Talks July 21-25

	Monday	Tuesday	Wednesday	Thursday	Friday
9:30 - 10:30	Szepessy	Sroczinski	-	Markfelder	Zumbrun
11:00 - 12:00	Szepessy	Sroczinski	-	Markfelder	Zumbrun
14:00 - 15:00 or 15:00 - 16:00	Yang	Bärlin	-	Pellhammer	-

Anders Szepessy (KTH, Stockholm): Conservation laws and their constitutive relations
I. Quantum observables determine, for instance, the stress tensor and heat flux in fluid dynamics. In the talk I will show which properties are used for approximating such quantum observables by molecular dynamics using features of the Gibbs distribution.
II. In the study of stochastic partial differential equations one may wonder what the noise is? Often the stochasticity modeled in partial differential equations has its origin in thermal fluctuations. Starting from a quantum formulation of a molecular system coupled to a heat bath, I will show that ab initio Langevin dynamics, with a certain rank-one friction matrix determined by the coupling, approximates the quantum system more accurately than any Hamiltonian system, for large mass ratio between the system and heat bath nuclei. I will also relate this to fluctuations in conservation laws.

Zhao Yang (CAS, Beijing): Recent progress in inclined thin-film flows
The inviscid Saint-Venant equations serve as a canonical model for inclined thin-film flows. These equations support two distinct types of traveling wave solutions: Dressler's periodic roll waves and hydraulic shocks. Periodic roll waves emerge when uniform laminar flows become unstable, while hydraulic shocks develop from the sudden release of a dam separating fluids of different depths. In both scenarios, the maximum fluid heights can greatly exceed those of the corresponding steady laminar flows with the same discharge, leading to potentially severe water overflow. Hence, the existence and stability of these waves attract attention in both hydro-engineering and mathematical fields. In this talk, we review recent longitudinal stability results for both types of waves, as well as multi-dimensional stability results for planar waves considered as solutions to the two-dimensional Saint-Venant equations. We will also discuss current difficulties encountered when constructing permanent flows in two dimensions and other related aspects.

Matthias Sroczinski (U Konstanz): Dissipativity conditions for hyperbolic systems: a general approach
I. The linear constant coefficient case
II. Non-linear stability of reference states
In the first talk, we consider first- and second-order hyperbolic systems and present a general method for formulating uniform dissipativity conditions, developed by Freistühler and the author. For linear systems, these conditions are equivalent to optimal decay in Fourier space. The second talk demonstrates how the conditions can be used to establish the nonlinear stability of constant equilibrium states and, in the case of certain second-order systems, of shock profiles.

Johannes Bärlin (U Konstanz / IU Bloomington): Spectral stability of shock profiles for hyperbolically regularized systems of conservation laws

This talk reports a proof that under natural assumptions shock profiles viewed as heteroclinic travelling wave solutions to a hyperbolically regularized system of conservation laws are spectrally stable if the shock amplitude is sufficiently small. This means that an associated Evans function $\mathcal{E}:\Lambda\to\mathbb{C}$ with $\Lambda\subset\mathbb{C}$ an open superset of the closed right half plane $\mathbb{H}^+\equiv\{\lambda\in\mathbb{C}:\mathrm{Re}\,\lambda\geq 0\}$, has only one zero, namely a simple zero at 0. The result is analogous to the one obtained in Freistühler & Szomlyan (2002) and Plaza & Zumbrun (2004) for parabolically regularized systems of conservation laws, and also distinctly extends findings on hyperbolic relaxation systems in Plaza & Zumbrun (2004), Mascia & Zumbrun (2009), and Ueda (2009).

Convex integration applied to the compressible Euler equations: non-uniqueness and admissibility criteria
In the past years, results based on a technique called convex integration have drawn lots of interest within the community of mathematical fluid mechanics. Among other fascinating results, this technique allows to prove existence of infinitely many solutions for the multi-dimensional compressible Euler equations. All these solutions satisfy the energy inequality which is commonly used in the literature to identify physically relevant solutions. On the other hand, intuitively at least some of the infinitely many solutions still seem to be non-physical. For this reason one has studied additional admissibility criteria like the maximal energy dissipation criterion or the least action criterion – to no avail: such criteria do not select the solution which is expected to be the physical one. In these talks we give an overview on the aforementioned non-uniqueness results, and we explain why maximal dissipation as well as the least action criterion fail to single out the solution which is presumably the physical solution.
I: **Simon Markfelder (U Konstanz)**: Non-uniqueness of weak entropy solutions
II: — : Maximal energy dissipation criterion
III: **Valentin Pellhammer (U Konstanz)**: Least action criterion

Kevin Zumbrun (Indiana University Bloomington):
I. Stable manifolds for a class of degenerate evolution equations and exponential decay of kinetic shock and boundary layers. (joint with Alin Pogan and Fedor Nazarov)
We construct stable/unstable manifolds for the stationary Boltzmann equation using a novel H^1 stable manifold construction together with an elementary bound on the (highly singular) linearized resolvent equation corresponding to a standard Friedrichs symmetric energy estimate. An additional result of instantaneous smoothing shows that the H^1 concept is sufficient to capture all solutions decaying in sup norm. Interestingly, it is small velocities that pertain to the main technical issues, and not the large velocities that one usually expects.
II. Accuracy of Burnett shock profiles in the small amplitude limit.
Burnett and super Burnett approximations of Boltzmann's equation, considered as time-evolution equations, are known to suffer from ill-posedness. Here, we show that nonetheless they can accurately predict structure of small-amplitude Boltzmann shock profiles with hard sphere collisions; specifically, whenever the associated profile ODE satisfy a nonsingularity condition of Pego guaranteeing existence and exponential convergence, then the Burnett approximation is accurate to the order predicted by formal expansion. Among other things, this clarifies the relation between Chapman-Enskog expansion and the small-amplitude limit. We evaluate the nonsingularity condition for the Jin-Xin model at all orders of approximation, and for the Boltzmann equation at second (classical Burnett) order, by methods in principle applying to all orders.