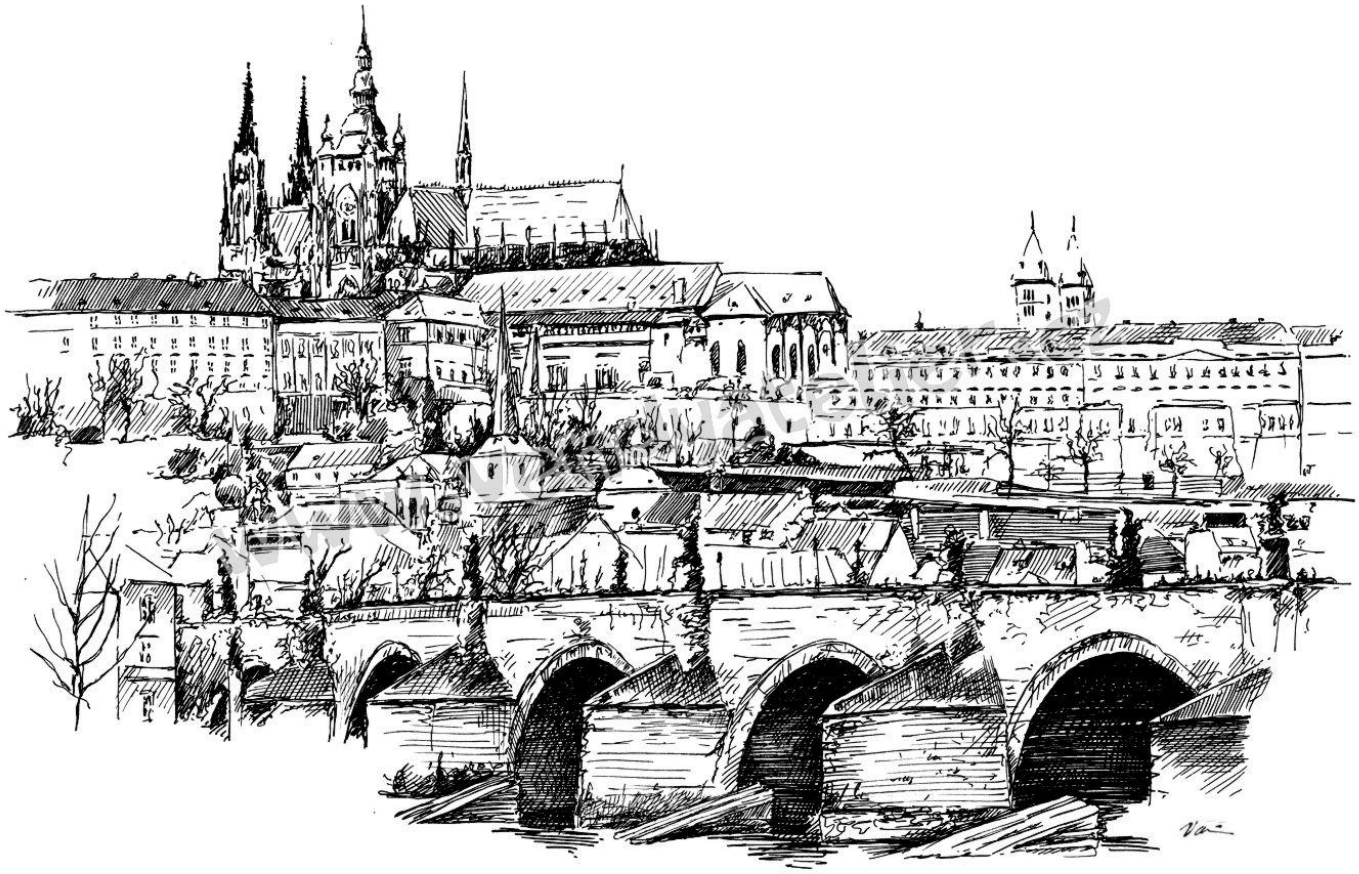

# The Second Chinese-Czech Conference on Mathematical Fluid Mechanics Prague, September 16-22, 2018

# PROGRAM

INSTITUTE of MATHEMATICS
Academy of Sciences
Czech Republic

FACULTY
OF MATHEMATICS
AND PHYSICS
Charles University

RSJ

**Sunday, September 16th**

***Registration***

**Monday, September 17th**

**9 30 – 9 40** **Opening of the conference**
**9 40 – 10 10** Yi Wang: *Wave phenomena to the three-dimensional fluid-particle model*
**10 15 – 10 45** Eduard Feireisl: *Markov selection and uniqueness problems for compressible viscous fluids*

**10 50 – 11 10** ***Coffee and tea break***

**11 10 – 11 40** Wei-Xi Li: *Well-posedness in Gevrey function space for the three-dimensional Prandtl equations*
**11 45 – 12 15** Petr Kučera: *Local in time existence and robustness of strong solutions of the Navier-Stokes equations with various types of boundary conditions*

**12 20 – 14 00** ***Lunch break***

**14 00 – 14 30** Huanyao Wen: *Global existence of weak solution to a two-fluid model with large initial data*
**14 35 – 15 05** Milan Pokorný: *Weak solutions for some compressible multicomponent fluid models*

**15 10 – 15 30** ***Coffee and tea break***

**15 30 – 16 00** Sebastian Schwarzacher: *On compressible fluids interacting with a linear-elastic Koitershell*
**16 05 – 16 35** Chengchun Hao: *On the motion of the free boundary incompressible neo-Hookean elastodynamics*
**16 40 – 17 10** Zdeněk Skalák: *Regularity results for the Navier-Stokes equations based on* $\partial_3 u$

***Welcome party***

**Tuesday, September 18th**

**9 30 – 10 00** Qiangchang Ju: *Three-Scale Singular Limits of Evolutionary PDEs*
**10 05 – 10 35** Josef Málek: *Derivation of the variants of the Burgers model using a thermodynamic approach and appealing to the concept of evolving natural configurations*

**10 40 – 11 00** ***Coffee and tea break***

**11 00 – 11 30** Fucai Li: *Singular limits to the isentropic compressible viscous magnetohydrodynamic equations*
**11 35 – 12 05** Miroslav Bulíček: *PDE analysis of a class of thermodynamically compatible viscoelastic compressible and incompressible rate-type fluids with stress-diffusion*

**12 05 – 13 45** ***Lunch break***

**13 45 – 14 15** Lizhi Ruan: *Some results on radiative Euler equations and related models*
**14 20 – 14 50** Ondřej Kreml: *Recent results on nonuniqueness of admissible solutions to the multi-D isentropic Euler system*

**14 55 – 15 15** ***Coffee and tea break***

**15 15 – 15 45** Li Jingyu: *Structure of stationary solutions to the hydrodynamic model in semiconductor*
**15 50 – 16 20** Bangwei She: *Dissipative measure-valued solutions and convergent numerical scheme for the compressible Navier-Stokes system*
**16 25 – 16 55** Wentao Cao: $C^{1,\alpha}$ *isometric extensions*
**17 00 – 17 30** Václav Mácha: *Non-uniqueness of admissible weak solution to the Riemann problem for the full Euler system in 2D*

**Wednesday, September 19th**

**9 30 – 10 00** Lili Du: *Incompressible axially symmetric jet incident on an uneven wall*
**10 05 – 10 35** Erika Maringová: *On a Navier-Stokes-Fourier-like system capturing transitions between viscous and inviscid fluid regimes and between no-slip and perfect-slip boundary conditions*

**10 40 – 11 00** ***Coffee and tea break***

**11 00 – 11 30** Dongjuan Niu: *Vortex-wave system on incompressible flows with helical symmetry*
**11 35 – 12 05** Šárka Nečasová: *Influence of pressure and bulk viscosity in congestion phenomena*
**12 10 – 12 40** Tomáš Los: *On three-dimensional flows of pore pressure activated Bingham fluids*

**12 45 – 14 15** ***Lunch***

***Free discussions***

**Thursday, September 20th**

**9 30 – 10 00** Guilong Gui: *Global stability of the inhomogeneous plasma slab of the compressible MHD equations with physical vacuum*
**10 05 – 10 35** Michal Bathory: *Identification of outflow boundary condition for an incompressible flow*

**10 40 – 11 00** ***Coffee and tea break***

**11 00 – 11 30** Yong Lu: S*ome recent studies on homogenization problems in fluid mechanics*
**11 35 – 12 05** Petr Kaplický: *Homogenization of an incompressible stationary flow of an electrorheological fluid*

**12 05 – 13 45** ***Lunch break***

**13 45 – 14 15** Xulong Qin: *Instability of Non-isentropic Fluid Flows*
**14 20 – 14 50** Šimon Axmann: *Steady flow of dense compressible chemically reacting mixture*

**14 55 – 15 15** ***Coffee and tea break***

**15 15 – 15 45** Feng Xie: *On the stabilizing effects of magnetic field on the boundary layer*
**15 50 – 16 20** Yuehong Feng: *Stability of Compressible Navier-Stokes/Euler-Maxwell systems*
**16 25 – 16 55** Jiří Neustupa: *Spectral instability of a steady flow of an incompressible viscous fluid past a rotating obstacle*

***Conference dinner***

**Friday, September 21st**

***Free discussions***

**Saturday, September 22nd**

***Free discussions***

# Monday, September 17th

### Wave phenomena to the three-dimensional fluid-particle model

Yi Wang

9:40–10:10

**Abstract**

We study the wave phenomena to a fluid-particle model described by the three-dimensional Vlasov–Fokker–Planck equations coupled with the compressible Navier–Stokes/Euler equations (denoted by NS/E-VFP in abbreviation). For this purpose, a new micro-macro decomposition around the local Maxwellian to the kinetic part of the NS/E-VFP system is first established and then a new two-fluid model, with one of the fluid equipped with the isothermal pressure and the degenerate viscosity coefficients depending on the density function linearly, is derived from the Chapman–Enskog expansion of the kinetic Vlasov–Fokker–Planck equation. Moreover, this new decomposition gives a unified proof framework for the stability analysis of basic wave patterns for NS/E-VFP system and as an application of the new decomposition, the time-asymptotic stability of planar rarefaction wave is proved for the three-dimensional both NS-VFP and E-VFP systems. Note that such a wave phenomena has never been observed to the pure Vlasov–Fokker–Planck equation and the wave phenomena here comes essentially from the fluid-particle interactions between the compressible fluids and the kinetic Vlasov–Fokker–Planck equations through the friction (or drag) force and Brownian motion.

### Markov selection and uniqueness problems for compressible viscous fluids

Eduard Feireisl

10:15–10:45

**Abstract**

We consider the compressible Navier–Stokes system driven by stochastic forcing. We show that the problem admits a Markov selection so it is in a certain way uniquely solvable in this setting. Implications of the results on the associated deterministic problem are also discussed.

## Well-posedness in Gevrey function space for the three-dimensional Prandtl equations

Wei-Xi Li

11:10–11:40

### Abstract

In this talk, we consider the three-dimensional Prandtl equations, and prove that if one component of the tangential velocity field satisfies the monotonicity assumption in the normal direction, then the system is locally well-posed in the Gevrey function space with Gevrey index in ]1, 2]. The proof relies on some new cancellation mechanism in the system in addition to those observed in the two-dimensional setting. It is a joint work with Tong Yang.

## Local in time existence and robustness of strong solutions of the Navier-Stokes equations with various types of boundary conditions

Petr Kučera

11:45–12:15

### Abstract

In this contribution we deal with the system of the Navier–Stokes equations with boundary conditions with Navier's boundary conditions or with boundary conditions of the Navier type on the bounded smooth domain. We give condition for local in time existence of strong solutions to this system. This result is modification of results of Robinson et al. for solutions of the Navier–Stokes system on the whole space or on the space-periodic domains. Further, we deal with perturbations of initial conditions of strong solutions of this system. We prove that if these perturbations are sufficiently small in some norms then corresponding solutions are strong too.

### Global existence of weak solution to a two-fluid model with large initial data

Huanyao Wen

14:00–14:30

#### Abstract

We shall talk about the global existence of weak solutions of Dirichlet problem for a one-velocity viscous two-fluid model. By relying on weak compactness tools we obtain existence results within the class of weak solutions in one dimension and in high dimensions respectively. An essential novel aspect of this analysis, compared to previous works on the same model, is that the solution space is large enough to allow for transition to single-phase flow without any constraints in one dimension. In high dimensions, similar result can be obtained subject to some constraints for the adiabatic index.

### Weak solutions for some compressible multicomponent fluid models

Milan Pokorný

14:35–15:05

#### Abstract

The principle purpose of this work is to investigate a "viscous" version of a "simple" but still realistic bi-fluid model described in [1] whose "non-viscous" version is derived from physical considerations in [2] as a particular sample of a multifluid model with algebraic closure. The goal is to show existence of weak solutions for large initial data on an arbitrarily large time interval. We achieve this goal by transforming the model to an academic system which resembles to the compressible Navier–Stokes equations, with however two continuity equations and a momentum equation endowed with pressure of complicated structure dependent on two variable densities. The new "academic system" is then solved by an adaptation of the Lions–Feireisl approach for solving compressible Navier–Stokes equation, completed with several observations related to the DiPerna–Lions transport theory inspired by [3] and [4]. We also explain how these techniques can be generalized to a model of mixtures with more then two species. It is a joint work with A. Novotný.

**References**

[1] D. Bresch, B. Desjardins, J.-M. Ghidaglia, E. Grenier, M. Hilliairet. Multifluid models including compressible fluids. in: *Handbook of Mathematical Analysis in Mechanics of Viscous Fluids.* Eds. Y. Giga et A. Novotný (2018), pp. 52.

[2] M. Ishii, T. Hibiki. *Thermo-fluid dynamics of two-phase flow.* Springer Verlag (2006).

[3] D. Maltese, M. Michálek, P.B. Mucha, A. Novotný, M. Pokorný, E. Zatorska. Existence of weak solutions for compressible Navier–Stokes equations with entropy transport. *J. Differential Equations* **261**, 4448–4485, 2016.

[4] A. Vasseur, H. Wen, C. Yu. Global weak solution to the viscous two-fluid model with finite energy. arXiv: 1704.07354.

## On compressible fluids interacting with a linear-elastic Koitershell

Sebastian Schwarzacher

15:30–16:00

### Abstract

The lecture is about the motion of a viscous incompressible fluid in three dimensions interacting with a flexible shell. The shell constitutes a moving part of the boundary of the physical domain. Its deformation is modelled by a linearized version of Koiter's elastic energy. We discuss the existence of weak solutions to the corresponding system of PDEs provided the adiabatic exponent satisfies $\gamma > \frac{12}{7}$ ($\gamma > 1$in two dimensions). It will be explained that a weak solution exists until the moving boundary approaches a self-intersection. This is a joint work with D. Breit (Heriot-Watt Univ. Edinburgh).

## On the motion of the free boundary incompressible neo-Hookean elastodynamics

Chengchun Hao

16:05–16:35

### Abstract

In this talk, I will show the a priori estimates of Sobolev norms for a free boundary problem of the incompressible neo-Hookean elastodynamics in two and three spatial dimensions by adopting a geometrical point of view of Christodoulou–Lindblad. Some estimates on the second fundamental form and velocity of the free surface are also obtained. This is based on a joint work with Professor D. Wang.

## Regularity results for the Navier-Stokes equations based on $\partial_3 u$

Zdeněk Skalák

16:40–17:10

### Abstract

We discuss several results concerning the conditional regularity for the Navier–Stokes equations in the entire three dimensional space. Supposing that $u = (u_1, u_2, u_3)$ is a solution, we mainly focus on the case, where the additional condition is imposed on $\partial_3 u$ and comment on recent results from the literature. We then show the regularity of $u$ on $[0, T]$ under the condition that $u \in L^p(0, T; L^q)$ if $2/p + 3/q = 2$ and $q \in (3/2, 3]$. At the end we discuss the non-optimal results for $q > 3$.

### References

[1] C. Cao. Sufficient conditions for the regularity to the 3D Navier-Stokes equations. *Discrete Contin. Dyn. Syst.* **26** (2010), 1141–1151.

[2] I. Kukavica, M. Ziane. Navier-Stokes equations with regularity in one direction. *J. Math. Phys.* **48** (2007), 10 pp.

[3] Z. Zhang. A improved regularity criterion for the Navier–Stokes equations in terms of one directional derivative of the velocity field. *Bull. Math. Sci.* **8** (2018), 33–47.

# Tuesday, September 18th

### Three-Scale Singular Limits of Evolutionary PDEs

Qiangchang Ju

9:30–10:00

**Abstract**

Singular limits of a class of evolutionary systems of partial differential equations having two small parameters and hence three time scales are considered. Under appropriate conditions solutions are shown to exist and remain uniformly bounded for a fixed time as the two parameters tend to zero at different rates. A simple example shows the necessity of those conditions in order for uniform bounds to hold. Under further conditions the solutions of the original system tend to solutions of a limit equation as the parameters tend to zero. Finally, we apply the results to the problem that motivated this research, namely the simultaneous zero Alfven number and zero Mach number limit of the scaled compressible inviscid MHD equations. This is a joint research work with Bin Cheng from Surrey university and Steve Schochet from Tel-Aviv University.

### Derivation of the variants of the Burgers model using a thermodynamic approach and appealing to the concept of evolving natural configurations

Josef Málek

10:05–10:35

**Abstract**

Viscoelastic rate-type fluid models involving the stress and frame-indifferent time derivatives of second order, like those in Burgers' model, are used to describe the complicated response of fluid like materials that are endowed with a complex microstructure that allows them to possess two different relaxation mechanisms as well as other non-Newtonian characteristics. Such models are used in geomechanics, biomechanics, chemical engineering and material sciences. We show how to develop such rate-type fluid models that include the classical Burgers' model as well as variants of Burgers' model, using a thermodynamic approach based on constitutive assumptions for two scalar quantities (namely how the material stores energy and how the energy is dissipated) and appealing to the concept of natural configuration associated with the placement of the body that evolves as the body deforms. The lecture is based on a joint work with K. R. Rajagopal and K. Tuma.

## Singular limits to the isentropic compressible viscous magnetohydrodynamic equations

Fucai Li

11:00–11:30

### Abstract

In this talk we shall discuss the singular limits to the isentropic compressible viscous magnetohydrodynamic equations in three cases: the whole space, periodic, and bounded domain.

## PDE analysis of a class of thermodynamically compatible viscoelastic compressible and incompressible rate-type fluids with stress-diffusion

Miroslav Bulíček

11:35–12:05

### Abstract

We present a system of PDEs governing the motion of non-Newtonian fluids described by a simplified viscoelastic rate-type model with a stress-diffusion term. The simplified model shares many qualitative features with more complex viscoelastic rate-type models that are frequently used in the modeling of fluids with complicated microstructure. As such, the simplified model provides important preliminary insight into the mathematical properties of these more complex and practically relevant models of non-Newtonian fluids. The simplified model that is analyzed from the mathematical perspective is shown to be thermodynamically consistent, and we extensively comment on the interplay between the thermodynamical background of the model and the mathematical analysis of the corresponding initial-boundary-value problem. Furthermore, we will show how the result can be extended to the non-simplified setting.

## Some results on radiative Euler equations and related models

Lizhi Ruan

13:45–14:15

### Abstract

In this talk, we will consider radiative Euler equations and related models. Some results and recent progresses on the global wellposedness will be discussed. This is joint work with Professor Renjun Duan, Lili Fan, Wenliang Gao, Wei Xiang and Changjiang Zhu.

## Recent results on nonuniqueness of admissible solutions to the multi-D isentropic Euler system

Ondřej Kreml

14:20–14:50

### Abstract

In this talk we survey recent results concerning uniqueness and nonuniqueness of admissible weak solutions related to the Riemann problem for the multi-dimensional isentropic Euler equations. While the solutions consisting only of rarefaction waves are unique due to the result of Chen and Chen, the convex integration method developed by De Lellis and Szekelyhidi for the incompressible Euler system allowed for proofs of nonuniqueness of admissible solutions whenever the standard 1D solution contains a shock.

## Structure of stationary solutions to the hydrodynamic model in semiconductor

Li Jingyu

15:15–15:45

### Abstract

We study the structure of stationary solutions to the hydrodynamic model of semiconductors modeled by Euler-Poisson equations with sonic boundary condition. When the doping profile is subsonic, we prove that, the steady-state equations possess a unique interior subsonic solution, and at least one interior supersonic solution; and if further the relaxation time is large, then the equations admit infinitely many interior transonic solutions of shock type; while if the relaxation time is small, then the system has no transonic solutions of shock type but has infinitely many smooth transonic solutions. When the doping profile is supersonic, the structure of the solution is completely different. We show that in this case, the system does not hold any subsonic solution; furthermore, the system doesn't admit any supersonic solution or any transonic solution if such a supersonic doping profile is small enough or the relaxation time is small, but it has at least one supersonic solution and infinitely many transonic solutions if the supersonic doping profile is close to the sonic line and the relaxation time is large. The subsonic/supersonic solutions all are globally $C^{1/2}$ Hölder continuous, and the Hölder exponent $1/2$ is optimal. We also discuss the further regularities of smooth transonic solutions.

## Dissipative measure-valued solutions and convergent numerical scheme for the compressible Navier-Stokes system

Bangwei She

15:50–16:20

### Abstract

We propose a new scheme for the compressible Navier–Stokes equations. We show that the scheme is energy stable, consistency, and finally convergent to the dissipative measure-valued solution of the system. Using the argument of weak-strong uniqueness [1], we further conclude that the numerical solution convergences to the strong solution as long as the latter exists.

### References

[1] E. Feireisl, P. Gwiazda, A. Świerczewska-Gwiazda, and E. Wiedemann. Dissipative measure-valued solutions to the compressible Navier-Stokes system. *Calc. Var.*, 55–141, 2016.

## $C^{1,\alpha}$ isometric extensions

Wentao Cao

16:25–16:55

### Abstract

In this paper we consider the Cauchy problem for isometric immersions. More precisely, given a smooth isometric immersion of a codimension one submanifold we construct $C^{1,\alpha}$ isometric extensions for any $\alpha < \frac{1}{n(n+1)+1}$ via the method of convex integration.

## Non-uniqueness of admissible weak solution to the Riemann problem for the full Euler system in 2D

Václav Mácha

17:00–17:30

### Abstract

The question of well- and ill-posedness of entropy admissible solutions to the multi-dimensional systems of conservation laws has been studied recently in the case of isentropic Euler equations. In this context special initial data were considered, namely the 1D Riemann problem which is extended trivially to a second space dimension. It was shown that there exist infinitely many bounded entropy admissible weak solutions to such a 2D Riemann problem for isentropic Euler equations, if the initial data give rise to a 1D self-similar solution containing a shock. In this work we study such a 2D Riemann problem for the full Euler system in two space dimensions and prove the existence of infinitely many bounded entropy admissible weak solutions in the case that the Riemann initial data give rise to the 1D self-similar solution consisting of two shocks and possibly a contact discontinuity. This is a joint work with Hind Al Baba, Christian Klingenberger, Ondřej Kreml and Simon Markfelder.

# Wednesday, September 19th

Lili Du

9:30–10:00

**Abstract**

In this talk, we will discuss the well-posedness of the axially symmetric free surface problem of an ideal incompressible jet issuing from a nozzle and impinging on an uneven wall. More precisely, given a semi-infinitely long axially symmetric nozzle, a mass flux in the inlet and a constant atmospheric pressure, there exists a unique incompressible impinging jet whose free surface goes to infinity and is close to the impermeable wall at far field. Moreover, the free surface of the impinging jet initiates at the edge of the semi-infinitely long nozzle and the pressure remains the constant atmospheric pressure on the free surface. The main ingredient to show the existence and the uniqueness of the impinging jet is based on the variational method. Furthermore, some important properties of the axially symmetric impinging jet, such as positivity of the radial velocity, asymptotic behavior of the impinging jet and the optimal decay rate of the free surface and the impinging jet are obtained. Moreover, the problem of the axially symmetric jet impinging on a hemispherical cup is also introduced.

## On a Navier-Stokes-Fourier-like system capturing transitions between viscous and inviscid fluid regimes and between no-slip and perfect-slip boundary conditions

Erika Maringová

10:05–10:35

**Abstract**

We study a model with implicit constitutive relations that captures non-Newtonian fluids with temperature-dependent coefficients, in particular those which are able to describe the threshold slip phenomenon with the temperature-dependent activation criteria. Such a model is able to describe all states of the fluid from the yield stress, through the Newtonian fluid up to the inviscid case only by the temperature change. Also, concerning the boundary conditions, we are able to capture the standard Navier's slip, but also the threshold slip case, i.e. the stick-slip or the perfect slip-slip condition. These models always include the activation, however, the standard constitutive relations (yield stress, inviscid fluid, no slip or perfect slip boundary conditions) are the limit cases when certain activating coefficient tends to infinity for some temperature. Finally, also the large-data and the long-time existence analysis is provided. It is a joint work with Josef Žabenský.

## Vortex-wave system on incompressible flows with helical symmetry

Dongjuan Niu

11:00–11:30

### Abstract

In this talk we will investigate the time evolution of a three-dimensional incompressible Euler equations with helical symmetry when the initial vorticity is consisted of a finite number of concentrated vortices moving in a distributed vorticity background. The global existence of a weak solution to this system is proved when the initial background vorticity belongs to $L^p$ space and the densities keep sign.

## Influence of pressure and bulk viscosity in congestion phenomena

Šárka Nečasová

11:35–12:05

### Abstract

We analyze in this lecture macroscopic models for heterogeneous media (mixtures, suspensions, crowd) in dense regimes. These regimes exhibit interesting behaviors such as transition phases (congestion, jamming, glass transition, etc.). Two different approaches are generally considered in the literature to model congestion phenomena at the macroscopic level. The first one, usually called *hard approach*, consists in coupling compressible dynamics in the free domain $\varrho < \varrho_*$, with incompressible dynamics in the congested domain $\varrho = \varrho_*$. The second one which, by opposition, is called *soft approach*, prevents the apparition of congested phases by introducing in the compressible dynamics repulsive forces which become singular as $\varrho$ approaches $\varrho_*$. An intuitive link can be made between the two approaches: if the scope of action of the repulsive forces tends to 0, one expects that the soft congestion model degenerates towards a hard congestion model. The goal of this lecture is to investigate rigorously this link, more precisely we aim at understanding how the choice of the constitutive laws (pressure and/or viscosities as functions of the density) in the soft model impacts the behavior of the limit hard system in congested regions. It is a joint work with D. Bresch and C. Perrin.

## On three-dimensional flows of pore pressure activated Bingham fluids

Tomáš Los

12:10–12:40

### Abstract

We are concerned with a system of partial differential equations describing internal flows of homogeneous incompressible fluids of Bingham type in which the value of activation (the so-called yield stress) depends on the internal pore pressure governed by an advection-diffusion equation. This model seems to be suitable for description of important complex processes, such as liquefaction, occuring at granular water-saturated materials. After providing the physical background of the considered model paying attention to the assumptions involved in its derivation, we focus on PDE analysis of initial and boundary value problems that are interesting from geophysical point of view. We give several equivalent descriptions for the considered class of fluids of Bingham type. In particular, we exploit the possibility to write such a response as an implicit tensorial constitutive equation, involving the pore pressure, the deviatoric part of the Cauchy stress and the velocity gradient. Interestingly, this tensorial response can be characterized by two scalar constraints. We employ a similar approach to treat the stick-slip boundary conditions that includes no-slip, Navier's slip and slip as special cases. Within such setting we prove long time and large data existence of weak solutions to the evolutionary problem in three dimensions. It is a joint work with Anna Abbatiello, Josef Málek and Ondřej Souček.

# Thursday, September 20th

### Global stability of the inhomogeneous plasma slab of the compressible MHD equations with physical vacuum

Guilong Gui

9:30–10:00

**Abstract**

Consideration in this talk is the effect of the inhomogeneous plasma slab on the motions of physical vacuum singularity for 2D compressible viscous non-resistive MHD system. It is shown that, for small perturbations of an inhomogeneous MHD equilibrium configuration in slab, there exists a unique global-in-time strong solution to the vacuum free boundary problem of the 2D compressible MHD system.

### Identification of outflow boundary condition for an incompressible flow

Michal Bathory

10:05–10:35

**Abstract**

In the talk we shall discuss several possibilities how to prescribe an outflow boundary condition for an incompressible stationary flow. First we discuss the properties of the "do-nothing" boundary condition that is often used in practice. It seems that there is no physical justification for this condition. Hence, we then discuss another method how to find the outflow boundary condition implicitly. Finally, we focus on the explicit form of this condition for several models of fluid (Stokes, power-law, Navier–Stokes, etc.).

## Some recent study on homogenization in fluid mechanics

Yong Lu

11:00–11:30

### Abstract

Homogenization problems in fluid mechanics in the study of fluid flows in domains perforated with a large number of small holes or obstacles. The asymptotic behavior of the fluid flows as the number of holes goes to infinity and the size of holes goes to zero is the main concern. I will recall the background and some known results in this filed. Then I will present some recent studies on collaboration with E. Feireisl, L. Diening, S. Schwarzacher, and Y. Sun.

## Homogenization of an incompressible stationary flow of an electrorheological fluid

Petr Kaplický

11:35–12:05

### Abstract

We combine two-scale convergence, theory of monotone operators and results on approximation of Sobolev functions by Lipschitz functions to prove a homogenization process for an incompressible flow of a generalized Newtonian fluid. We avoid the necessity of testing the weak formulation of the initial and homogenized systems by corresponding weak solutions, which allows optimal assumptions on lower bound for a growth of the elliptic term. We show that the stress tensor for homogenized problem depends on the symmetric part of the velocity gradient involving the limit of a sequence selected from a family of solutions of initial problems.

### References

[1] M. Bulíček, M. Kalousek, P. Kaplický. Homogenization of an incompressible stationary flow of an electrorheological fluid. *Annali di Matematica* **196** (2017) 1185–1202.

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### Instability of non-isentropic fluid flows

Xulong Qin

13:45–14:15

#### Abstract

Nonlinear dynamic instability of steady smooth profile is rigorously demonstrated for non-isentropic, compressible inviscid fluid flows when the convection is present.

### Steady flow of dense compressible chemically reacting mixture

Šimon Axmann

14:20–14:50

#### Abstract

We consider a model describing the steady flow of compressible heat-conducting chemically reacting mixture. We show the existence of strong solutions under the additional assumption that the fluid is sufficiently dense. We work in the $L^p$ -setting combining the methods for the weak solutions with the method of decomposition. This result is a generalization of our previous work concerning the case of single-constituted fluid. It is a joint work with M. Pokorný.

## On the stabilizing effects of magnetic field on the boundary layer

Feng Xie

15:15–15:45

### Abstract

In this talk we will discuss the effects of magnetic field on the stability of boundary layer, which include the local well-posedness theory, justification of Prandtl ansatz of boundary layer expansion, and the long-time existence of solutions etc. By comparing with the classical boundary layer theory of pure hydrodynamics, it shows that the magnetic field has the stabilizing effects on stability of the boundary layer.

## Stability of compressible Navier–Stokes/Euler–Maxwell systems

Yuehong Feng

15:50–16:20

### Abstract

In this talk, we give the long time decay rates and stabilities of solutions for Euler/Navier–Stokes–Maxwell systems, which are partial differential equations arising from plasmas. My talk is essentially composed of three parts dealing with Cauchy problems and periodic problems. In the first part, we study the long time decay rates of the global smooth solutions for compressible Euler–Maxwell systems in non isentropic case when the equilibrium solutions are constants. In the second part, we consider the stabilities of smooth solutions near non constant equilibrium states for the compressible Euler–Maxwell systems. In part three, we investigate the global existence of smooth solutions near constant equilibrium states and the stability of smooth solutions near non-constant equilibrium states for the compressible Navier–Stokes–Maxwell systems, respectively.

**Spectral instability of a steady flow of an incompressible viscous fluid past a rotating obstacle**

Jiří Neustupa

16:25–16:55

## Abstract

We show that a steady solution to the system of equations of motion of an incompressible Newtonian fluid past a rotating body is unstable if an associated linear operator $L$ has a part of the spectrum in the right half-plane. The result does not directly follow from a series of preceding theorems on instability, mainly because the nonlinear term in the equation for perturbations is not bounded in the same space in which the instability is studied. As an important auxiliary result, we also show that the uniform growth bound of the $C_0$ semigroup, generated by operator $L$, is equal to the spectral bound of $L$.