New Trends in Quantum and Classical Kinetic Equations and Related PDEs

On the occasion of the 60th birthday of Peter Markowich

October 6th – 8th

Department of Mathematics, University of Wisconsin Madison

Venue: van Vleck Hall 911

Thursday	
8:30 – 9:30	**Registration**
9:30 – 9:50	**Opening remarks**
9:55 – 10:45	J. Bona *Ill-posedness Results for Model Equations for Water Waves*
10:45 – 11:10	**Coffee**
11:10 – 12:00	A. Tzavaras *Relative entropy for the Euler-Korteweg system*
12:00 – 14:00	**Lunch**
14:00 – 14:50	H. Chen *Higher order nonlinear dispersive equation on a quarter plane*
15:00 – 15:30	**Coffee**
15:30 – 16:20	C. Klein *Numerical study of break-up in Kadomtsev-Petviashvili equations*
16:25 – 17:15	Blanca Ayuso de Dios *TBA*

Friday	
9:00 – 9:50	L. Caffarelli *Non local models for the porous media equation*
9:55 – 10:45	W. Gangbo *Paths of minimal lengths on the set of exact differential k–forms*
10:45 – 11:10	***Coffee***
11:10 – 12:00	P.E. Jabin *Global weak solutions of PDEs for compressible media*
12:00 – 14:00	**Lunch**
14:00 – 14:50	A. Chertock *An Asymptotic Preserving Scheme for Kinetic Chemotaxis Models in Two Space Dimensions*
15:00 – 15:30	**Coffee**
15:30 – 16:20	A. Kurganov *Numerical Methods for Hyperbolic Systems of PDEs with Uncertainties*
18:00 – 20:00	**Conference dinner**

Saturday	
9:00 – 9:50	I. Gamba *TBA*
9:55 – 10:45	J. G. Liu *Least action, incompressible flow, and optimal transportation*
10:45 – 11:10	**Coffee**
11:10 – 12:00	C. Ringhofer *Kinetic Models for Differential Games*
12:00 – 12:20	**Closing Remarks**

List of Abstracts

Blanca Ayuso de Dios: TBA

Jerry Bona: The discussion will center around both deep and shallow water wave models. Certain naturally derived models are examined and shown to be ill-posed in Hadamard's classical sense. The ill-posedness does not stem from trying to work in very large function classes, but instead seems intrinsic to the models and obtains even in quite smooth function spaces.

Luis Caffarelli: We will discuss existence and regularity theory for porous media equations that exhibit space and time memory.

Hongqiu Chen: The focus of the talk is a higher order nonlinear dispersive equation which models unidirectional propagation of small amplitude long waves in dispersive media. The dependent variable is a real-valued function of time and space. It represents the deviation of the free surface relative to its undisturbed state. The specific interest of this talk is in the initial-boundary value problem where both spatial and time variables lie in a quarter plane. With proper requirements on initial and boundary condition, we show local and global well-posedness.

Alina Chertock: We study a two-dimensional multiscale chemotaxis model based on a combination of the macroscopic evolution equation for chemoattractant and the microscopic model for cell evolution. The latter is governed by a Boltzmann-type kinetic equation with a local turning kernel operator which describes the velocity change of the cells. The parabolic scaling yields a nondimensional kinetic model with a small parameter, which represents the mean free path of the cells. We propose a new asymptotic preserving (AP) numerical scheme that reflects the convergence of the studied micro-macro model to its macroscopic counterpart—the Patlak-Keller-Segel (PKS) system—in the singular limit. The AP property of our numerical approach is achieved by implementing an operator splitting technique combined with the idea of the even-odd formulation and we prove the the resulting scheme yields a consistent approximation of the PKS system as the mean-free path tends to 0. The performance of the proposed numerical method is illustrated on a number of numerical experiments.

Irene Gamba: TBA

Wilfried Gangbo: We initiate the study of optimal transportation of exact differential k–forms and introduce various distances as minimal actions. Our study involves dual maximization problems with constraints on the codifferential of k–forms. When $k < n$, only some direc- tional derivatives of a vector field are controlled. This is in contrast with prior studies of optimal transportation of volume forms ($k = n$), where the full gradient of a scalar function is controlled. Furthermore, our study involves paths of bounded variations on the set of k–currents. This talk is based a joint work with B. Dacorogna and O. Kneuss.

Pierre-Emmanuel Jabin: We present global in time existence of solutions for some non-linear coupled system like the compressible Navier-Stokes equations, some models of tumor growth etc. The results are based on a new method to estimate the explicit regularity of the density, where a new log log scale for transport equation appears. This is a joint work with D. Bresch.

Christian Klein: The onset of a dispersive shock in solutions to the Kadomtsev-Petviashvili (KP) equations is studied numerically. First we study the shock formation in the dispersionless KP equation by using a map inspired by the characteristic coordinates for the one-dimensional Hopf equation. This allows to numerically identify the shock and to unfold the singularity. A conjecture for the KP solution near this critical point in the small dispersion limit is presented. It is shown that dispersive shocks for KPI solutions can have a second breaking where modulated lump solutions appear.

Alexander Kurganov: Many system of hyperbolic conservation and balance laws contain uncertainties in model parameters, initial or boundary data due to modeling or measurement errors. Quantifying these uncertainties is important for many applications since it helps to conduct sensitivity analysis and to provide guidance for improving the models. Among the most popular numerical methods for uncertainty quantification are stochastic spectral methods. Such methods decompose random quantities on suitable approximation bases. Their attractive feature is that they provide a complete probabilistic description of the uncertain solution. A classical choice for the stochastic basis is the set of generalized Polynomial Chaos (gPC) spanned by random polynomials, continuous in the stochastic domain and truncated to some degree. It is well-known, however, that when applied to general nonlinear (non-symmetric) hyperbolic systems, such approximations result in systems for the gPC coefficients, which are not necessarily globally hyperbolic since their Jacobian matrices may contain complex eigenvalues. In this talk, I will present a splitting strategy that allows one to overcome this difficulty and demonstrate the performance of the proposed approach on a number of numerical examples including systems of compressible Euler and shallow water equations.

Jan-Guo Liu: We describe a striking connection between Arnold's least-action principle for incompressible Euler flows and geodesic paths for Wasserstein distance. The least-action problem for geodesic distance on the `manifold' of fluid-blob shapes exhibits instability due to microdroplet formation. A connection with fluid mixture models via a variant of Brenier's relaxed least-action principle for generalized Euler flows will be outlined also. This is joint work with Bob Pego and Dejan Slepcev.

Christian Ringhofer: Kinetic models for the time evolution of multi agent systems generally drive the system towards a global minimum energy state. We present an alternative kinetic framework for the time evolution of multi agent systems where individual agents make decisions based on concepts of behavioral and evolutionary game theory and the system is driven towards a Pareto optimum or Nash equilibrium. Applications to the design of insurance policies and the wealth distribution in economies are discussed.

Athanasios Tzavaras: We consider a class of abstract Euler flows generated by a variational structure induced by an energy functional. This model admits as examples the Euler-Korteweg system and the Euler-Poisson system. If the functional is convex, the second variation of the functional provides a natural means to measure the distance between two states. Exploiting the variational structure, we develop a relative energy identity. The latter is used to derive various applications like (a) stability in the case of monotone or even non-monotone pressure laws; (b) convergence in the high-friction limit from Euler-Korteweg to Cahn-Hilliard equations ; (c) convergence to smooth compressible Euler flows in the zero-capillarity limit.