

Conference on “Mathematical Fluid Mechanics and Related Topics” on the occasion of Reinhard Farwig’s 70th birthday

organised by Helmut Abels, Richard Höfer, Amru Hussein, Anca Matioc,
Jonas Sauer, Patrick Tolksdorf

Regensburg, March 9–13, 2026

Venue: The lectures will be held in the lecture hall **H31**, located in the mathematics building at the University of Regensburg. Coffee breaks will take place in room **M104**. Room **M103** is available for discussions.

The **conference dinner** will be on Thursday, 7 pm, in the Restaurant Bischofshof, Krautermarkt 3, 93047 Regensburg.

Remark: The Thursday lectures will follow a hybrid format: Two lectures will be held online via Zoom and simultaneously broadcast in lecture hall H31. The remaining lectures on Thursday will take place in person in H31, with a live stream available for remote participants. Interactive discussions between online and in-person attendees will be possible. No recordings will be made.

Programme

Monday, March 9, 2026		
11:00 – 13:00	<i>Registration</i>	
13:00 – 13:05	<i>Opening</i>	
13:05 – 13:50	Giovanni Paolo Galdi	On Local Regularity of Distributional Solutions to the Navier–Stokes Equations
13:50 – 14:35	Takeo Takahashi	Large time behavior for a system rigid body/viscous compressible fluid
14:35 – 15:15	<i>Coffee break</i>	
15:15 – 15:45	Andrea Signori	Navier–Stokes–Cahn–Hilliard modelling of biological membranes with curvature effects
15:45 – 16:05	Amartya Chakraborty	Homogenization of a 3D Navier–Stokes–Cahn–Hilliard System with Source Term in a Perforated Domain
16:05 – 16:35	Andrea Poiatti	Convergence to equilibrium of weak solutions to the Cahn–Hilliard equation with non-degenerate mobility
16:35 – 16:55	Julia Wittmann	Two-Phase Flows with Phase Transition: Weak Solutions for a Quasi-Stationary Diffuse Interface Model
16:55 – 17:15	Jonas Stange	Two-phase flows with bulk-surface interaction: A Navier–Stokes–Cahn–Hilliard model with dynamic boundary conditions

Tuesday, March 10, 2026		
9:00 – 9:45	Toshiaki Hishida	Large time decay of the Oseen flow in exterior domains subject to the Navier slip-with-friction boundary condition
9:45 – 10:15	Robert Denk	Second-order boundary value problems with dynamic boundary conditions
10:15 – 10:45	<i>Coffee break</i>	
10:45 – 11:15	Thomas Eiter	On existence theory for a model of nearly incompressible visco-elasto-plasticity
11:15 – 11:45	Dennis Trautwein	Convergent numerical schemes for viscoelastic fluid models
11:45 – 12:05	Zhuoya Yao	Some results of rotating MHD system
12:05 – 13:30	<i>Lunch break</i>	
13:30 – 14:15	Dominic Breit	Fluid mechanics in irregular domains
14:15 – 14:45	Karoline Disser	Fluid-elastic interaction and the Schiffer Conjecture
14:45 – 15:05	Hanifah Mumtaz	Sharp Interface Limit of mass conserving Allen–Cahn/Navier–Stokes System
15:05 – 15:45	<i>Coffee break</i>	
15:45 – 16:15	Gianmarco Del Sarto	Global well-posedness for small data in a 3D temperature-velocity model with Dirichlet boundary noise
16:15 – 16:35	Kilian Hacker	Homogenization of a Stokes-transport system in an anisotropic porous medium with thin, evolving tubes
16:35 – 17:05	Nibedita Ghosh	Multiscale analysis of a phase-field model for reactive transport in a porous medium
17:05 – 17:25	Pascal Hadré	Homogenization with Slender Bodies

Wednesday, March 11, 2026		
9:00 – 9:45	Agnieszka Świerczewska-Gwiazda	On the relative entropy method and unconditional stability of radially symmetric steady states of compressible viscous fluids
9:45 – 10:15	Takahito Kashiwabara	Local-in-time strong solvability of Navier–Stokes variational inequalities, with application to friction boundary conditions
10:15 – 10:45	<i>Coffee break</i>	
10:45 – 11:15	Antonio Agresti	Stochastic perturbation in fluid dynamics: Motivations, and challenges in L^p -regularity
11:15 – 11:45	Petru A. Cioica-Licht	Maximal regularity for stochastic PDEs: from smooth to non-smooth domains
11:45 – 13:30	<i>Lunch break</i>	
13:30 – 14:00	Matthieu Hillairet	On the planar exterior Navier–Stokes problem
14:00 – 14:30	Jürgen Saal	Dynamical Systems and Maximal Regularity
14:30 – 14:50	Paul Beckermann	From Boundary Conditions to H^∞ -Calculus: u'' on the Half-Line in L^p
14:50 – 15:30	<i>Coffee break</i>	
15:30 – 16:00	Emiel Lorist	Weighted maximal regularity for parabolic PDE with boundary singularities
16:00 – 16:20	Erik Heidrich	Bounded H^∞ -calculus for the Stokes operator
16:20 – 16:50	Anatole Gaudin	On the Boussinesq system in bounded rough domains
16:50 – 17:10	Ciro S. Campolina	On the inviscid limit of the Navier–Stokes equations with no-slip boundary conditions

Thursday, March 12, 2026		
9:00 – 9:45	Yoshikazu Giga (online/hybrid)	Dynamic stability of energetically stable equilibria to the Navier–Stokes–Korteweg equations
9:45 – 10:30	Hideo Kozono	Stationary MHD equations in 3D bounded domains with arbitrary geometry
10:30 – 11:00	<i>Coffee break</i>	
11:00 – 11:45	Reinhard Farwig	From Weighted Estimates via an \mathcal{H}^∞ -calculus to the Stokes Operator in Exterior Domains
11:45 – 12:15	Kazuyuki Tsuda	Time periodic problem of the Navier–Stokes equations in an exterior domain with periodically moving boundary
12:15 – 13:45	<i>Lunch break</i>	
13:45 – 14:30	Šárka Nečasová (online/hybrid)	The primitive equations: rigorous derivation and Onsager conjecture
14:30 – 15:00	Jiří Neustupa	On stationary solutions to the MHD equations for a class of generalized Newtonian fluids
15:00 – 15:45	<i>Coffee break</i>	
15:45 – 16:15	Konstantinas Pileckas	Swirling Poiseuille Flow
16:15 – 16:45	Jonas Sauer	Limited-Range Multilinear Off-Diagonal Extrapolation generalized Newtonian fluids
16:45 – 17:15	Milan Pokorný	Steady compressible Navier–Stokes–Fourier system with temperature dependent viscosities
19:00–	<i>Conference dinner</i>	

Friday, March 13, 2026		
9:00 – 9:45	Senjo Shimizu	Local well-posedness of free boundary problems for the compressible Navier–Stokes equations in critical spaces
9:45 – 10:15	Yutaka Terasawa	Existence and Nonlocal-to-Local Convergence for Singular, Anisotropic Nonlocal Cahn–Hilliard Equations
10:15 – 10:45	<i>Coffee break</i>	
10:45 – 11:05	King Ming Lam	The Euler–Poisson system: on the stability of Lane–Emden and Goldreich–Weber stars
11:05 – 11:25	Stephan Schmitz	On the compactness of artificial compressibility approximations of weak solutions for fluid problems in a general moving geometry
11:25 – 12:10	Raphaël Danchin	Large time asymptotics of Vlasov–Navier–Stokes flows in a 2D periodic box
	<i>End of conference</i>	

Abstracts (in Alphabetical Order)

Antonio Agresti (Sapienza University of Rome)

Wednesday, 10:45–11:15

Title: **Stochastic perturbation in fluid dynamics: Motivations, and challenges in L^p -regularity**

Abstract: Stochastic perturbation of fluid dynamics models has recently attracted a lot of attention. There are several different ways to physically justify noise in the mathematical modeling of fluids. A long-standing conjecture is that such stochastic perturbations can improve the behaviour of the solutions to the 3D Navier–Stokes equations, and in particular ensure their global well-posedness. The latter fact is often referred to as regularization by noise. In this talk, we give an overview of the physically relevant noises as well as open problems in stochastic maximal L^p -regularity related to the regularization by noise conjecture.

Dominic Breit (University of Duisburg-Essen)

Tuesday, 13:30–14:15

Title: **Fluid mechanics in irregular domains**

Abstract: We present several new results on PDEs from fluid mechanics in irregular domains. In particular, we give minimal conditions on the boundary regularity for a maximal regularity theory for the steady and unsteady Stokes system. This includes estimates in Sobolev spaces, Campanato spaces and Besov spaces. We also give applications to the Navier–Stokes equations.

Paul Beckermann (RPTU Kaiserslautern-Landau)

Wednesday, 14:45–15:05

Title: **From Boundary Conditions to H^∞ -Calculus: u'' on the Half-Line in L^p**

Abstract: Inspired by Laplacians on quantum graphs, we study realizations of the second-derivative operator u'' on the half-line \mathbb{R}_+ acting in $L^p(\mathbb{R}_+; X)$, where X is a Banach space. Boundary conditions are implemented via linear relations. We give an explicit characterization of sectoriality of these realizations in terms of the boundary conditions. This also yields structural constraints on admissible boundary conditions. Moreover, and perhaps unexpectedly, we show that every sectorial realization in this framework already admits a bounded H^∞ -functional calculus. This is joint work with Amru Hussein.

Ciro S. Campolina (Scuola Normale Superiore, Pisa)

Wednesday, 17:05–17:25

Title: On the inviscid limit of the Navier–Stokes equations with no-slip boundary conditions

Abstract: Whether Leray–Hopf solutions converge in the inviscid limit to a strong Euler solution in the presence of boundaries is a long-standing open problem. In this talk, we shall present special initial conditions for the Navier–Stokes Cauchy problem on a 2D periodic channel with no-slip boundaries. Such data have a viscosity-dependent boundary layer, whose thickness scales as in the Prandtl boundary layer theory, and the associated Prandtl equations are known to blowup in finite time. Yet, the initial conditions converge in L^2 -norm to an analytical stationary Euler solution. With high resolution direct numerical simulations, we obtain well-resolved solutions for decreasing viscosities. Based on rigorous mathematical criteria, we provide numerical evidence of convergence toward Euler, despite the breakdown of Prandtl boundary layer expansion due to detachments. We explain this counterintuitive result through careful analysis of measures of detached vortices, which seem to collapse in the inviscid limit. This is a joint work with J er emie Bec.

Amartya Chakraborty (Fraunhofer ITWM & RPTU Kaiserslautern–Landau)

Monday, 15:45–16:05

Title: Homogenization of a 3D Navier–Stokes–Cahn–Hilliard System with Source Term in a Perforated Domain

Abstract: We study a diffuse–interface model for a binary incompressible mixture in a periodically perforated porous medium, described by a time–dependent Navier–Stokes–Cahn–Hilliard (NSCH) system posed on the pore domain $\Omega_p^\varepsilon \subset \mathbb{R}^3$. The microscopic model involves a variable viscosity tensor, a non–conservative source term in the Cahn–Hilliard equation, and mixed boundary conditions consisting of no–slip on the exterior boundary and Navier slip with zero tangential stress on the surfaces of the solid inclusions. The capillarity strength λ^ε depends on the microscopic scale $\varepsilon > 0$. For each fixed $\varepsilon > 0$, we establish the existence of weak solutions on a finite time interval $(0, T)$ together with a priori estimates that are uniform with respect to ε (and λ^ε). A major analytical difficulty stems from the presence of the source term, which breaks mass conservation and prevents a direct application of the classical Poincar e–Wirtinger inequality. This issue is resolved through refined estimates for the spatial mean combined with suitable extension and restriction operators adapted to the perforated geometry. We then investigate the asymptotic behavior of the system as $\varepsilon \rightarrow 0$ and perform a rigorous periodic homogenization using the periodic unfolding method. The uniform estimates provide the compactness required to identify the macroscopic limit fields and to pass to the limit in the nonlinear coupling terms, yielding effective tensors that encode the influence of the microscopic geometry. Depending on the limit value $\lambda = \lim_{\varepsilon \rightarrow 0} \lambda^\varepsilon \in [0, +\infty)$, two qualitatively different homogenized models emerge. In the vanishing capillarity regime $\lambda = 0$, the limit system is of Stokes–Cahn–Hilliard type and exhibits no macroscopic convection or phase advection, corresponding to a creeping–flow behavior. In contrast, when $\lambda \in (0, +\infty)$, the homogenized equations retain nonlinear convection and advective transport, leading to a genuine Navier–Stokes–Cahn–Hilliard structure at the macroscopic scale. Finally, we prove the convergence of the microscopic free energy towards a homogenized energy functional satisfying a corresponding dissipation law.

Petru A. Cioica-Licht (University of Kassel)

Wednesday, 11:15–11:45

Title: **Maximal regularity for stochastic PDEs: from smooth to non-smooth domains**

Abstract: Although there exists an almost fully-fledged L_p -theory for (semi-)linear second order stochastic partial differential equations (SPDEs, for short) on smooth domains, very little is known about the regularity of these equations on non-smooth domains that have corners and/or edges. As it is already known from the deterministic theory, singularities of the boundary may have a negative effect on the regularity of the solution. For stochastic equations, this effect comes on top of the already known incompatibility of noise and boundary condition. In this talk I will first give an overview of the existing L_p -theory for SPDEs on smooth domains, emphasizing the role of weighted spaces for capturing the behaviour of the solution at the boundary. Moreover, I will summarize a series of papers, where a first weighted L_p -Sobolev theory for second-order SPDEs on angles, polygons and smooth cones has been established by means of Green function estimates and PDE techniques. Finally, I will discuss some more recent developments from an operator theoretic perspective.

Raphaël Danchin (Université Paris-Est Créteil Val de Marne)

Friday, 11:25–12:10

Title: **Large time asymptotics of Vlasov–Navier–Stokes flows in a 2D periodic box**

Abstract: A number of recent works have been dedicated to the mathematical analysis of the so-called incompressible Vlasov–Navier–Stokes system, which is a prototype model for describing the dynamics of aerosols (that is, suspensions of light particles immersed in a surrounding viscous incompressible fluid). The Vlasov–Navier–Stokes system is a coupling between a kinetic transport equation for the distribution of particles (depending on the time, space and kinetic variables) and the incompressible Navier–Stokes equations. The equations are coupled through a drag term, the so-called Brinkman force. In 2020, Han-Kwan, Moussa and Moyano showed that in the three-dimensional case with periodic boundary conditions and close to equilibrium regime, the solution to the Vlasov–Navier–Stokes equations converges exponentially fast to a Dirac mass supported at the velocity ultimately reached by the fluid. More recently, Han-Kwan, then the speaker obtained convergence results in the whole space. The present talk is dedicated to the two-dimensional case with periodic boundary conditions. We show that the finite-energy solutions (not necessarily small) always converge to an explicit monokinetic state. For general solutions, the convergence rate is algebraic and deteriorates as the initial particle distribution increases. When it is sufficiently small, it becomes exponential, even if the fluid velocity is large. Similar results hold true in the case where the surrounding fluid is nonhomogeneous. Then, the density of the fluid does not need to be smooth. It just has to be bounded and bounded away from zero. This is a joint work with Ling-You Shou (Nanjing Normal University).

Gianmarco Del Sarto (Technical University of Darmstadt)

Tuesday, 15:45–16:15

Title: **Global well-posedness for small data in a 3D temperature-velocity model with Dirichlet boundary noise**

Abstract: I will present well-posedness results for a three-dimensional Boussinesq-type temperature-velocity system on a bounded domain, where randomness enters through a small noisy Dirichlet boundary condition on the temperature. Because boundary noise generates a very rough stochastic convolution, the temperature (and, indirectly, the velocity) must be treated in low-regularity Sobolev spaces. For sufficiently small initial data, we prove the existence and uniqueness of mild solutions up to a stopping time. Moreover, for any fixed horizon T , the solution is global on $[0, T]$ with high probability. This is a joint work with M. Lenzi (SNS).

Robert Denk (University of Konstanz)

Tuesday, 9:45–10:15

Title: **Second-order boundary value problems with dynamic boundary conditions**

Abstract: In this talk, we consider boundary value problems with dynamic boundary conditions under various aspects. The problems we consider have the form

$$\begin{aligned} \partial_t u + A(D)u &= f && \text{in } (0, \infty) \times \mathbb{R}_+^n, \\ B_0(D)u + (\partial_t + C_0(D'))\rho &= g && \text{on } (0, \infty) \times \mathbb{R}^{n-1}, \\ B_1(D)u + C_1(D')\rho &= 0 && \text{on } (0, \infty) \times \mathbb{R}^{n-1}. \end{aligned} \tag{1}$$

(with appropriate initial conditions), where A is a second-order partial differential operator, B_j are boundary operators, and C_j are tangential differential operators. We investigate the corresponding operator matrix which acts on the space $L^p(G) \times B_{pp}^s(\partial G)$ for some range of s . We discuss conditions for well-posedness, generation of an analytic semigroup, and existence of a bounded H^∞ -calculus for the corresponding operator matrix. For the last result, we use a diagonalization trick and results on parameter-elliptic pseudo-differential operators. For low values of s , one has to define the trace on the boundary in a generalized sense. This talk is based on joint work with Simon Bau and Annalena Mattes (both Konstanz).

Karoline Disser (University of Kassel)

Tuesday, 14:15-14:45

Title: **Fluid-elastic interaction and the Schiffer Conjecture**

Abstract: In a series of papers, Avalos and Triggiani established the fluid-elastic semigroup for the coupled Stokes-Lamé system modelling the coupled dynamics of a linearly elastic structure immersed in a viscous Newtonian fluid. They analyzed the spectrum of its generator and proved that the semigroup is strongly stable, if the domain of the structure satisfies a geometric condition, i.e., it is not a bad domain. We extend these results in two directions: first, for bad domains, we prove a decomposition of the dynamics into a strongly stable part and a pressure wave, a special solution of the Dirichlet-Lamé system, that can be determined from the initial values. This fully characterizes the long-time behaviour of the semigroup. Secondly, we show that the characterization of bad domains is equivalent to the Schiffer problem. This strengthens the conjecture that balls are the only bad domains and establishes a further connection to geometric and harmonic analysis. We also discuss implications for associated nonlinear systems. Based on joint work with Michelle Luckas.

Thomas Eiter (WIAS Berlin)

Tuesday, 10:45-11:15

Title: **On existence theory for a model of nearly incompressible visco-elasto-plasticity**

Abstract: We study a model for the deformation of a visco-elasto-plastic material that is only slightly compressible. It is given in Eulerian description and combines a Kelvin–Voigt rheology in the spherical part with a Jeffreys-type rheology in the deviatoric part. Despite a constant density, an adapted momentum equation allows for non-isochoric deformation and the propagation of pressure waves. By an evolution equation for the small elastic strain we model visco-elasto-plasticity through a non-smooth dissipation potential. Since the well-posedness in a weak setting cannot be expected, we study two possible modifications: the regularization by an stress diffusion, and the relaxation of the solvability concept by transition to energy-variational solutions. In both cases, solutions are constructed by the same time-discrete scheme, consisting of solving a saddle-point problem in each time step.

Reinhard Farwig (Technical University of Darmstadt)

Thursday, 11:00–11:45

Title: **From Weighted Estimates via an \mathcal{H}^∞ -calculus to the Stokes Operator in Exterior Domains**

Abstract: In this joint work with K. Tsuda (Fukuoka) we will give a tour of the Stokes operator and its fractional powers on an exterior domain in homogeneous weighted Sobolev spaces. Radial weights of power type are an efficient tool in our luggage to analyze the Stokes operator in nonhomogeneous and also homogeneous Sobolev spaces and to apply the results to the nonlinear Navier–Stokes system.

The most exhausting stage is to prove that the Stokes operator has a bounded \mathcal{H}^∞ -calculus on weighted spaces so that domains of fractional powers can be identified with complex interpolation spaces. A second strenuous step concerns the identification of such domains with fractional homogeneous Sobolev spaces. This part of the tour takes care of the weak Stokes problem and its variational inequalities on weighted spaces.

With these achievements of a weighted analysis we will construct at the final destination time-periodic solutions of the Navier–Stokes system on an exterior domain with periodically moving boundary, see the talk by K. Tsuda.

- 1 R. FARWIG, K. TSUDA: *The Stokes Operator on Exterior Domains in Homogeneous Weighted Function Spaces: From Weak Theory to \mathcal{H}^∞ -calculus to Fractional Domains*. Submitted (2025)
- 2 R. FARWIG, K. TSUDA: *Time periodic problem of the Navier–Stokes equations in an exterior domain with periodically moving boundary*. Manuscript (2026)

Giovanni Paolo Galdi (University of Pittsburgh)

Monday, 13:05–13:50

Title: **On Local Regularity of Distributional Solutions to the Navier–Stokes Equations**

Abstract: We provide sharp sufficient conditions that guarantee that a distributional solution is regular in the spatial variables. The solution does not need to belong to the (local) Leray–Hopf class, but only needs to satisfy the Prodi–Serrin condition.

Anatole Gaudin (University of Duisburg-Essen)

Wednesday, 16:35–17:05

Title: **On the Boussinesq system in bounded rough domains**

Abstract: In this talk, we discuss the well-posedness of the Boussinesq system in bounded three-dimensional Lipschitz and $C^{1,\alpha}$ domains, which models geophysical fluid flows driven by a transported temperature. We address the difficulties induced by the lack of boundary regularity, and show how to construct unique mild or weak solutions depending on the chosen critical functional framework and the chosen regularity of the boundary. When the initial data are sufficiently small in a suitable sense, the solution is global in time and converges exponentially to an equilibrium state, for which the limiting temperature is given everywhere by the spatial average of the initial temperature of the fluid. Most importantly, the temperature can be made arbitrarily large, only its difference with its average needs to be small. This work relies on several, minor but essential, improvements in the regularity theory for the Stokes operator and the Neumann Laplacian in bounded Lipschitz domains.

Yoshikazu Giga (University of Tokyo)

Thursday, 9:00–9:45

Title: **Dynamic stability of energetically stable equilibria to the Navier–Stokes–Korteweg equations**

Abstract: The system of the Navier–Stokes–Korteweg (NSK) equations is a phase-field model to describe motion of fluids where liquid and vapor phase coexist. By a choice of a small Korteweg relaxation parameter, there exists an energetically stable equilibrium which has two phases. If the system is a gradient flow, its stability is much easier to discuss even if the set of equilibria is not isolated. In this talk, we consider the system of NSK in a bounded domain with suitable boundary conditions including periodic boundary conditions and discuss the stability of energetically stable equilibria. Applying generalized stability principle due to J. Prüss and G. Simonett (2016), we prove that if initial data is close to an equilibrium, then there is a global-in-time solution converging to possibly another equilibrium provided that equilibrium set is non-degenerate. Our study confirms a recent numerical result by T. Kashiwabara, H. Takemura and the lecturer (Physica D, 482 (2025)). This talk is based on a work in progress with K. Furukawa (Toyama), N. Kajiwara (Gifu) and K. Tsuda (Kyushu).

Nibedita Ghosh (RWTH Aachen)

Tuesday, 16:35–17:05

Title: **Multiscale analysis of a phase-field model for reactive transport in a porous medium**

Abstract: We consider crystal dissolution and precipitation in a porous medium. The pore space is completely filled with a fluid that contains two mobile species with different diffusion coefficients. Two mobile species react with each other and produce a mineral that precipitates on the grain boundary. The mineral can also dissolve and become a part of the fluid. Therefore, the volume of the pore space and the sharp interface evolve with time. We describe the interface evolution by a phase field variable, which is determined through the Allen–Cahn equation. The phase field variable has a smooth, diffuse transition of non-zero width between the fluid and the mineral phase. We prove that the phase field formulation is upscaled to the Darcy scale by homogenization. The average of the phase field variable represents the porosity. Through cell problems, the effective diffusion matrices are dependent on the phase field variable.

Kilian Hacker (FAU Erlangen-Nuremberg)

Tuesday, 16:15–16:35

Title: **Homogenization of a Stokes-transport system in an anisotropic porous medium with thin, evolving tubes**

Abstract: In this contribution, we study the asymptotic behavior of a Stokes flow in an array of thin, evolving tubes, coupled with advective-diffusive transport within the tubes and in the surrounding medium. The domain evolution is induced by the transport process via chemical reactions at the microscopic lateral boundaries of the tubes, leading to a fully coupled problem. Our approach aims to model the thermal control of blood flow in human skin, including temperature-dependent production of biochemical substances and the subsequent dilation and constriction of blood vessels. After a transformation of the microscopic problem onto a periodic microscopic reference domain, we rigorously derive a fully coupled effective model, by means of the methods of homogenization. It consists of an anisotropic Darcy model coupled to an effective reaction-diffusion-advection system of partial and ordinary differential equations. The effective coefficients (permeability, diffusivity) of the macroscopic model are computed from solutions to standard cell problems involving the time and space dependent macroscopic deformation gradient. The anisotropies induced by the special features of the geometry (array of thin tubes) are exhibited in the effective model. This is joint work with Markus Gahn and Maria Neuss-Radu.

Pascal Hadré (University of Regensburg)

Tuesday, 17:05–17:25

Title: **Homogenization with Slender Bodies**

Abstract: In this talk, we aim to derive macroscopic equations for suspensions of slender bodies. A slender body is a rigid particle of length a_ϵ and width b_ϵ , where $b_\epsilon \ll a_\epsilon$ and $a_\epsilon \rightarrow 0$ as $\epsilon \rightarrow 0$. More precisely, we focus on the case in which these particles are fixed and distributed on a periodic grid of size $\epsilon > 0$. We determine the critical scaling for a_ϵ and b_ϵ such that the solutions (u_ϵ, p_ϵ) of the stationary Stokes equation in a domain perforated by the particles converge, as $\epsilon \rightarrow 0$, to a solution (u, p) of the stationary Stokes equation with an additional Brinkman term Mu , where $M \in \mathbb{R}^{3 \times 3}$. We illustrate the steps required to rigorously set up this problem and present the main ideas of the proof, which follows the strategy introduced by Cioranescu and Murat. Moreover, we determine the structure of the matrix M and discuss possible generalizations and directions for future work.

Erik Heidrich (RPTU Kaiserslautern-Landau)

Wednesday, 16:15–16:35

Title: **Bounded H^∞ -calculus for the Stokes operator**

Abstract: In the study of the incompressible Navier–Stokes equations one is interested in functional analytic properties of the Stokes operator, such as maximal regularity or a bounded H^∞ -calculus. In particular, the existence of a bounded H^∞ -calculus is a strong result that implies further properties such as a probabilistic analogue of maximal regularity called stochastic maximal regularity. This makes it possible to study the incompressible Navier–Stokes equations with an additional stochastic noise term in a functional analytic framework.

When one deals with solutions of low regularity, it can be advantageous to study the problem not in the usual Sobolev scale, but instead in spaces with weights, where the weights provide additional control over the behaviour of the solution near the boundary. In particular, it can be possible to simplify the set of boundary conditions accompanying the equation.

In this talk, we will prove the boundedness of the H^∞ -calculus for the Stokes operator in L^q -spaces with Muckenhoupt weights. Then, we provide an application to the incompressible Navier–Stokes equations with Dirichlet boundary conditions in three dimensions.

Matthieu Hillairet (Université de Montpellier)

Wednesday, 13:30–14:15

Title: **On the planar exterior Navier–Stokes problem**

Abstract: In this talk, I will consider the stationary Navier–Stokes equations outside a disk with non-vanishing Dirichlet boundary condition on the disk and vanishing condition at infinity. If one linearizes this system around 0, it faces the Stokes paradox: any solution to the Stokes problem with constant boundary condition on the disk and vanishing at infinity must vanish globally. Existence and uniqueness of a solution to the full nonlinear problem remains thus open for general boundary conditions without symmetries. In this talk I will present a recent result on this problem focusing on the lack of uniqueness of solutions when non-zero flux boundary condition is allowed on the disk. This result has been obtained in collaboration with Zhengguang Guo (Huaiyin Normal University).

Toshiaki Hishida (University of Nagoya)

Tuesday, 9:00–9:45

Title: **Large time decay of the Oseen flow in exterior domains subject to the Navier slip-with-friction boundary condition**

Abstract: Consider the motion of a viscous incompressible fluid filling a 3D exterior domain Ω subject to the Navier slip-with-friction boundary condition as well as outflow at infinity. For the Oseen system as the linearization, we discuss the resolvent set under a certain relationship among the geometry of the boundary $\partial\Omega$, friction coefficient $\alpha(x)$ and the outflow u_∞ . We then study the regularity of the resolvent near the origin in the complex plane to develop L^q - L^r decay estimates of the Oseen semigroup provided that $\alpha(x) + u_\infty \cdot \nu(x)/2 \geq 0$ for every $x \in \partial\Omega$, where $\nu(x)$ stands for the outward unit normal to the boundary $\partial\Omega$.

Takahito Kashiwabara (University of Tokyo)

Wednesday, 9:45–10:15

Title: **Local-in-time strong solvability of Navier–Stokes variational inequalities, with application to friction boundary conditions**

Abstract: We consider parabolic variational inequalities in a Hilbert space V , which have a non-monotone nonlinearity of Navier–Stokes type represented by a bilinear operator B and a monotone nonlinearity described by a convex, proper, and lower-semicontinuous functional φ . Existence and uniqueness of a local-in-time strong solution in a maximal- L^2 -regularity class and in a Kiselev–Ladyzhenskaya class are proved by discretization in time (also known as Rothe’s method), provided that a corresponding stationary Stokes problem admits a regularity structure better than V . This better regularity than V , which is typically H^2 -regularity, is then inherited to the strong solution of the parabolic variational inequality.

Important examples covered by our abstract result are the Navier-Stokes equations with slip and leak boundary conditions of friction type. The H^2 -regularity, which could not be obtained by Galerkin’s method in the previous work (Kashiwabara 2013), is now established for these BCs. We emphasize that the leak BC is more involved since the so-called cancelation property $(B(u, v), v) = 0$ may not hold.

Hideo Kozono (Waseda University, Tokyo)

Thursday, 9:45–10:30

Title: **Stationary MHD equations in 3D bounded domains with arbitrary geometry**

Abstract: In the talk, we show existence and uniqueness of weak and strong solutions to the magnetohydrodynamic equations in 3D bounded domains. We do not impose any geometric or topological restriction on the domain except smoothness of its boundary. To this end, the L^r Helmholtz–Weyl decomposition characterizing harmonic vector fields plays an essential role. Our result is based on the joint work of Senjo Shimizu (Kyoto) and Taku Yanagisawa (Nara).

King Ming Lam (Delft University of Technology)

Friday, 10:45–11:05

Title: **The Euler–Poisson system: on the stability of Lane–Emden and Goldreich–Weber stars**

Abstract: A star is a lump of fluid surrounded by a vacuum, where internal pressure acts to expand the fluid while self-gravity acts to compress it. The classical model describing these dynamics is the Euler–Poisson system: the compressible Euler equations coupled with the Poisson equation within a free boundary framework. Two important classes of spherically symmetric solutions are the Lane–Emden stars, which represent time-independent stars in hydrostatic equilibrium, and the Goldreich–Weber stars, which describe expanding and collapsing bodies (modeling phenomena such as supernovae). In our universe, we observe both stable stars like our Sun and unstable ones that, for example, collapse into black holes. This motivates the study into the stability of these stellar solutions—we will discuss recent results concerning the stability and instability of these solutions under both radial and non-radial perturbations.

Emiel Lorist (Delft University of Technology)

Wednesday, 15:45–16:15

Title: **Weighted maximal regularity for parabolic PDE with boundary singularities**

Abstract: Using the Dirichlet Laplacian as a model operator, in this talk I will discuss how (Muckenhoupt) weighted L^p -spaces can be used to study maximal regularity and H^∞ -functional calculus in the presence of boundary singularities. Two types of singular behaviour will be highlighted: geometric singularities of the domain (sharp edges and corners) and singularities arising from irregular prescribed boundary data. Both can be treated within a unified framework by working in mixed weighted spaces, where the weight degenerates at the relevant singular set: towards the edge/corner in the geometric case and towards (parts of) the boundary in the boundary data case. This talk is based on joint work with Petru Cioica-Licht and Tobias Werner.

Hanifah Mumtaz (University of Regensburg)

Tuesday, 14:45–15:05

Title: **Sharp Interface Limit of mass conserving Allen–Cahn/Navier–Stokes System**

Abstract: Understanding the interplay between diffuse and sharp interface descriptions is a central theme in the mathematical analysis of two-phase flows. In this talk, I will present a derivation of the sharp-interface limit of a mass-conserving Navier–Stokes/Allen–Cahn system in a smooth two-dimensional domain. As the interface thickness $\varepsilon \rightarrow 0$, solutions of the diffuse model converge to those of a two-phase Navier–Stokes system coupled with a mass-conserving mean curvature flow including convection effects. The analysis combines tools from singular-limit theory, matched asymptotic expansions, and spectral estimates for the linearized Allen–Cahn operator. A new ansatz for the leading-order interfacial profile allows for a uniform control of the approximation error and provides a rigorous link between diffuse and sharp interface models.

Šárka Nečasová (Czech Academy of Sciences, Prague)

Thursday, 13:45–14:30

Title: **The primitive equations: rigorous derivation and Onsager conjecture**

Abstract: In the talk, we will describe the rigorous derivation of the compressible primitive equations. Moreover, we will focus on the problem of energy conservation for the weak solutions to the compressible Primitive Equations (CPE) system with degenerate viscosity.

This is a joint work with M. A. Rodriguez-Bellido, H. J. Gao and T. Tang.

Jiří Neustupa (Charles University Prague)

Thursday, 14:30–15:00

Title: **On stationary solutions to the MHD equations for a class of generalized Newtonian fluids**

Abstract: We formulate the mathematical model of a flow of a generalized Newtonian electrically conductive incompressible fluid in a generally multiply connected bounded domain $\Omega \subset \mathbb{R}^3$. The model includes the no-slip boundary condition for the velocity and the boundary conditions for the magnetic field, which come from the assumption that the material boundary of the flow field is electrically perfectly insulating. We introduce the notion of a stationary weak solution and we show the proof of existence of such a solution in case the fluid is Newtonian or shear-thickening.

Konstantinas Pileckas (Vilnius University)

Thursday, 15:45–16:15

Title: **Swirling Poiseuille Flow**

Abstract: The stationary Navier–Stokes system is considered in an infinite cylinder. An exact axially symmetric solution is found, in which the velocity component along the cylinder axis coincides with the Poiseuille solution, and, in addition, there is a rotational velocity component. The corresponding pressure is irregular: its derivative with respect to the angular variable contains a delta function. A similar problem is considered in an axially symmetric perturbed cylinder. Existence and uniqueness (for small data) theorems are proved. The properties of the solution are investigated. Unanswered questions are also formulated. The results were obtained jointly with Gianmarco Speroni.

Andrea Poiatti (University of Vienna)

Monday, 16:05–16:35

Title: **Convergence to equilibrium of weak solutions to the Cahn–Hilliard equation with non-degenerate mobility**

Abstract: We consider the initial and boundary value problem for the Cahn–Hilliard equation with non-degenerate mobility and singular potential. We show that any weak solution converges to a single equilibrium using only minimal assumptions, i.e., the existence of a global weak solution satisfying an energy inequality. This result also holds in the three-dimensional case, which was an open problem so far due to the lack of regularity of solutions, especially when the mobility is just a continuous function. This novel method is robust and can be used also for other models like, for instance, Cahn–Hilliard–Navier–Stokes type systems with unmatched densities and viscosities as the one proposed by Abels, Garcke, and Grün (Math. Models Methods Appl. Sci. 22, 2012).

Milan Pokorný (Charles University Prague)

Thursday, 16:45–17:15

Title: **Steady compressible Navier–Stokes–Fourier system with temperature dependent viscosities**

Abstract: We consider the model describing the steady flow of a compressible heat conducting fluid in a bounded three-dimensional domain

$$\begin{aligned}\operatorname{div}(\varrho \mathbf{u}) &= 0, \\ \operatorname{div}(\varrho \mathbf{u} \otimes \mathbf{u}) - \operatorname{div} \mathbf{S} + \nabla p &= \varrho \mathbf{f}, \\ \operatorname{div}(\varrho E \mathbf{u}) &= \varrho \mathbf{f} \cdot \mathbf{u} - \operatorname{div}(p \mathbf{u}) + \operatorname{div}(\mathbf{S} \mathbf{u}) - \operatorname{div} \mathbf{q}\end{aligned}$$

with ϱ the density, \mathbf{u} the velocity field, \mathbf{S} the stress tensor (here we assume the fluid to be Newtonian with temperature dependent viscosity), p the pressure, \mathbf{f} the given volume force, \mathbf{q} the heat flux and the total energy $E = \frac{1}{2}|\mathbf{u}|^2 + e$ with e the internal energy. We assume the pressure law of the form $p(\varrho, \vartheta) \sim \varrho^\gamma + \varrho^\vartheta$ with $\gamma > 1$ and the viscosities $\mu(\vartheta), \xi(\vartheta) \sim (1 + \vartheta)^\alpha$, $\alpha \in [0, 1]$.

We show the existence of a weak or variational entropy solution for the above model with internal energy fulfilling the Gibbs relation and the heat flux fulfilling the Fourier law $\mathbf{q} \sim (1 + \vartheta)^m \nabla \vartheta$ with ϑ the temperature, $m = m(\gamma, \alpha) > 0$.

We first review the results for the case $\alpha = 1$ from papers [1], [4] and [5] which were created in collaboration with French co-authors. Then we show extensions for $\alpha < 1$. First we concentrate on the case $\gamma > \frac{3}{2}$ both for Dirichlet and Navier boundary conditions for the velocity and Robin (we extend the results from [2]) and Dirichlet boundary conditions for the temperature. Finally we briefly touch the situation when $\gamma \leq \frac{3}{2}$, here only for Robin boundary conditions for the temperature. The solutions are constructed for arbitrarily large sufficiently integrable data.

It is a joint work with Ondřej Kreml, Tomasz Piasecki and Emil Skříšovský [3].

References

- [1] *D. Jesslé, A. Novotný, M. Pokorný:* Steady Navier–Stokes–Fourier system with slip boundary conditions. *Math. Models Methods Appl. Sci.* **24** (2014), 751–781.
- [2] *O. Kreml, Š. Nečasová, M. Pokorný:* On the steady equations for compressible radiative gas, *Z. Angw. Math. Phys.* **64** (2013), 539–571.
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- [4] *A. Novotný, M. Pokorný:* Steady compressible Navier–Stokes–Fourier system for monoatomic gas and its generalizations, *J. of Differential Equations* **251** (2011), 270–315.
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Jürgen Saal (University of Düsseldorf)

Wednesday, 14:15–14:45

Title: **Dynamical Systems and Maximal Regularity**

Abstract: The theory of dynamical systems is in most instances very general. Important properties of an existing attractor for many systems can be verified in a direct manner. In this talk we raise the question, to what extent for more specific classes of PDE such kind of properties follow directly from their structure. Of particular interest in this context are quasilinear parabolic C^1 evolution systems. Based on maximal regularity we will be able to show that for suitable but still fairly general subclasses properties like injectivity of a corresponding semiflow, existence of a dynamical system, globality and finite dimensionality of the attractor can be deduced in an abstract manner. We also demonstrate how the obtained abstract theorems apply to a system describing living fluids.

Jonas Sauer (University of Jena)

Thursday, 16:15–16:45

Title: **Limited-Range Multilinear Off-Diagonal Extrapolation**

Abstract: In this talk I report on Multilinear L^p extrapolation results in a limited-range, multilinear, and off-diagonal setting for mixed-norm Lebesgue spaces over σ -finite measure spaces. Integrability exponents are allowed in the full range $(0, \infty]$. We detach the exponents for the weight classes completely from the exponents for the initial and target spaces for the extrapolation except for the basic consistency condition. This enables us to cover the full range $(0, \infty]$ for all integrability exponents and provides new insights into the dependency of the extrapolated bounds on the weight characteristic.

Stephan Schmitz (RPTU University Kaiserslautern-Landau)

Friday, 11:05–11:25

Title: **On the compactness of artificial compressibility approximations of weak solutions for fluid problems in a general moving geometry**

Abstract: In this talk, a fluid flow problem on a deforming domain for a Newtonian fluid in two and three space dimensions with small artificial compressibility is studied. The equicontinuity in time of the solutions under suitable domain regularity assumptions is proven, which serves as an alternative compactness argument for weak solution sequences.

The corresponding estimate is obtained by remapping the problem onto a fixed reference domain and using appropriate divergence freeness preserving test functions involving the difference of two solutions at different points in time.

This talk is based on joint work with Anna Hundertmark.

Senjo Shimizu (Kyoto University)

Friday, 9:00–9:45

Title: **Local well-posedness of free boundary problems for the compressible Navier–Stokes equations in critical spaces**

Abstract: Local well-posedness of the compressible Navier–Stokes equations with a free boundary condition is considered in the scaling critical spaces. We prove local well-posedness for the Lagrange transformed compressible Navier–Stokes system in the homogeneous Besov space $\dot{B}_{p,1}^{n/p}(\mathbb{R}_+^n) \times \dot{B}_{p,1}^{-1+n/p}(\mathbb{R}_+^n)$ with the exponent $n - 1 < p < 2n - 1$ in accordance with Solonnikov’s derivation. A key ingredient in the proof is the end-point maximal L^1 -regularity for the associated linear initial-boundary value problem of the Lamé equation governing the velocity field. This is joint work with Takayoshi Ogawa (Waseda University).

Andrea Signori (Politecnico di Milano)

Monday, 15:15–15:45

Title: **Navier–Stokes–Cahn–Hilliard modelling of biological membranes with curvature effects**

Abstract: This work addresses coupled partial differential equation systems modelling the interaction between an incompressible viscous fluid and a flexible membrane described via a phase-field variable. We consider different fluid regimes, including Navier–Stokes, Brinkman, and Darcy flows, to capture a wide range of physical situations relevant for biological membranes and amphiphilic materials. The aim is to provide well-posed formulations of these models, study their qualitative behavior, and investigate associated optimal control problems. The approach highlights how fluid dynamics and membrane curvature jointly influence phase evolution and morphology.

Dominik Spyrka (University of Kassel)

Friday, 11:05–11:25

Title: **A Derivation of the Stochastic Primitive Equations**

Abstract: In this talk, we will consider the *primitive equations* for geophysical problems, which are an approximation of the Navier–Stokes equations based on the assumption of *hydrostasis*. Therefore, they can be seen as a simplification of the general Navier–Stokes equations, which remain one of the famous Millennium Problems to this day. Since one is an approximation of the other, one may ask whether the corresponding solutions are close to each other.

In the deterministic setting, this problem is well understood and has already been positively proven, for instance, in the maximal L^2 -regularity setting. This motivates the investigation of a similar model in the stochastic setting. Thus, we take the opportunity to consider the so-called *stochastic primitive equations with transport noise and turbulent pressure* along with the corresponding *stochastic Navier–Stokes equations*. We will then discuss how stochastic maximal regularity can be used to compare the solutions of both problems. The talk is based on ongoing work with Amru Hussein.

Jonas Stange (University of Regensburg)

Monday, 16:55–17:15

Title: **Two-phase flows with bulk-surface interaction: A Navier–Stokes–Cahn–Hilliard model with dynamic boundary conditions**

Abstract: In this talk, I present a new diffuse interface model for incompressible, viscous fluid mixtures with bulk-surface interaction. This system consists of a Navier–Stokes–Cahn–Hilliard model in the bulk that is coupled to a surface Navier–Stokes–Cahn–Hilliard model on the boundary. Compared with previous models in the literature, the inclusion of an additional surface Navier–Stokes equation is motivated, for example, by biological applications. We prove the existence of weak solutions by means of a semi-Galerkin scheme combined with a fixed-point argument. To discretize the Navier–Stokes subsystem, we analyze a novel bulk-surface Stokes system and its corresponding bulk-surface Stokes operator, whose eigenfunctions serve as a natural basis to approximate the velocity fields. Lastly, if time permits, I will mention ongoing work concerning the existence of strong solutions and their uniqueness.

Agnieszka Świerczewska-Gwiazda (University of Warsaw)

Wednesday, 9:00–9:45

Title: **On the relative entropy method and unconditional stability of radially symmetric steady states of compressible viscous fluids**

Abstract: I will discuss various applications of the relative entropy method in equations of fluid mechanics such as weak strong uniqueness results or asymptotic limits. I will mostly concentrate on recent result (with E. Feireisl and P. Gwiazda) on unconditional stability of certain radially symmetric steady states of compressible viscous fluids in domains with inflow/outflow boundary conditions. This means that any not necessarily radially symmetric solution of the associated evolutionary problem converges to a single radially symmetric steady state.

Takeo Takahashi (Université de Toulouse)

Monday, 13:50–14:35

Title: **Large time behavior for a system rigid body/viscous compressible fluid**

Abstract: In this talk, I will present recent results obtained in collaboration with Debayan Maity regarding the interaction between a rigid body and a viscous compressible fluid in an exterior domain. Our analysis focuses on the existence of strong solutions and their asymptotic behavior. By combining an appropriate change of variables with L_p - L_q decay estimates, we establish the global well-posedness of the coupled system for small initial data. A key feature of our study is the description of the long-term dynamics: we prove that both fluid and solid velocities vanish as $t \rightarrow \infty$, and that the rigid body reaches a specific final position.

Yutaka Terasawa (Nagoya University)

Friday, 9:45–10:15

Title: **Existence and Nonlocal-to-Local Convergence for Singular, Anisotropic Nonlocal Cahn–Hilliard Equations**

Abstract: We study the nonlocal-to-local convergence for a nonlocal Cahn–Hilliard equation with anisotropic and singular kernels. In particular, we show convergence of weak solutions of the nonlocal Cahn–Hilliard equation to weak solutions of a corresponding anisotropic Cahn–Hilliard equation for suitable subsequences. Moreover, we show existence of weak solutions for the nonlocal equation under a condition, which guarantees existence of weak solutions for suitably localized or singular kernels. This talk is based on a joint work with Helmut Abels (Regensburg University).

Dennis Trautwein (University of Regensburg)

Tuesday, 11:15–11:45

Title: **Convergent numerical schemes for viscoelastic fluid models**

Abstract: In this talk, we review a class of energy-stable numerical methods for the viscoelastic Oldroyd-B and Giesekus models. The model couples the incompressible Navier–Stokes equations with an evolution equation for an additional stress tensor accounting for elastic effects. This coupled evolution equation models transport and nonlinear relaxation effects and is usually stated in terms of the elastic deformation gradient, the conformation tensor, or the log-conformation approach. In the existing literature, numerical schemes for such models often suffer from accuracy limitations and convergence problems, usually due to the lack of rigorous existence results or inherent limitations of the discretization. The core of this presentation introduces a novel convergence result (joint work with Endre Süli). We prove the (subsequence) convergence of a proposed numerical method to a large-data global weak solution of the Giesekus model in two dimensions. Crucially, this result is achieved without the use of artificial cut-offs or regularization in the limit system, providing a constructive alternative to the existence proof by Bulíček et al. (Nonlinearity, 2022). Finally, we demonstrate the robustness of the method through numerical experiments, including convergence rate studies and typical benchmark problems.

Kazuyuki Tsuda (Kyushu Sangyo University)

Thursday, 11:45–12:15

Title: **Time periodic problem of the Navier–Stokes equations in an exterior domain with periodically moving boundary**

Abstract: In this talk we consider the Navier–Stokes equations in exterior domains of \mathbb{R}^n , $n \geq 3$, with moving boundary periodically in time and with a periodic external force. For this case we prove the existence of a locally unique mild time periodic solution in weighted function spaces with radially symmetric Muckenhoupt weights. The solutions split into a stationary part controlled by potential theoretic estimates and a purely oscillatory part constructed as mild solution via analytic semigroup theory. To deal with perturbation terms of even second order—coming from a coordinate transform and the moving boundary—a maximal L^1 type regularity estimate is used in weighted Lorentz spaces. To control the convective term an H^∞ -calculus in weighted spaces of the Stokes operator is established used to control fractional powers of the Stokes operator.

Julia Wittmann (University of Regensburg)

Monday, 16:35–16:55

Title: **Two-Phase Flows with Phase Transition: Weak Solutions for a Quasi-Stationary Diffuse Interface Model**

Abstract: We study the flow of two macroscopically immiscible, viscous, incompressible fluids with different densities, allowing for mass transfer between the constituents due to phase transition. To this end, the quasi-stationary version of a quasi-incompressible diffuse interface model proposed by Aki, Dreyer, Giesselmann, and Kraus (2014) is considered. The resulting quasi-stationary Stokes system coupled to a Cahn–Hilliard equation with a source term corresponds to the Lowengrub–Truskinovsky model (1998) in the same regime. In this talk, we present an existence result for global weak solutions with singular (logarithmic) free energy, based on joint work with Helmut Abels and Harald Garcke.

Zhuoya Yao (Lyon 1 Université)

Tuesday, 11:45–12:05

Title: **Some results of rotating MHD system**

Abstract: Magnetohydrodynamics (MHD) is a field that studies the behavior of conducting fluids in the presence of magnetic fields. In this talk, we first need to briefly introduce the MHD system, and then we will focus on the MHD models which take into account the Coriolis force. Under the assumption that the rotation is strong (that is, when ε goes to zero), we first establish the global existence of weak solutions and the local existence of strong solutions, followed by the global existence and convergence theorem. We will also introduce that MHD flows under a constant magnetic field aligned with the rotation axis, which are of considerable current interest.