

Seminar of the Work Group
Nonlinear Partial Differential Equations
SS 26

July 29th, 2026, 12:15 - 13:00
Seminar room: SR 3.069

Non-smooth Steady States and their Energies in a Vasculogenesis Model

Dorothea Gallos, Indiana University Bloomington

Abstract

In this talk I will derive non-smooth Barenblatt-like solutions to a vasculogenesis model and address aspects of the stability of these solutions. I will also consider the energy of smooth and non-smooth solutions and compare with the energy of Barenblatt-like solutions on a doubled domain.

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July 22th, 2026, 11:30 - 13:00
Seminar room: SR 3.069

Planar Fronts on the Whole Space: Stability and Effective Motion

Joris Van Winden, Leiden University

Abstract

We study nonlinear stability of planar traveling fronts in reaction-diffusion systems on $\mathbb{R}^d$ with $d \geq 2$ against nonlocalized (i.e., L^∞) perturbations. Under natural spectral stability assumptions, we prove that the motion of the interface is governed by a viscous Hamilton-Jacobi equation to leading order. This allows us to deduce that planar fronts are Lyapunov stable but not asymptotically stable, and may oscillate indefinitely in space and time. The nonlocalized perturbations present challenges both at the linear and nonlinear level, which we overcome by innovating on recent techniques introduced for the study of (one-dimensional) periodic wave trains.

This is joint work with Björn de Rijk (KIT).

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On the Existence and Stability of Smooth Solutions to a Vasculogenesis Model

Christiane Gallos, Indiana University Bloomington

Abstract

The distinction between genome and phenome reflects the difference between genetic potential and realized biological form. Motivated by this context, we will look at a system of partial differential equations that model vasculogenesis, the formation of blood vessels. In this talk, I will present some results regarding the existence and stability of smooth solutions of the model.

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July 15th, 2026, 11:30 - 13:00
Seminar room: SR 3.069

Orbital Stability for Cnoidal Waves in the Defocusing Nonlinear Schrödinger Equation under Localized Perturbations

Rafael Hirsch, KIT

Abstract

In this talk, we establish an orbital stability result for cnoidal waves in the defocusing nonlinear Schrödinger equation under localized perturbations. Previously, only orbital stability under coproduct perturbations was known [Gallay, Pelinovsky '15]. Our proof relies on higher-order energies, where the second variation exhibits nonnegative spectrum. Our main result demonstrates that a double-modulated perturbation—accounting for both translational and rotational invariance—remains bounded if the initial perturbation is sufficiently small. A central challenge lies in finding appropriate modulation functions. By employing spectral analysis and Floquet-Bloch theory, we derive coercive energy estimates that provide lower bounds for the second variation. This work is joint work with E. Bukieda, P. Kunstmann, and B. de Rijk.

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July 8th, 2026, 11:30 - 13:00
Seminar room: SR 3.069

Polychromatic Localized Waves in Nonlinear Maxwell Equations with Time Delayed Polarization

Maximilian Hanisch, University of Halle

Abstract

We study the Maxwell equations with a cubically nonlinear and nonlocal in time dependence of the polarization on the electric field. In an essentially one-dimensional wave-guide geometry, we deduce a method to obtain so called polychromatic solutions with complex frequencies for the generally non-selfadjoint problem.

These solutions are in the form of a Fourier series of traveling waves along the wave-guide, combined with a series over arbitrarily large decay rates in time. The leading frequency is given as a complex eigenvalue of the corresponding linear operator pencil and the leading order terms of the solution are given by a corresponding eigenfunction. Our method allows us to construct such polychromatic solutions by repeatedly solving *linear* ODEs under some assumptions on the spectrum and resolvent estimates of the linear operator.

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July 1st, 2026, 11:30 - 13:00
Seminar room: SR 3.069

On the Energy Constrained Optimal Mixing Problem

Björn Gebhard, University of Münster

Abstract

The optimal mixing problem addresses the question of how fast a passive scalar can be mixed under the influence of an incompressible velocity field. The talk focuses on the case where the energy of the allowed fields, i.e. their L^2 norm, is uniformly bounded in time. In that setting perfect mixing in finite time is permitted and indeed realized in some examples by Depauw 2003 and Lunasin, Lin, Novikov, Mazzucato, Doering 2012. On the other hand a lower bound on the time in which perfect mixing can be achieved is known due to Lin, Thiffeault, Doering 2011. In the talk we will show an improvement of the lower bound for the special case of initial data depending only on one spatial coordinate. We will also discuss an example for which the new lower bound is sharp. The proofs rely on differential inclusions, variational methods and ideas of steepest descent.

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June 17th, 2026, 11:30 - 13:00
Seminar room: SR 3.069

Nonlocalized Damping Estimates for Hyperbolic Relaxation Systems in One Space Dimension

Johannes Bärlin, University of Konstanz

Abstract

In this talk, a new approach to obtain so-called damping estimates for self-similar solutions to general hyperbolic relaxation systems in one space dimension is presented. Such estimates play an important role when closing nonlinear stability arguments for shock profiles with and without subshock (c.f. Yang and Zumbrun (2020) and Mascia and Zumbrun (2005)) while also appearing in the study of periodic roll waves (Rodrigues and Zumbrun (2025)). Previously obtained damping estimates for localized perturbations of shock profiles are extended to the non-symmetric and nonlocalized case utilizing the method of characteristics. The results open the door to a nonlocalized stability theory of self-similar solutions of hyperbolic relaxation systems.

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June 10th, 2026, 11:30 - 13:00
Seminar room: SR 3.069

Nonlinear Stability Analysis and Pattern Formation in Reaction-diffusion-ODE Systems

Finn Münnich, Heildeberg University

Abstract

Reaction-diffusion-ODE systems have emerged as powerful models for biological pattern formation. They couple diffusive and non-diffusive nonlinear processes and exhibit a rich variety of spatial structures, including classical Turing patterns as well as far-from-equilibrium patterns with singularities and jump discontinuities. This singular behavior distinguishes reaction-diffusion-ODE systems from classical reaction-diffusion systems and substantially complicates the analysis of nonlinear stability. In this talk, we develop a general framework for the analysis of bounded stationary solutions, establishing conditions for nonlinear stability and instability. As an application, we derive conditions for diffusion-driven instability (DDI), a key mechanism underlying pattern formation in these systems. While previous studies have primarily focused on DDI induced by instability of the purely non-diffusive subsystem, we show that DDI can also arise from coupling between non-diffusive and slowly diffusing components, leading to dynamics involving three distinct spatial scales.

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June 3rd, 2026, 11:30 - 13:00
Seminar room: SR 3.069

On the Fritz John problem for a freely floating object

Martin Oen Paulsen, University of Bordeaux

Abstract

The Fritz John problem is a linear model describing the interaction between an incompressible, irrotational free-surface fluid and a partially immersed solid object. Introduced by John in 1949, it is closely related to the Cummins equations, which are widely used in naval engineering to model wave–structure interactions. A rigorous analysis is subtle because the contact points between the free surface and the object create corner singularities and lead to a non-standard trace space for the velocity potential.

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May 6th, 2026, 11:30 - 13:00
Seminar room: SR 3.069

Dispersion in a Two-dimensional Stratified Fluid

Catalina Jurja, Zürich University

Abstract

The inviscid Boussinesq system is a widely used model in the study of oceanic flows, however, the description of its global dynamics remains an open problem. As a step towards understanding the long-time behaviour of its solutions, in this talk we will look at stability of a prototypical stratified steady state. In particular, the combined effect of gravity and stable stratification leads to a dispersive effect in the system for the perturbation and acts as a stabilising mechanism in the fluid. We will discuss the key properties of the perturbed system that allow for extended times of stability (from the local well-posedness timescale) as well as some elements of the proofs. This talk is based on joint works with Klaus Widmayer and Haram Ko.