WWU MÜNSTER

Workshop
Stability, Mixing and Fluid Dynamics

August 14 – 16, 2023
Münster

Book Of Abstracts

Organizers

Víctor Navarro-Fernández
André Schlichting
Christian Seis

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DFG Deutsche Forschungsgemeinschaft

MM Mathematics Münster Cluster of Excellence

	Monday August 14	Tuesday August 15	Wednesday August 16
09.00-10.00	Galeati	Zatorska	Gess
10.00-10.30	**Coffee**	**Coffee**	**Coffee**
10.30-11.30	Dietert	Dolce	Wiedemann
11.30-12.30	Gallay	Gvalani	Prange
12.30-14.00	**Lunch**	**Lunch**	**Lunch**
14.00-15.00	Enciso	Widmayer	
15.00-16.00	Perrin	Zillinger	
16.00-16.30	**Coffee**	**Coffee**	
16.30-17.30	6 Short Talks à 10min	Bossy	
18.00-	**Reception**		
19.00-		**Dinner**	

General information

Venue. The talks of the workshop are in the lecture hall M4 located in the lecture building. Registration and coffee breaks are on the second floor of the Seminarraumzentrum (SRZ) at Orléans-Ring 12, 48149 Münster. See map on page 3.

You can find the latest information on the webpage:
www.uni-muenster.de/MathematicsMuenster/events/2023/fluids23.shtml

Wi-Fi access. If you are part of the eduroam community, you may connect to the network "eduroam" as usual. Otherwise you can connect to the SSID "GuestOnCampus" and start any web browser. You will automatically be redirected to the login page. Confirm the terms of use and click on "log in for free". 1 GB data volume is available per device and day. Please note that the connection is not encrypted.

Coffee break/Lunch. We provide coffee and snacks during the coffee breaks.

There are a couple of restaurants for lunch in the vicinity:

- Canteen – Mensa am Ring, Domagkstraße 61 (most convenient option, even if not the most idyllic place)
- Ristorante Milano (Italian), Wilhelmstraße 26 (closed Mondays)
- Il Gondoliere (Italian), Von-Esmarch-Straße 28 (closed Mondays)
- Buddha Palace (Indian), Von-Esmarch-Straße 18 (closed Tuesdays)
- La Gondola D'oro (Italian), Hüfferstraße 34

- Gustav Grün (Green Fast Food), Wilhelmstraße 1
- Áro (Green Fast Food), Neutor 3

Conference dinner. The conference dinner is on Tuesday 15th August at 19:00 at Pinkus Müller (pinkus.de) in the city center Kreuzstraße 4–10, 48143 Münster.

Public transportation. You can check the bus schedule on the website of Stadtwerke-Münster (in German and English), or use Google maps.

Suggestions for free time. Go see the castle, the park behind it and the embedded botanic garden. Visit a museum, e.g. the LWL Museum of Art and Cultural History or the Picasso-Museum. Have a walk around the lake 'Aasee' or make yourself familiar with European history at the Historical City Hall which is one of the two places where 1648 the Peace of Westphalia was signed.

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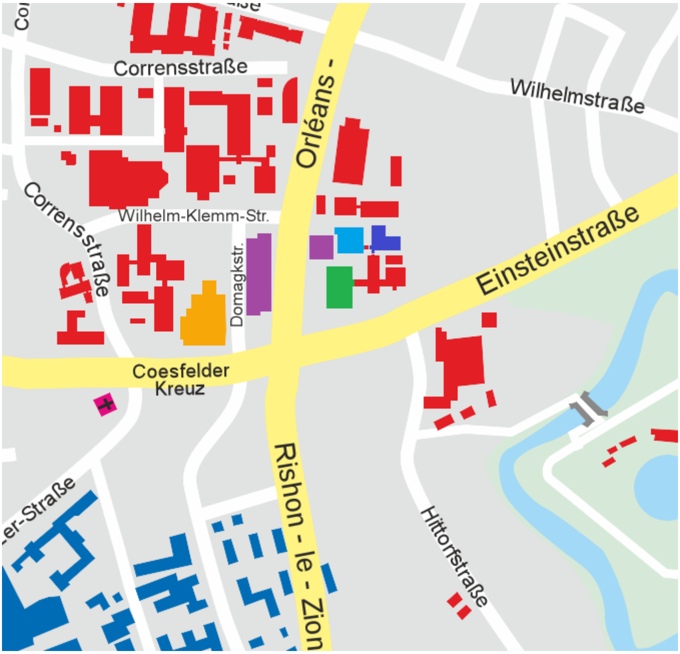

Lecture building (Talks)
SRZ 2nd floor (Registration, Coffee breaks)
Math Department
canteen
multi-storey car park.

Book of abstracts

Stochastic modelling of the turbulent transport of non spherical particles

Mireille Bossy

Investigating the dynamics of non-spherical particles suspended in turbulent flows is paramount for various industrial, biological and environmental applications (to name a few examples, fibres in paper-making industries, plankton in the ocean, bacteria, complex-shaped ice-crystals in clouds, soot and ashes in the atmosphere).

In addition to its translational dynamics, a non-spherical particle displays a complex rotational dynamics. And both dynamics depend on the particle properties (especially its shape and inertia). Besides, in many mentioned applications, the flow is highly turbulent and it has a profound effect on the rotational dynamics, alignment trends and correlations of anisotropic particles. Dealing with such level of description implies to introduce a dedicated model of the flow velocity gradient seen by the particles.

In this talk, we introduce a stochastic model for the orientation dynamics of spheroids (parametrized by their aspect ratio) and review several aspects of the proposed stochastic differential equation, its physical derivation, and its validation in some dedicated turbulente situations. In particular, we study how high vorticity structures in 2D turbulence can be introduce in the model through the time transition between Levy noise and Brownian noise regimes.

This talk is based on joint works with J. Bec [1], L. Campana [1, 2], C. Henry [2] and work in progress with Paul Maurer[3].

[1] L. Campana, M. Bossy, and J. Bec. Stochastic model for the alignment and tumbling of rigid fibers in two-dimensional turbulent shear flow. Phys. Rev. Fluids, 7:124605, Dec 2022. doi: 10.1103/PhysRevFluids.7.124605 .

[2] L. Campana, M. Bossy, C. Henry, Lagrangian stochastic model for the orientation of inertialess non spherical particles in turbulent flows: an efficient numerical method for CFD approach, Computers and Fluids, 2023, 257. doi:10.1016/j.compfluid.2023.105870 .

[3] M. Bossy and P. Maurer. Strong convergence of the -Euler-Maruyama scheme for time inhomogeneous jump-driven SDEs (in preparation)

Mixing and enhanced dissipation with velocities on the sphere

Helge Dietert

Motivated by a popular kinetic model by Saintillan and Shelley for the dynamics of suspensions of active elongated particles, we study phase-mixing and enhanced dissipation with velocities on the sphere. In particular, we show that, up to log errors, the phase mixing estimate persists until the enhanced dissipation takes over. This is proved by combining an optimised hypocoercive approach with the vector field method.

Taylor dispersion and enhanced dissipation in the non-cutoff Boltzmann equation

Michele Dolce

We investigate stability properties of a global Maxwellian background in the non-cutoff Boltzmann equation with soft potentials. Our focus is on the large Knudsen number $Kn \gg 1$ regime, which applies to gases in the upper atmosphere. We prove that, for initial data sufficiently small (independent of Kn), the solution exhibits several dynamics resulting from the interplay between the singular collision the transport operators. In the periodic box, we quantify the enhanced dissipation mechanism, that is an exponential convergence towards x-averages on a time-scale $O(Kn^{1/3})$. In the whole space, we obtain the Taylor dispersion, showing that the perturbation decay polynomially fast on a time-scale $O(1)$. Both are faster relaxation time-scales compared to the $O(Kn)$ expected when neglecting transport. Furthemore, we prove almost-uniform phase mixing estimates. For macroscopic quantities as the density ρ, these bounds imply almost-uniform in v decay of $\partial_X \rho$? in L^∞ due to "Landau damping" and dispersive decay. This is a joint work with M. Coti Zelati and J. Bedrossian.

Finite-time singularity formation for angled-crested water waves

Alberto Enciso

We shall see that the water waves system is locally wellposed in a class of weighted Sobolev spaces that allows for interfaces with corners. These singular points are not rigid: if the initial interface exhibits a corner, it remains a corner but generically its angle changes. Using a characterization of the asymptotic behavior of the fluid near a corner that follows from the a priori energy estimates, we shall show that there are initial data in these spaces (possibly smooth but at a unique corner point) for which the fluid becomes singular in finite time. The talk is based one joint work with Diego Córdoba and Nastasia Grubic.

Regularisation by transport noise for 2D fluid dynamics equations

Lucio Galeati

A major open problem in fluid dynamics is to understand whether solutions to 2D incompressible Euler equations with L^p-valued vorticity are unique, for some $p \in [1, \infty)$. A related question, more probabilistic in flavour, is whether one can find a physically meaningful noise restoring well-posedness of the PDE. In this talk I will present some recent advances on the latter problem, for a class of slightly regularised 2D Euler-type equations (specifically, logEuler and hypodissipative Navier-Stokes), in the presence of a rough Kraichnan-type noise, modelling the small scales of a turbulent fluid; uniqueness in law can then be shown for solutions with L^2-valued vorticity. Based on a joint work with Dejun Luo (arXiv:2305.08761).

Mixing in shear flows: from enhanced dissipation to Taylor dispersion

Thierry Gallay

We consider the long-time dynamics of a passive scalar advected by a shear flow in an infinite cylinder, in any space dimension. Under generic assumptions on the shear velocity, we obtain optimal decay estimates both in the enhanced dissipation regime, where the diffusivity is small compared to the streamwise wave number, and in converse regime where Taylor dispersion occurs. Our results follow from relatively standard resolvent estimates, and are also conveniently obtained via the hypocoercivity method, at least in particular situations. This talk is based on joint work with Michele Coti Zelati (Imperial College, London).

Stability, Lyapunov exponents and synchronization by noise for systems of SPDEs

Benjamin Gess

The stochastic quantisation of Euclidean quantum field theory in [Parisi, Wu, 1981] was motivated in parts by Markov Chain Monte Carlo sampling methods, used to generate samples from the Φ^4-measure. Extrapolation methods lead to the analysis of coupled diffusions, and thereby to the analysis of the long-time behavior of the two-point motion. The variance of the resulting sampling method can be controlled by proving synchronization/stabilization by noise. Since the Higgs standard model of quantum field theory is vector-valued, this poses the problem of synchronization by noise for systems of SPDEs. In this talk

we present an approach to quantitative estimates for the corresponding Lyapunov exponents, and how to deduce global asymptotic stability from this.

Exponential mixing for random flows

Rishabh Gvalani

We consider the question of exponential mixing for random dynamical systems on arbitrary compact manifolds without boundary. We put forward a robust, dynamics-based framework that allows us to construct space-time smooth, uniformly bounded in time, universal exponential mixers. The framework is then applied to the problem of proving exponential mixing in a classical example proposed by Pierrehumbert in 1994, consisting of alternating periodic shear flows with randomized phases. This settles a longstanding open problem on proving the existence of a space-time smooth (universal) exponentially mixing incompressible velocity field on a two-dimensional periodic domain while also providing a toolbox for constructing such smooth universal mixers in all dimensions. This is joint work with Alex Blumenthal and Michele Coti Zelati.

Hard congestion limit of the p-system in the BV setting

Charlotte Perrin

In this talk, I will discuss the transition from a compressible (inviscid) system with singular pressure towards a mixed compressible-incompressible system modeling partially congested dynamics. The two systems may be used for the modeling of mixtures, of collective motions, or partially free surface flows. From the mathematical point of view, I will present a first convergence result for small BV perturbations of a reference state represented by one or more partially congested propagating fronts.

Isotropic norm inflation for the Navier-Stokes equations

Christophe Prange

This talk is about norm inflation for the 3D Navier-Stokes equations in connection with a conjecture of Chemin, Zhang and Zhang about the global regularity when one component of the initial data is small. This is work in collaboration with Tobias Barker (University of Bath) and Jin Tan (Cergy Paris University).

On the stability of a point charge for the Vlasov-Poisson system

Klaus Widmayer

We consider the dynamics of the repulsive Vlasov-Poisson equations near a point charge, addressing the question of its stability: For solutions which start as small, smooth and suitably localized perturbations of a point charge we capture the precise asymptotic behavior. Building on optimal decay estimates, this is revealed to be a modified scattering dynamic. Our analysis relies on the Hamiltonian/symplectic structure of the equations, and makes use of an exact integration of the linearized equation through angle-action coordinates. This is joint work with Jiaqi Yang (ICERM) and Benoit Pausader (Brown University).

Some Remarks on the Viscosity Limit Problem

Emil Wiedemann

Historically, the equations of ideal fluid dynamics written down by Euler in 1757 were among the first partial differential equations ever to be formulated. It took decades to develop a refinement of Euler's model – the Navier-Stokes system – where friction effects within the fluid are taken into consideration. Yet, close-to-ideal fluids remain of great interest, as they are likely to display effects of turbulence. It is therefore an important question whether, as viscosity tends to zero, the solutions of the corresponding Navier-Stokes equations converge to the, or a, solution of the Euler system. We will present recent insights into this question in various settings, including shear flows and two-dimensional flows with unbounded vorticity.

Analysis of traffic and collective behaviour models in 1D

Ewelina Zatorska

I will present our recent results on the 1-dimensional hydrodynamic models of traffic, lubrication and collective behaviour in one space dimension. I will discuss existence results, interesting two-velocity reformulations, singular limits (hard congestion) and long-time behaviour of solutions.

On resonance chains in the Boussinesq equations

Christian Zillinger

The 2D Boussinesq equations describe the evolution of a heat conducting viscous or inviscid fluid. In this talk, we consider the long-time behavior of these equations near a combination of a shear flow and thermal stratification. While the linearized equations exhibit very good stability properties, these results do not extend to the nonlinear equations and instead one observes ”echoes” – nonlinear resonances. We show that in settings of partial dissipation chains of such resonances can lead to norm inflation and infinite time blow-up and that the behavior strongly depends on the frequency localization of perturbations.

Young Researchers

Navier-slip boundary conditions for two-dimensional buoyancy driven flows

Fabian Bleitner

While usually the Navier-Stokes equations are equipped with either No-Slip or Free-Slip boundary conditions, this talk is focused on the Navier-Slip boundary conditions that interpolate between these two and, depending on the underlying problem, better reflect the physical behavior of the fluid. We are discussing two buoyancy driven applications, first Rayleigh-Bénard convection with rough boundaries, where the major interest is bounds on the heat transfer through the fluid, while the second application is a partially diffusive setting, where we are interested in the well-posedness, long time behaviour and linear stability of the system.

Multiphasic representation in kinetic theory

Lucas Ertzbischoff

I will explain how a multiphase fluid formulation of Vlasov-type equations can be used to deal with (in)stability problems around stationnary solutions which are only measures in velocity. It can be applied to the study of the instability of Vlasov-Poisson equations around rough profiles in velocity, or to the stability of Vlasov-Navier-Stokes equations around monokinetic profiles. This is a joint work with Aymeric Baradat (CNRS and Lyon 1) and Daniel Han-Kwan (CNRS and Nantes Université).

Large deviations of Landau-Lifschitz-Navier-Stokes and relationship to the Energy Equality

Daniel Heydecker

The Landau-Lifschitz-Navier-Stokes equations are stochastic partial differential equations, which introduce a stochastic forcing term to describe the macroscopic fluctuations away from the deterministic Navier-Stokes equations. In dimension $d = 3$, we consider the large deviations in a scaling regime where the noise intensity and correlation length go to zero simultaneously, with a coupled rate. We show that the large deviations reproduce those of the lattice gas studied by Quastel and Yau, which justifies the Landau-Lifschitz-Navier-Stokes as an effective and numerically tractable model to capture deviations from the deterministic limit. The large deviations also produce a simple argument relating weak-strong uniqueness to cases were the classical energy inequality is an equality.

On echo chains in magnetohydrodynamics

Niklas Knobel

We consider the evolution of the magnetohydrodynamic (MHD) equations with magnetic dissipation in a periodic channel near an affine flow and a constant magnetic field. Here we, in particular, aim to capture resonances between high and low frequency perturbations, which are known as echoes. More precisely, we construct explicit low frequency waves and study high frequency (chains of) resonances and resulting norm inflation in the linearized problem around these waves.

The magnetic field here is shown to have a large effect on the behavior of resonances as compared to the Euler setting.

Steady vortex rings with surface tension

David Meyer

We construct travelling wave vortex rings of small cross-section with surface tension at the interface. Our construction is based on shape calculus and a Lyapunov-Schmidt reduction. We are also able to construct ”hollow” vortex rings where the vorticity is concentrated at the interface.

Weak solutions of the two-dimensional incompressible inhomogeneous Navier-Stokes equations in the presence of variable odd viscosity

Rebekka Zimmermann

The talk is concerned with the existence of weak solutions of the two-dimensional incompressible inhomogeneous Navier-Stokes equations with odd viscosity, where both the shear and the odd viscosity coefficients depend continuously on the density function. We study both the evolutionary and the stationary system. If the odd viscosity coefficient is identically zero, the existence of weak solutions has been proven by P.-L. Lions (for the evolutionary system), and Z. He and X. Liao (for the stationary system).

Acknowledgements

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