COST Action CA18232 -

Mathematical models for interacting dynamics on networks

WG2 Workshop on *Nonlinear problems in traffic and multispecies diffusion models*

May 18, 2021

organized by
Paola Goatin, Bérénice Grec and Milana Pavić-Čolić

Schedule

10.00 - 10.15	*gathering*
10.15 - 10.50	Felisia Angela Chiarello
10.50 - 11.25	Benjamin Anwasia
11.25 - 11.35	*break*
11.35 - 12.10	Elena Rossi
12.10 - 12.45	Esther S. Daus

Abstracts

Benjamin Anwasia (University of Minho)

Formal passage from a system of Boltzmann equations for reactive mixtures to a Maxwell-Stefan type reaction-convection-diffusion system

Abstract. We consider the simple reacting sphere kinetic model, which describes the evolution of a reactive mixture of monatomic-like gases. The aim is to show how to formally derive a reaction-convection-diffusion system where the diffusion process is, modelled by the Maxwell-Stefan equations from the simple reacting sphere kinetic equations. The derivation is achieved: by considering a scaling of the kinetic equations, which describe a physical situation where the dominant role in the evolution of the species in the reactive mixture is played by mechanical interactions, while the chemical reaction is, assumed to be very slow, together with the assumption of isobaric and isothermal conditions.

Felisia Angela Chiarello (Politecnico di Torino)

Multiscale control of generic second order traffic models by driver-assist vehicles

Abstract. In this talk, we study the derivation of generic high order macroscopic traffic models from a follow-the-leader particle description via a kinetic approach. We introduce a binary control modeling the automatic feedback provided by driver-assist vehicles and we upscale such a new particle description by means of an Enskog-based hydrodynamic limit. The resulting macroscopic model is a Generic Second Order Model (GSOM), which contains in turn a control term inherited from the microscopic interactions. We show that such a control may be chosen so as to optimise global traffic trends, such as the vehicle flux or the road congestion, constrained by the GSOM dynamics. By means of numerical simulations, we investigate the effect of this control hierarchy in some specific case studies, which exemplify the multiscale path from the vehicle-wise implementation of a driver-assist control to its optimal hydrodynamic design.

Esther S. Daus (Technical University of Vienna)

Cross-diffusion systems in biology: rigorous derivation, analysis and entropy structure

Abstract. In this talk I will discuss the global existence analysis and how to derive cross-diffusion systems from stochastic many-particle systems and from a reversible Markov chain model. The equations are strongly coupled and the diffusion matrix is in general neither symmetric nor positive definite, furthermore, we can also treat non-local effects.

Elena Rossi (Università degli Studi di Modena e Reggio Emilia)

Multilane traffic flow models: road junctions and nonlocal approaches

Abstract. Starting from the recent multilane model [H. Holden and N.H. Risebro, SIAM J. Math. Anal., 51 (2019), pp-3694-3713], we propose two generalisations.

First, aiming to describe macroscopically traffic flow on a multilane road network, we allow for the presence of discontinuities both in the speed law and in the number of lanes. This enable us to describe a number of realistic situations.

Then, starting again from the original model, we include a nonlocal dependence in the term accounting for the lane changing rate, and study the resulting model both with local and nonlocal flux. In this way, at position x, we allow the flow between neighbouring lanes to be governed by a term evaluating not only the density at position x, but also the average density around this position. Indeed, at the moment of changing lane, drivers usually check what is happening behind and in front of them, both on their lane and on the neighbouring one(s).

In both cases under study, compactness results on a sequence of Godunov's approximations ensure the existence of solutions to the problem, while uniqueness follows from an application of the doubling of variables technique.

Finally, some numerical integrations illustrate the behaviour of solutions in sample cases.

Joint works with Paola Goatin (Inria Sophia Antipolis - Méditerrannée, France), Jan Friedrich and Simone Göttlich (Universität Mannheim, Germany).