled primarily by the temperature dependence of magma viscosity, by the initial composition of the magma, and by magma cooling history. Finally, using direct numerical simulations, we examine how the heterogeneous release of latent heat feeds back on the convective vigor in the chamber, and in turn on the settling signature itself.

Jakub Cach: Predictive theory of recirculation onset in expanding pipe flow. Flow through an expanding pipe first loses wall attachment through steady near-wall recirculation, which alters transport and limits the performance of hydraulic components such as diffusers. Experiments and simulations have mapped this transition, but its onset has lacked a predictive theory. Here we derive a parameter-free criterion from a local radial formulation of the Navier–Stokes equations under explicit minimal assumptions. Finite inertia deforms the conical velocity profile until the near-wall flow reverses. Flux normalization identifies the combined parameter $K = Re \sin\alpha$ and yields a nonlinear eigenvalue problem. In the slender-cone limit, it gives the universal law $Re\, K_0/\alpha$, with $K_0 = 6.94403...$ The opposite right-angle endpoint is treated independently by continuation from the exact conical Stokes solution. Both results extrapolate consistently through intermediate angles. The theory reproduces published numerical simulations, including the predicted inverse-law amplitude to within one percent.

Adam Dvořák: Phase-field simulation of the β-to-ω transformation in Ti–Mo alloys. Metastable Ti–Mo alloys exhibit complex microstructural evolution during thermomechanical processing. We investigate the athermal β-to-ω phase transformation using a phase-field approach based on a multi-well model with a double-ditch augmentation. The model incorporates anisotropic elasticity, a realistic chemical background derived from the local molybdenum concentration, and stochastic thermal fluctuations. The governing equations are solved using the finite element method within the Firedrake framework, with an efficient nonlinear solver enabling large-scale simulations. We investigate the effects of elastic anisotropy, stochastic Langevin forces, and chemical heterogeneity on ω-phase nucleation and growth, including simulations of the quenching process.

Andrew Haar: Shifted Maximal Functions and the Boundedness of Rough Singular Integral Operators. A classical problem at the intersection of harmonic analysis and PDE is the boundedness of the so-called Calderon commutators, which, not being of convolution type, require creative tools to analyze. We will see a new tool developed in 2014 by C. Muscalu, which has seen great success in approaching not only the problem of Calderon's commutators, but also much more general singular integrals, especially those that are multilinear.

Anna Kneselová: Properties of classical operators on discrete classical Lorentz spaces. While the theory of operators acting on continuous function spaces is highly developed, the corresponding theory for discrete sequence spaces remains substantially less complete, often presenting unique structural challenges. Our intention is to fill some of the existing gaps in the discrete theory.

First, we systematically develop the discrete Hardy inequalities. Next, we characterize the continuous embeddings of classical discrete Lorentz sequence spaces $\lambda_p(b) \hookrightarrow \lambda_q(a)$, providing necessary and sufficient conditions for these inclusions across all admissible parameters p and q. Building upon these estimates, we establish a comprehensive discrete analogue of E. Sawyer's fundamental duality theorem. Finally, we apply this extensive theoretical framework to characterize the boundedness of the discrete Hardy-Littlewood maximal operator on classical Lorentz sequence spaces, establishing precise conditions for both the $p \leq q$ and $q < p$ parameter ranges.

Jovi Koikkara: Beyond Poisson–Boltzmann: Classical Density Functional Theory of Electrolytes at Charged Interfaces. Electrolytes mediate critical interactions across proteins, biological membranes, and charged surfaces. At biomolecular length scales, water acts not as a passive dielectric background, but as an active molecular medium where excluded-volume packing, dipolar polarization, ion-specific hydration, and hydrogen bonding govern interfacial free energy. While explicit-water Molecular Dynamics (MD) resolves these effects, it remains computationally prohibitive for mesoscale biophysical systems; conversely, classical Poisson–Boltzmann theory breaks down near structured interfaces where steric, orientational, and electrostatic correlations are strongly coupled.

In this talk, I will present the theoretical framework and preliminary numerical results for a transferable, coarse-grained classical Density Functional Theory (cDFT) designed to bridge this gap. By coupling Fundamental Measure Theory (FMT) for unequal hard-core packing, Perturbed-Chain SAFT (PC-SAFT) for dispersion, orientation-coupled Wertheim (TPT1) association for hydrogen bonding, and the unrestricted nonprimitive Mean-Spherical Approximation (MSA) for explicit ion-dipole electrostatics, we construct a unified grand-potential functional that preserves bulk and interfacial sum rules demonstrating how this framework captures water layering, oscillatory screening, and improved infinite-dilution ion solvation energetics at a fraction of explicit-water MD cost.

Lenka Košárková: Multicomponent flow in domains with moving boundary. We consider a multicomponent flow in which the bulk momentum transport is described by the Navier-Stokes equations and diffusion is described by the Stefan-Maxwell model, which captures cross-diffusive effects between species. We also account for the motion of the domain boundary and reformulate the equations in the Arbitrary Eulerian-Lagrangian framework. We then discuss the

discretization of the coupled governing equations and present numerical simulations of the system in some simplified settings.

David Kubíček: Properties of a certain functional generated by two rearrangement-invariant spaces. Given two rearrangement-invariant spaces X and Y over a non-atomic σ-finite measure space, we define the functional

$$\|f\|_{X^{\langle Y\rangle}} = \left\| \frac{1}{\varphi_Y(t)} \|f^* \chi_{(0,t)}\|_{\overline{Y}} \right\|_{\overline{X}},$$

in which $\overline{X}$ and $\overline{Y}$ are the representation spaces of X and Y, respectively, and φ_Y is the fundamental function of the space Y. We denote by $X^{\langle Y\rangle}$ the collection of all almost everywhere finite functions f such that $\|f\|_{X^{\langle Y\rangle}}$ is finite. This construction recovers many customary function spaces as well as generalises function spaces which recently appeared in connection with optimality of function spaces in Sobolev embeddings involving upper Ahlfors regular measures. We present a variety of results on these spaces, including their basic functional properties, their relations to customary function spaces and mutual embeddings. This is a joint work with Hana Turčinová.

Tobiáš Krupa: Chemically reacting mixtures: entropy method for asymptotic stability. In many applications, we are interested in mixtures in which chemical reactions occur. There is a well-known theory of mixtures that can capture this effect in its equations. However, the terms describing the interchange of mass between the constituents are often quite complicated and nonlinear. One particularly important aspect of interest is the equilibrium state, especially in cases involving multiple independent chemical reactions. In such cases, we study the existence, uniqueness, and, most importantly, the stability of the steady solution. We observe that the question of stability is not straightforward even at the level of a simple reaction-diffusion system or in a spatially-homogeneous setting. In many cases, the stability can be established via the so-called entropy method, while in certain cases the system can oscillate around an unstable equilibrium.

Jaromír Mielec: (Inv) condition in fractional Sobolev spaces. abstract: We develop the theory of (INV) mappings in context of fractional Sobolev spaces $W^{s,p}$, $sp > n-1$. We show that such mappings with positive distributional Jacobian are injective a.e. both in the domain and in the target.

Jiří Puček: On the Existence of a Weak Martingale Solution for a Stochastic MHD System. The study of magnetohydrodynamics (MHD) plays a fundamental role in understanding physical phenomena in plasma physics, astrophysics, and engineering applications such as fusion reactors. We study the existence of a weak martingale solution of a three-dimensional compressible MHD system in which randomness enters through the initial data and a stochastic forcing in the magnetic induction equation. The continuity and momentum equations contain no stochastic forcing.

Martin Vejvoda: Numerical simulations of metamaterials. Metamaterials are materials with specifically designed microstructure which grants them unusual properties not typically seen in nature especially regarding wave propagation. We present an overview of different approaches to designing metamaterials, including our model of homogeneous linear elastic material with effective rate-type constitutive relation, and discuss potential problems. Numerical simulations are presented for selected approaches. o

Lucie Wintrová: A Multiscale Mixture Model for Brain Tissue Clearance. How does microscopic cellular geometry shape the macroscopic transport and clearance of amyloid-beta in brain tissue? Addressing this question requires bridging two vastly different spatial scales while accounting for the nonlinear interplay between bulk diffusion and receptor-mediated surface reactions. We develop a microscale class I mixture model on a periodically perforated domain, coupling diffusion-reaction processes in the interstitial space with nonlinear reactions and exchange at cellular interfaces. Using two-scale convergence techniques, we derive a homogenized model that captures the influence of cellular microstructure through effective transport and reaction coefficients. Our analysis provides a mathematically justified passage from cell-scale dynamics to

tissue-scale transport laws, establishing a framework for computationally tractable simulations of amyloid-beta clearance at physiologically relevant scales.