hausdorff
CENTER FOR MATHEMATICS

UNIVERSITÄT BONN

Conference

"Perspectives in Applied Mathematics" in Honor of Felix Otto

May 26-29, 2026

organized by
Antoine Gloria, Tim Laux, Angkana Rüland, Martin Rumpf, Theo Sturm, Maria G. Westdickenberg

Abstracts

Luigi Ambrosio (Scuola Normale Superiore of Pisa)

Well posedness of ODE's for nonsmooth velocities and in non Euclidean ambient spaces: a survey

Abstract: In this lecture I will make a survey of the theory of regular lagrangian flows, that allows to prove existence, uniqueness and stability for ODE's associated to vector fields with little regularity, beyond the classical Cauchy-Lipschitz theory. Initiated in a seminal work by Di Perna and Lions who dealt with Sobolev vector fields, the RLF axiomatization provides natural links with Probability and other fields. More recent developments, including the regularity of the flow map, counterexamples and the case when even the ambient space is not smooth, will be discussed.

John Ball (Heriot-Watt University, Edinburgh)

Highly irregular microstructures and TN configurations

Abstract: Remarkable martensitic microstructures are observed in the alloy Ti76Nb22Al2, which undergoes a cubic to orthorhombic transformation with six martensitic variants $U_i = U_i^T > 0$ having middle eigenvalue $\lambda_2(U_i) = 1$, thus allowing exact interfaces between the high temperature cubic austenite phase and the low temperature orthorhombic martensite phase. The unusual microstructure arises from the fact that the 12 matrices in the set of martensitic energy wells $6_{i=1}SO(3)U_i$ which are compatible with the undistorted austenite, i.e. which are rank-one connected to 1, are pairwise incompatible. The talk will explain the underlying theory and describe attempts to understand the observed microstructures by studying gradient Young measures, exact gradients and TN-configurations supported on these 12 incompatible matrices. This is joint work with Tomonari Inamura and Francesco Della Porta.

Yann Brenier (University Paris-Saclay)

Recent examples of non-markovian behaviour in nonlinear PDEs

Abstract: It has been known for a long while that non-markovian behaviour (typically memory effects) may result from the homogenization of (linear) PDEs with oscillatory coefficients (L. Tartar '84) or other type of weak limits. In this talk, recent examples are provided for non-linear PDEs. A first example is the Benjamin-Ono equation for which it has been recently proven (P. Gérard '24) that the weak zero-dispersion limit of its solution at a given time t is entirely described by the non-markovian "transport-collapse" operator $T(t)$, which had been introduced (Y.B. '81) to recover the Kruzhkov semi-group $S(t)$ for the (inviscid) Burgers equation through the Trotter formula $S(t) = \lim T(t/n)^n$). A second example is given by the solution of a large class of nonlinear PDEs (including the Burgers and the incompressible Euler equations) by space-time convex optimization (Y.B. '18, D. Vorotnikov '22) on a fixed given time interval $[0, t]$. A typical feature of this method is an automatic change of initial condition leading to the expected entropy solution at time t in the case of the Burgers equations, while for the incompressible Euler equations, unstable stationary vortex sheets are automatically ruled out and substituted for by turbulent layers of thickness linearly growing in t, as noticed since by H. Dietert.

Bjoern Bringmann (Princeton University)

Construction of the 2D Yang-Mills-Higgs measure

Abstract: We construct the 2D Yang–Mills–Higgs (YMH) measure via stochastic quantization. To this end, we show global well-posedness and uniform-in-time bounds for the associated Langevin dynamics, which is given by the 2D stochastic YMH equations. A key component of our approach is the further development of techniques in stochastic geometric analysis, combining ideas from geometric analysis and stochastic analysis. These methods yield a manifestly gauge-covariant local existence theory, refined estimates for covariant stochastic objects, and a decay mechanism driven by unstable Yang–Mills connections. This is joint work with S. Cao, M. Hairer, and W. Zhao.

Antonin Chambolle (University Paris-Dauphine)

"Flow matching" and optimal transport

Abstract: "Flow matching" is a priori just a new point of view on the score-learned based approaches to generative AI, popular for generating images according to the distribution of a given dataset. A few years ago, Liu showed that "rectified flow matching", which consists in iterating the process several time, was a valid approach to compute an optimal transport between distributions in large dimension. The talk will propose a formalization of this process, and the "minibatch-optimal-transport" which are used in the optimization, and try to actually prove that (or give conditions, a bit more general than Liu's, under which) it allows to compute an optimal transport. Based on joint work with Julie Delon and Johannes Hertrich (ENS Paris).

Peter Constantin (Princeton University)

Radiation and reconnection

Abstract: 1. Radiation produces damping of particle energy. I will show how this effect can be used in a radiative Vlasov-Maxwell system to obtain unconditional global regularity for large data. 2. Magnetic reconnection events are important astrophysical processes. Ideal magnetic fields do not change topology of magnetic lines, as a consequence of the magnetic induction equation. But electronic inertia can modify transport, and magnetic reconnection can be produced without singularities, in smooth dynamics without magnetic resistivity. I will show how.

Camillo DeLellis (Institute for Advanced Study, Princeton)

Clannish algebras with idempotent loops

Abstract: Dipping a wire made of metal or plastic into soapy water and then pulling it out is a classic classroom experiment. Typically, the soapy water forms a thin film attached to the wire. The classical Plateau laws, formulated by the Belgian physicist Joseph Plateau in the nineteenth century, state that away from the wire, the local geometry of a soap film can be described by a small number of shapes: a flat surface, three surfaces meeting along a common line at equal angles, and a cone-like structure based on the edges of a regular tetrahedron. A natural question is whether there is a similar classification for the shapes that occur where the soap film meets its boundary, namely the wire in the experiment. The classical Plateau laws were later given a rigorous mathematical foundation by Jean Taylor in the 1970s. In essence, Taylor's theorem classifies the possible conical shapes that minimize surface area. In this talk, I will present recent joint work with Federico Glaudo that extends this classification to include shapes that meet a boundary line. The resulting list suggests a boundary version of Plateau's laws for soap films, and these predictions are in strong agreement with both real-world observations and numerical simulations.

Mitia Duerinckx (ULB)

Batchelor's formula and infra-red renormalization for sedimentation

Abstract: This talk is devoted to the sedimentation of stationary random suspensions of rigid particles in Stokes flow. Batchelor's formula, predicted in the 1970s, describes the leading correction to the infinite-volume mean settling speed due to interactions between particles. Long-range hydrodynamic interactions induce large-scale divergences in naive estimates, requiring renormalization, which has long eluded rigorous analysis. In dimension $d > 2$, for stationary suspensions with suitable decay of correlations, we construct the mean settling speed in infinite volume and derive the dilute asymptotic expansion leading to Batchelor's formula, together with explicit control of the error term. Starting from a cluster expansion, the proof relies on a careful decomposition of many-body interactions in terms of elementary building blocks, which allows to make the relevant cancellations explicit, thereby implementing a rigorous infra-red renormalization. (Joint work with Antoine Gloria).

Selim Esedoglu (University of Michigan)

Algorithms for triple junction drag, surface grooving, and sintering

Abstract: Recent experimental results on the evolution of microstructure in polycrystalline materials during heat treatment have called into question the long established model in this subject, namely Mullins' model based on multiphase mean curvature motion that has been influential in materials science as well as in mathematics. The quest to reconcile modeling and experiments, in thin films in particular, has identified several physical effects that may need to be accounted for: Triple junction drag that modifies the Herring angle condition, and surface grooving that describes how the free surface of the film may deform and interact with the microstructure. The latter is particularly challenging as it entails surface diffusion — a high order geometric flow. I will describe new phase field and threshold dynamics methods that aim to approximate these enhanced models of microstructure evolution.

Alessio Figalli (ETH Zurich)

The De Giorgi conjecture for the free Boundary Allen—Cahn Equation

Abstract: The Allen—Cahn equation is known to approximate minimal surfaces. This connection led to the conjecture that global stable solutions of the Allen—Cahn equation should be one-dimensional in dimensions up to seven. If true, this statement would imply the celebrated De Giorgi conjecture for monotone solutions.

Adriana Garroni (Sapienza University of Rome)

Phase-field model for polycrystals

Abstract: I will present a recent result obtained in collaboration with S. Conti, V. Crismale and A. Malusa.
We considera phase-field model à la Ambrosio Tortorelli in order to approximate sharp interface energies for grain boundaries accounting for the Read–Shockley law for small-angle grain boundaries. The independent variable takes values in the orthogonal group $O(d)$ modulo a lattice point group G, reflecting the crystallographic symmetries of the underlying lattice. We also consider a discrete version of this approximation which can be applicable to the reconstruction of grain boundaries from imaging data.

Jiangfeng Lu (Duke University)

Quantitative hypocoercive convergence estimates for underdamped Langevin Equations

Abstract: The underdamped Langevin dynamics is perhaps one of the most familiar models used in sampling and non-equilibrium relaxation. Compared with its overdamped limit, the underdamped dynamics exhibits diffusive-to-ballistic acceleration of convergence. Nevertheless, quantifying such acceleration is challenging due to the degeneracy of diffusion. A large literature of hypocoercive estimates has been developed over the years to establish such quantitative rates. In this talk, we will discuss some recent progress in sharp convergence rate estimates for underdamped Langevin dynamics, in χ^2 divergence and in relative entropy, based on modified L^2 and modified entropy methods respectively.

Svitlana Mayboroda (University of Minnesota)

Free boundary problems associated to partially reflective Brownian motion

Abstract: We discuss the dimension and the structure of the harmonic measure associated to partially reflective (Robin or Fourier) boundary conditions and why the human lungs are fractal.

Alexander Mielke (Humboldt University of Berlin)

Fast-slow gradient systems and non-equilibrium steady states

Abstract: Starting with the fundamental work of Onsager in the 1930s, the theory of gradient flows provides a fundamental link between dissipative processes in thermodynamics and the theory of dissipative PDEs. The groundbreaking work of Felix Otto around 2000 lifted the understanding of this link to a much higher level, e.g., by considering PDEs with state-dependent Riemannian tensors. Our interest lies in gradient systems that display fast and slow dynamics. The main observation is that the fast dynamics can be understood as gradient systems driven via so-called ports that connect the fast system with the slow system. A major step in the derivation of an effective gradient structure for the slow dynamics lies in the understanding of the steady states of the fast system, which are so-called Non-Equilibrium Steady States (NESS). We present a saddle-point characterization for such NESS, which can be seen as an exact version of Prigogine's approximate minimum-dissipation principle. This allows us to show that the slow dynamics can be formulated via an effective gradient structure. We illustrate this fast-slow reduction by studying the membrane limit of porous medium equations with slow diffusion in a thin layer. The effective gradient structure will contain a nonlinear kinetic relation for the transmission condition, even though it is derived from the linear kinetic relation of diffusion, i.e., Otto's gradient structure.

Andrea Nahmod (University of Massachusetts Amherst)

Invariant Gibbs measures, propagation of randomness and the theory of random tensors for NLS

Abstract: In this talk, we will review recent joint work with Yu Deng and Haitian Yue on the solution of the invariance of the Gibbs measure under the 2D nonlinear Schrödinger flow (NLS) flow via the method of random averaging operators and the development of the random tensors theory. The latter yielded the resolution of the random data Cauchy problem for NLS in its full probabilistic subcritical regime. In particular, we will explain the fundamental shift in paradigm that arises from the notion of probabilistic scaling for random data Cauchy problems and how these ideas opened the door to unveil the random structures of nonlinear waves that live on high frequencies and fine scales as they propagate. We will end the talk with a short discussion of some current open challenges.

Nicolas Perkowski (Free University of Berlin)

Energy Lagrangian flows for singular SPDEs and applications

Abstract: Energy Lagrangian flows are a formulation of the Lagrangian flows of Di Perna–Lions and their stochastic counterparts by Le Bris-Lions and Figalli in the setting of singular stochastic dynamics, partly in regimes where classical and pathwise theories break down. A key notion is "probabilistic subcriticality": even for scaling critical or supercritical equations, regularity of the law combined with coercivity of the generator may yield existence and uniqueness. I will outline the construction and

well-posedness results, the relation to pathwise constructions, and applications to hydrodynamics and numerical analysis. Based on joint works with Lukas Gräfner, Ana Djurdjevac, Abdulwahab Mohamed and Shyam Popat.

Panagiotis Souganidis (University of Chicago)

Large deviations for the eigenvalues of large random matrices

Abstract: We provide a complete and direct proof for the large deviations principle for the spectrum of large random matrices across the full range of inverse temperatures for which the Dyson Brownian motion is well–posed, and we study the asymptotic behavior of the transition probabilities of the Dyson Brownian motion. Our methods are based on novel arguments about partial differential equations in infinite dimensions, particularly the well–posedness of the infinite–dimensional Hamilton–Jacobi pde satisfied by the value of the controlled Dyson equation, combined with the analysis of the behavior of the transition probabilities of the Dyson Brownian motion.

Hendrik Weber (University of Münster)

Solving the stochastic porous medium equation with regularity structures

Abstract: We prove a priori bounds for solutions of singular stochastic porous media equations with multiplicative noise in their natural L^1-based regularity class. We consider the first singular regime, i.e. noise of space-time regularity $\alpha - 2$ for $\alpha \in (2/3, 1)$, and prove modelledness of the solution in the sense of regularity structures with respect to the solution of the corresponding linear stochastic heat equation. The proof relies on the kinetic formulation of the equation and a novel renormalized energy inequality. A careful analysis allows to balance the degeneracy of the diffusion coefficient against sufficiently strong damping of the multiplicative noise for small values of the solution. This is joint work with Markus Tempelmayr (Münster/Lausanne).

Julian Fischer (IST Austria)

Quantitative stochastic homogenization of nonlinear material models

Abstract: While the first qualitative homogenization results for random media date back to the 70s, even for linear elliptic PDEs with random coefficients optimal convergence rates were only established in the past decade by Gloria and Otto. Inspired by an earlier work by Naddaf and Spencer, the approach by Gloria and Otto relies on a combination of spectral gap inequalities with elliptic regularity theory, an idea that nowadays forms the basis of one of the two main approaches to quantitative stochastic homogenization. While originally developed in the linear elliptic setting, we discuss the robustness of these techniques in a nonlinear context, highlighting both situations to which they apply and problems that require novel ideas. In particular, we discuss recent progress in the quantitative stochastic homogenization of monotone elliptic PDEs, variational models for fracture, and geometric motions through fields of random obstacles.
