**European Mathematical Society School on Mathematical Aspects of Fluid Flows**

May 12 – May 17, 2024, Kácov, Czech Republic

SCHEDULE

## Sunday, May 12

| Time | Speaker | Title |
|---|---|---|
| | *Chair: Josef Málek* | |
| 19:30 | | Dinner |
| 20:45 | | Opening and Introduction |

## Monday, May 13

| Time | Speaker | Title |
|---|---|---|
| 8:00 | | Breakfast |
| 9:00 | Paolo Antonelli | An introduction to the mathematical theory of quantum fluids – Part 1 |
| 10:10 | | Coffee & Refreshment |
| 10:45 | Vincent Giovangigli | Mathematical modeling of multicomponent reactive flows from the kinetic theory – Part 1 |
| 11:55 | | Break |
| 12:00 | Miroslav Bulíček | Analysis of heatconducting viscoelastic fluids |
| 12:10 | Erika Kokavcová | Further updates on implicitly constituted fluids |
| 12:20 | Tomáš Los | On three dimensional flows of viscoelastic fluids of Giesekus type |
| 12:30 | | Lunch & Break |
| 15:30 | | Coffee & Refreshment |
| 16:00 | John Lowengrub | Growth, patterning, and control in fluid flows out of equilibrium – Part 1 |
| 17:10 | | Break |
| 17:30 | Šárka Nečasová | On the motion of fluid in a moving domain and applications to fluid structure interaction |
| 17:40 | Florian Oschmann | Collision of rigid bodies in a non-Newtonian fluid |
| 17:50 | Antonín Češík | Fluid-structure interactions with full slip at the interface |
| 18:00 | Václav Mácha | On time-periodic solutions to an interaction problem between compressible viscous fluids and viscoelastic beams |
| 18:10 | Jean-Paul Adogbo | Partially diffuse hyberbolic systems in the Besov space |
| 18:20 | Petr Kaplický | Stability of equilibria to generalized Navier-Stokes-Fourier system |
| 18:30 | | Break |
| 18:45 | | Dinner & Pub visit |

EMS SCHOOL ON MATHEMATICAL ASPECTS OF FLUID FLOWS

Sporthotel Kácov May 12 – 17, 2024

https://ems-maff.cuni.cz/

### Tuesday, May 14

| Time | Speaker | Title |
|---|---|---|
| 8:00 | | Breakfast |
| 9:00 | Vincent Giovangigli | Mathematical modeling of multicomponent reactive flows from the kinetic theory – Part 2 |
| 10:10 | | Coffee & Refreshment |
| 10:45 | Paolo Antonelli | An introduction to the mathematical theory of quantum fluids – Part 2 |
| 11:55 | | Break |
| 12:00 | Dalibor Pražák | On $L^p$ semigroup to Stokes equation with dynamic boundary condition in the half-space |
| 12:10 | Lucie Wintrová | Existence of a weak solution to the generalized Navier-Stokes-Fourier system with the Dirichlet boundary condition |
| 12:20 | Michael Zelina | Remarks on DBC in unbounded domains |
| 12:30 | | Lunch & Break |
| 15:30 | | Coffee & Refreshment |
| 16:00 | John Lowengrub | Growth, patterning, and control in fluid flows out of equilibrium – Part 2 |
| 17:10 | | Break |
| 17:30 | Aaron Baier-Reinio | High-order finite element schemes for multicomponent flow problems |
| 17:40 | Kars Knook | Multigrid preconditioners for the Onsager-Stefan-Maxwell equations |
| 17:50 | Lenka Košárková | On oscillatory three-dimensional flows of the incompressible Navier-Stokes fluid in aortic root |
| 18:00 | Ladislav Trnka | Bifurcation analysis using deflation techniques |
| 18:10 | Maja Szlenk | Weak solutions to the Navier-Stokes equations for steady compressible non-Newtonian fluids |
| 18:20 | Jakub Woźnicki | Cahn–Hillard and Keller–Segel systems as high-friction limits of Euler–Korteweg and Euler–Poisson equations |
| 18:30 | | Break |
| 18:45 | | Dinner |
| 20:00 | | Session dedicated to the memory of Antonín Novotný (1958–2021) |

### Wednesday, May 15

| Time | Speaker | Title |
|---|---|---|
| 8:00 | | Breakfast |
| 9:00 | Noemi David | Singular limits arising in mechanical models of tissue growth – Part 1 |
| 10:10 | | Coffee & Refreshment |
| 10:45 | Anna Abbatiello | On a blow-up criterion for the Navier-Stokes-Fourier system under general equations of state |
| 10:55 | Martin Kalousek | On weak solutions to a model for a mixture of two heat conducting gases |
| 11:05 | Ondřej Kreml | Strong solutions to the compressible Navier-Stokes system in a moving domain |
| 11:15 | Mingjie Li | Global strong solutions to the Cauchy problem for planar magnetohydrodynamic equations with large initial data |
| 11:25 | Yong Lyu | Unconditional stability of equilibria in thermally driven compressible fluids |
| 11:35 | Milan Pokorný | Existence analysis of a stationary compressible fluid model for heat-conducting and chemically reacting mixtures |
| 11:45 | | Lunch |
| 12:45 | | Organized trip to Sázava monastery or free afternoon |
| 19:00 | | Dinner & Fire session |

## Thursday, May 16

| Time | Speaker | Title |
|---|---|---|
| 8:00 | | Breakfast |
| 9:00 | Paolo Antonelli | An introduction to the mathematical theory of quantum fluids – Part 3 |
| 10:10 | | Coffee & Refreshment |
| 10:45 | Noemi David | Singular limits arising in mechanical models of tissue growth – Part 2 |
| 11:55 | | Break |
| 12:00 | Martin Vejvoda | Modelling of transversely isotropic and fiber-reinforced elastic materials |
| 12:10 | Akash Parmar | Fractional regularity for conservation laws with discontinuous flux |
| 12:20 | Josef Málek | On the well-possedness of time-dependent three-dimensional Euler fluid flows |
| 12:30 | | Lunch & Break |
| 15:30 | | Coffee & Refreshment |
| 16:00 | John Lowengrub | Growth, patterning, and control in fluid flows out of equilibrium – Part 3 |
| 17:10 | | Break |
| 17:30 | Vincent Giovangigli | Mathematical modeling of multicomponent reactive flows from the kinetic theory – Part 3 |
| 18:40 | | Break |
| 18:45 | | Conference dinner |

## Friday, May 17

| Time | Speaker | Title |
|---|---|---|
| 7:30 | | Breakfast |
| 8:30 | | John's Lowengrub session |
| 9:30 | Noemi David | Singular limits arising in mechanical models of tissue growth – Part 3 |
| 10:40 | | Coffee & Refreshment |
| 11:05 | | Discussion: perspectives, difficulties, open problems |
| 11:55 | Closing | |
| 12:05 | | Lunch |
| 13:00 | Departure | |

**Paolo Antonelli, An introduction to the mathematical theory of quantum fluids.** A quantum fluid is a system of interacting particles that shows the effects of quantum statistics also on a macroscopic scale. Typical examples comprise superfluid Helium II, or Bose-Einstein condensates. From a mathematical perspective, these systems are usually described by a compressible, inviscid, barotropic fluid, subject to a stress tensor depending on the mass density and its derivatives.

During this short course, some rigorous results concerning the analysis of solutions to such models will be presented. In particular, we will discuss the mathematical framework that allow the study of global in time weak solutions with vacuum and, consequently, the treatment of quantized vortices. This class of solutions is particularly relevant because of its deep physical motivations. Within this framework, we will analyze various singular limits corresponding to asymptotic regimes, that are studied in some applications. If time permits, some open problems and directions of research will be mentioned.

**Noemi David, Singular limits arising in mechanical models of tissue growth.** Based on the mechanical viewpoint that living tissues present a fluid-like behaviour, PDE models inspired by fluid dynamics are nowadays well established as one of the main mathematical tools for the macroscopic description of tissue growth. Depending on the type of tissue, these models link the pressure to the velocity field using either Brinkman's law (visco-elastic models) or Darcy's law (porous-medium equations (PME)). Moreover, the stiffness of the pressure law plays a crucial role in distinguishing density-based (compressible) models from free boundary (incompressible) problems where saturation of the density holds.

This course aims to analyse how to relate different mechanical models of living tissues through singular limits. In particular, we will address the inviscid limit towards the PME and the incompressible limit from the PME to free boundary problems of Hele-Shaw type for equations including convective effects as well as for systems of coupled nonlinear equations.

**Vincent Giovangigli, Mathematical modeling of multicomponent reactive flows from the kinetic theory.** Multicomponent reactive flow models derived from the kinetic theory are considered. The mathematical structure of the resulting systems of equations is closely related to the underlying kinetic framework. We first address multicomponent diffusion, complex reaction networks, entropic structure, local existence and asymptotic stability of constant equilibrium states. We further address relaxation issues for reactive fluids as well as for two temperature models and discuss the apparition of the bulk viscosity coefficient. We finally consider nonideal fluids and their cohesive properties that lead to single species as well as multicomponent diffuse interfaces models.

**John Lowengrub, Growth, patterning, and control in fluid flows out of equilibrium.** A variety of pattern-forming phenomena, ranging from the growth of bacterial colonies to snowflake formation, share similar underlying physical mechanisms and mathematical structure. Dense-branching or dendritic morphologies are among the most common forms of microstructural patterning in systems driven out of equilibrium. Understanding the formation kinetics and the interplay of system parameters can lead to understanding of growth and form in nature, as well as improved control and efficiency in a variety of physical, biological, and engineering systems. Prediction and control of the emergent patterns are difficult due to the nonlocality and nonlinearity of the system.

In this course, we focus on viscous fingering as a paradigm for such phenomena. We will study theoretically and numerically the dynamics and control of viscous fingering patterns and, when possible, present experimental validation of model predictions. Extensions of the results to other pattern-forming systems will be discussed.

## Abstracts of contributed talks

**Anna Abbatiello, On a blow-up criterion for the Navier-Stokes-Fourier system under general equations of state.** We prove a blow-up criterion for the compressible Navier-Stokes- Fourier system for general thermal and caloric equations of state with inhomogeneous boundary conditions for the velocity and the temperature. Assuming only that Gibb's equation and the thermodynamic stability hold, we show that solutions in a certain regularity class remain regular under the condition that the density, the temperature and the modulus of the velocity are bounded. This is joint work with D. Basaric and N. Chaudhuri.

**Jean-Paul Adogbo, Partially diffuse hyberbolic systems in the Besov space.** Many systems of evolutionary PDEs that model physical phenomena are couplings of first order hyperbolic equations with degenerate dissipative or diffusive terms. This is the case for example in a gas dynamics, where the mass is conseved during the evolution, but the momentum balance includes a diffusion (viscosity) or damping (relaxation) term. Other examples come from electromagnetism, magnetohydrodynamics, viscoelasticity,... Under the (SK) (for Shizuita-Kawashima ) condition and using Beauchard and Zuazua's approach, we get the global of strong solution. In this talk, we will try to present this system, and the tools allowing us to get the global existence. This is joint work with Raphaël Danchin.

**Aaron Baier-Reinio, High-order finite element schemes for multicomponent flow problems.** In this talk we consider the Stokes–Onsager–Stefan–Maxwell (SOSM) equations, which model the flow of concentrated mixtures of distinct chemical species in a common thermodynamic phase. The equations account for both the diffusive interactions between chemical species and the bulk convection. Our aim is to develop computationally efficient high-order finite element schemes that discretize these nonlinear equations in two and three spatial dimensions. Because the SOSM equations relate many unknown variables (e.g. the bulk and species velocities, pressure, concentrations, chemical potentials, etc.), this is a difficult task. In particular, there are many choices of which variables should be explicitly solved for in the formulation, and it is not clear which discrete finite element function spaces should be employed. To tackle this challenge, we derive a novel weak formulation of the SOSM problem in which the species mass fluxes are treated as unknowns. We show that this new formulation naturally leads to a large class of high-order finite element discretizations that are straightforward to implement and have desirable linear-algebraic properties. Moreover, from a theoretical standpoint, we are able to prove that when applied to a linearized version of the SOSM problem, the proposed finite element schemes are convergent. Our findings are illustrated with numerical experiments. This is joint work with Patrick E. Farrell.

**Miroslav Bulíček, Analysis of heatconducting viscoelastic fluids.** We discuss several models for viscoelastic rate-type fluid models used in engineering practice. We let all the material parameters depend on the temperature and provide a basic thermodynamical analysis. On the basis of that, we further discuss the existence analysis for Giesekus (and its generalisation) models with or without stress diffusion.

**Antonín Češík, Fluid-structure interactions with full slip at the interface.** This work in progress concerns the interaction of Navier-Stokes fluid with a largely deforming visco-elastic bulk solid, with full slip at the fluid-solid interface. We present a notion of weak solution which is amenable to the variational time-stepping scheme developed by Benešová, Kampschulte and Schwarzacher in the no-slip case. The technical challenges here are that with slip, the test functions can have a tangential jump at the interface. These need to be properly approximated with test functions admissible for the approximate solutions. This is joint work with Malte Kampschulte, Sebastian Schwarzacher.

**Martin Kalousek, On weak solutions to a model for a mixture of two heat conducting gases.** We address the problem of global-in-time existence of weak solutions to a dissipative one velocity Baer-Nunyiato type model for a mixture of two compressible heat conducting gases. This is joint work with Šárka Nečasová.

**Petr Kaplický, Stability of equilibria to generalized Navier-Stokes-Fourier system.** We consider a non-Newtonian incompressible heat conducting fluid with prescribed nonuniform temperature on the boundary and with the no-slip boundary conditions for the velocity. We assume no external body forces. For the power-law like models with the power law index bigger than 11/5 in three dimensions, we identify a class of solutions fulfilling the entropy equality and converging to the equilibria exponentially in a proper metric. In fact, we show the existence of a Lyapunov functional for the problem. Consequently, the steady solution is nonlinearly stable and attracts all proper weak solutions. This is joint work with A. Abbatiello, M. Bulíček.

**Kars Knook, Multigrid preconditioners for the Onsager-Stefan-Maxwell equations.** In this talk a monotlithic multigrid preconditioner is presented for the Onsager-Stefan-Maxwell (OSM) equations, which describe a multicomponent flow driven by diffusion. We start by introducing a new weak formulation and discretisation for the OSM equations, and discuss how this can be preconditioned using additive Schwarz methods. Time permitting, I will also showcase how to build high-performance finite element code with Firedrake. This is joint work with Patrick Farrell.

**Erika Kokavcová, Further updates on implicitly constituted fluids.** In this talk we will review our work on implicitly constituted fluids with M. Bulíček and J. Málek. We will also present some new results in numerical analysis obtained with A. Gazca Orozco, F. Gmeineder and T. Tscherpel.

**Lenka Košárková, On oscillatory three-dimensional flows of the incompressible Navier-Stokes fluid in aortic root.** We follow the objective to understand the formation of vortices and the development of other flow characteristics such as dissipation, vorticity, wall shear stress and pressure drop associated with the three-dimensional motions of an incompressible Navier–Stokes fluid in aortic root. We extend the results presented in Chabionik et al. (2022) International Journal of Engineering Science, 180(103749) by focusing on three following aspects. First, instead of considering tubes containing a sinusoidal extension, we consider more reatistic geometry containing the extension with three sinuses. Second, we impose the so called Womersley velocity profile as an inflow boundary condition that reflects the flow generated by the oscillatory pressure gradient. Third, the boundary of the discretised computational domain is approximated by piecewise higher order polynomials to better capture the imposed boundary conditions. For such modifications we investigate the character of the soluti ons and how the flow characteristics changes if we vary the value of the slip mechanisms on the wall.

**Ondřej Kreml, Strong solutions to the compressible Navier-Stokes system in a moving domain.** We prove the local well-posedness for the barotropic compressible Navier-Stokes system on a moving domain, a motion of which is determined by a given vector field V, in a maximal Lp - Lq regularity framework. Under additional smallness assumptions on the data we show that the solution exists globally in time and satisfies a decay estimate. In particular, for the global well-posedness we do not require exponential decay or smallness of V, however, we require exponential decay and smallness of its derivatives. This is joint work with Šárka Nečasová, Tomasz Piasecki.

**Mingjie Li, Global strong solutions to the Cauchy problem for planar magnetohydrodynamic equations with large initial data.** We consider the Cauchy problem to the compressible planar magnetohydrodynamic equations without heat conduction, and establish the local and global existence and uniqueness of strong solutions with general large initial data. This is a joint work with Professor Jinkai Li.

**Tomáš Los, On three dimensional flows of viscoelastic fluids of Giesekus type.** Viscoelastic rate-type fluid models are popular in many applications involving fluid-like materials with complex micro-structure. A well-developed mathematical theory for the most of these classical fluid models is however missing. We provide a complete proof of long-time and large-data existence of weak solutions to unsteady internal three-dimensional flows of Giesekus fluids subject to a no-slip boundary condition. We also generalize the result to higher dimensions, to viscoelastic models with multiple relaxation mechanisms and to viscoelastic models with different type of dissipation. This is joint work with Miroslav Bulíček, Josef Málek.

**Yong Lyu, Unconditional stability of equilibria in thermally driven compressible fluids.** We show that small perturbations of the spatially homogeneous equilibrium of a thermally driven compressible viscous fluid are globally stable. Specifically, any weak solution of the evolutionary Navier-Stokes-Fourier system driven by thermal convection converges to an equilibrium as time goes to infinity. The main difficulty to overcome is the fact the problem does not admit any obvious Lyapunov function. The result applies, in particular, to the Rayleigh-Bénard convection problem. This is joint work with Eduard Feireisl, Yong Lu.

**Václav Mácha, On time-periodic solutions to an interaction problem between compressible viscous fluids and viscoelastic beams.** We study a nonlinear fluid-structure interaction problem between a viscoelastic beam and a compressible viscous fluid. The beam is immersed in the fluid which fills a two-dimensional rectangular domain with periodic boundary conditions. Under the effect of periodic forces acting on the beam and the fluid, at least one time-periodic weak solution is constructed which has a bounded energy and a fixed prescribed mass. This is joint work with O. Kreml, š. Nečasová, S. Trifunovic.

**Josef Málek, On the well-possedness of time-dependent three-dimensional Euler fluid flows.** We study the mathematical properties of time-dependent flows of incompressible fluids that respond as an Euler fluid until the modulus of the symmetric part of the velocity gradient exceeds a certain, a-priori given but arbitrarily large, critical value. Once the velocity gradient exceeds this threshold, a dissipation mechanism is activated. Assuming that the fluid, after such an activation, dissipates the energy in a specific manner, we prove that the corresponding initial-boundary-value problem is well-posed in the sense of Hadamard. In particular, we show that for an arbitrary, sufficiently regular, initial velocity there is a unique weak solution to the spatially-periodic problem. This is a joint result with Miroslav Bulíček.

**Šárka Nečasová, On the motion of fluid in a moving domain and applications to fluid structure interaction.** Problems of fluid flow inside a moving domain deserve a lot of interest as they appear in many practical applications. Such problems can also be seen as a preparation step for research of fluid-structure interaction problems. Research of the compressible version of the Navier-Stokes system dates back to the nineties when the groundbreaking result of the existence of the global weak solutions to the compressible barotropic Navier–Stokes system on a fixed domain was proved by P. L. Lions and, later, by E. Feireisl and collaborators who extended the existence result to more physically relevant state equations. After that the theory of weak solutions was extended to the problem of fluid flow inside a moving domain. Such existing theory was applied to more complicated problem e.g. to the interaction between system of compressible fluid with a shell of Koiter type with Navier-type of boundary conditions or into the case of two compressible mutually noninteracting fluids and a shell of Koiter type encompassing a time dependent 3D domain filled by the fluids. Moreover, the weak-strong uniquenss and low Mach number limit together with invisid limit is shown in the case of monofluid system with an elastic boundary. It is a join work with M. Kalousek,Y. Liu, S. Mitra.

**Florian Oschmann, Collision of rigid bodies in a non-Newtonian fluid.** We generalize the known collision results for a solid in a 3D compressible Newtonian fluid to compressible non-Newtonian ones, and to Newtonian fluids with temperature depending viscosities. It is a join work with Šárka Nečasová.

**Akash Parmar, Fractional regularity for conservation laws with discontinuous flux.** In this talk, we discuss the regularity aspects of the entropy solutions for scalar conservation laws with discontinuous flux. From the work [Adimurthi et al., Comm. Pure Appl. Math. 2011], it is well-known that there exists initial data in $BV$ such that the corresponding entropy solution does not belong to $BV$ space. Consequently, we investigate the necessity of fractional $BV^s$ spaces, which is a bigger space than $BV$, with $0 < s \leq 1$. We prove the optimal regularizing effect for the discontinuous flux with $L^f$ initial data. The optimal regularizing effect in $BV^s$ is proven in an important case using control theory, and the fractional exponent $s$ is at most $1/2$, even when the fluxes are uniformly convex. This is joint work with Shyam Sundar Ghoshal and Stéphane Junca.

**Milan Pokorný, Existence analysis of a stationary compressible fluid model for heat-conducting and chemically reacting mixtures.** The existence of large-data weak solutions to a steady compressible Navier–Stokes–Fourier system for chemically reacting fluid mixtures is proved. General free energies are considered satisfying some structural assumptions, with a pressure containing a $\gamma$-power law. The model is thermodynamically consistent and contains the Maxwell–Stefan cross-diffusion equations in the Fick–Onsager form as a special case. Compared to previous works, a very general model class is analyzed, including cross-diffusion effects, temperature gradients, compressible fluids, and different molar masses. A priori estimates are derived from the entropy balance and the total energy balance. The compactness for the total mass density follows from an estimate for the pressure in $L^p$ with $p > 1$, the effective viscous flux identity, and uniform bounds related to Feireisl's oscillations defect measure. These bounds rely heavily on the convexity of the free energy and the strong convergence of the relative chemical potentials. The presentation follows the publication [1]. This is joint work with Miroslav Bulíček, Ansgar Jüngel and Nicola Zamponi.

[1] M. Bulíček, A. Jüngel, M. Pokorný, N. Zamponi, *Existence analysis of a stationary compressible fluid model for heat-conducting and chemically reacting mixtures*, J. Math. Phys. **63** (2022), no. 5, Paper No. 051501, 48 pp.

**Dalibor Pražák, On $L^p$ semigroup to Stokes equation with dynamic boundary condition in the half-space.** We consider evolutionary Stokes system, coupled with the so-called dynamic boundary condition, in the simple geometry of $d$-dimensional half-space. Using the Fourier transform, we obtain an explicit formula for the resolvent. Maximal regularity estimates and existence of analytic semigroup in the $L^p$-setting are then deduced using classical multiplier theorems. This is joint work with Michael Zelina.

**Maja Szlenk, Weak solutions to the Navier-Stokes equations for steady compressible non-Newtonian fluids.** We prove the existence of weak solutions to steady, compressible non-Newtonian Navier-Stokes system on a bounded, two- or three-dimensional domain. Assuming the viscous stress tensor is monotone satisfying a power-law growth with power $r$ and the pressure is given by $\varrho^\gamma$, we construct a solution provided that $r > \frac{3d}{d+2}$ and $\gamma$ is sufficiently large, depending on the values of $r$. Additionally, we also show the existence for time-discretized model for Herschel-Bulkley fluids, where the viscosity has a singular part. This is joint work with Cosmin Burtea.

**Ladislav Trnka, Bifurcation analysis using deflation techniques.** Deflation techniques are numerical methods for finding multiple distinct solutions of stationary nonlinear equations. In contrast to other methods in numerical bifurcation analysis, deflation techniques have three main advantages. First, deflation techniques are able to find disconnected solution branches. Second, the techniques are based on suppressing the convergence of Newton's method to known roots which leads to good scalability with respect to problem dimension (no computation of subproblems required). Third, no special insight in choosing initial guesses is required (finding multiple solutions from the same initial guess).

**Martin Vejvoda, Modelling of transversely isotropic and fiber-reinforced elastic materials.** Cauchy elasticity (hyperelasticity) is a popular theory for modeling nonlinear ideally elastic materials. In this short talk, we will show how it can be used to model isotropic and transversely isotropic materials. We will also discuss fiber-reinforced materials, including materials reinforced by multiple fiber families.

**Lucie Wintrová, Existence of a weak solution to the generalized Navier-Stokes-Fourier system with the Dirichlet boundary condition.** We consider the incompressible Navier-Stokes-Fourier system describing the motion of a non-Newtonian fluid in the two-dimensional bounded domain. In addition, the system is equipped with the entropy equation. We define the notion of a solution and prove its existence. We approach the problem by modifying techniques used in several papers studying the generalized NSF system and the entropy equation. Since we are treating the two-dimensional case as opposed to the more frequent 3D case, we are able to relax conditions on the initial data.

**Jakub Woźnicki, Cahn–Hillard and Keller–Segel systems as high-friction limits of Euler–Korteweg and Euler–Poisson equations.** We consider a combined system of Euler–Korteweg and Euler–Poisson equations with friction and exponential pressure with exponent $\gamma > 1$. We show the existence of dissipative measure-valued solutions in the cases of repulsive and attractive potential in Euler–Poisson system. The latter case requires additional restriction on $\gamma$. Furthermore in case of $\gamma \geq 2$ we show that the strong solutions to the Cahn–Hillard–Keller–Segel system are a high-friction limit of the dissipative measure-valued solutions to Euler–Korteweg–Poisson equations. This is joint work with Dennis Gallenmuller, Piotr Gwiazda, Agnieszka Świerczewska-Gwiazda.

**Michael Zelina, Remarks on DBC in unbounded domains.** We will present our current work on NS system with dynamic boundary condition in the space between two infinite flat plates. We will talk about the linearization principle and the stability of Couette flow. This is joint work with Dalibor Pražák.