Abstracts

Propagation of chaos for aggregation equations with no-flux boundary conditions and sharp sensing zones

Young-Pil Choi

December 11th–December 24th, 2016

Fakultät für Mathematik
Technische Universität München
Garching bei München, 85748, Germany

E-mail:**ychoi@ma.tum.de**

Abstract

The aggregation equation appears in various context as a mathematical model for swarming behavior, for example, a school of fish, a flock of birds, etc. In this talk, I will present the propagation of chaos for large ensembles of interacting diffusing particles. We will discuss the rigorous derivation of a continuity-type of mean-field equation with discontinuous kernels and no-flux boundary conditions from the stochastic particle system as the number of particles N goes to infinity. This is a joint work with S. Salem(Centre de Mathématiques et Informatique, Université de Provence, Technopôle Château-Gombert, Marseille, France)

$\boxed{\text{MEMO}}$

Gradient flow techniques and applications to collective dynamics.

Javier Morales

December 11th–December 24th, 2016

Department of Mathematics, ETH Zürich and The University of Texas at Austin.

E-mail:**jmorales@math.utexas.edu**

Abstract

I will discuss applications of the theory of gradient flows to the dynamics of evolution equations. First, I will review how to obtain convergence rates towards equilibrium in the strictly convex case. Second, I will introduce a technique developed in collaboration with Moon-Jin Kang that allows one to obtain convergence rates towards equilibrium in some situations where convexity is not available. Finally, I will describe how these techniques were useful in the study of the dynamics of homogeneous Vicsek model and the Kuramoto-Sakaguchi equation. The contributions on the Kuramoto-Sakaguchi equation are based on a joint work with Seung-Yeal Ha, Young-Heon Kim, and Jinyeong Park. The contributions to the Vicsek model are based on works in collaboration with Alessio Figalli and Moon-Jin Kang.

$\boxed{\text{MEMO}}$

Emergence of synchronization for the Kuramoto-Sakaguchi equation

Jinyeong Park

December 11th–December 24th, 2016

Departamento de Matemática Aplicada, Universidad de Granada

E-mail:**parkjy40@gmail.com**

Abstract

The Kuramoto model describes synchronous behavior of weakly coupled oscillators. When the number of oscillators is large, the dynamics of Kuramoto system can be approximated by its mean-field limit, the Kuramoto-Sakaguchi equation. In this talk, we study a unique global solvability of bounded variation weak solutions to the Kuramoto-Sakaguchi equation for identical oscillators using the wave front-tracking method. Furthermore, for nonidentical oscillators, we show the asymptotic phase concentration by analyzing the detailed dynamics of the order parameters.

$\boxed{\text{MEMO}}$

Riemann problem of the relativistic Euler equations

Qinghua Xiao

December 11th–December 24th, 2016

Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences

E-mail:**xiaoqh@wipm.ac.cn**

Abstract

We investigate the Riemann problem of the relativistic Euler equations related to the relativistic Boltzmann equation. Analogous mathematical theory of the classical Euler equations for the Riemann problem is provided by some observations and delicate analysis of the modified Bessel functions of the second kind. As a byproduct, two previous conjectures, which are associated with the hyperbolicity of the relativistic Euler equations and the speed of sound in the relativistic setting, are also rigorously proved. Our result demonstrated in this paper lays the foundation of further study of the wave structure for the relativistic Boltzmann equation.

MEMO

Wave structures of the linearized 1D Landau equation

Haitao Wang

December 11th–December 24th, 2016

Institute of Mathematics, Academia Sinica

E-mail:**haitaowang@math.sinica.edu.tw**

Abstract

In this talk, I will show the pointwise behaviour of the linearized 1D Landau equation. The results reveal the particle and fluid aspects of the equation. The fluid-like waves reveal the dissipative behaviour of the type of Navier-Stokes equation as usually seen by the Chapman-Enskog expansion, it represents the long time behaviour of the solution. The kinetic-like waves dominate the short time behavior, the smoothing effect of these waves come from the ellipticity in the velocity variable of the linearized collision operator and the transport part of the equation. This is a joint work with Kung-Chien Wu.

MEMO

Cucker-Smale flocking with leadership

Zhuchun Li

December 11th–December 24th, 2016

Department of Mathematics, Harbin Institute of Technology

E-mail:**lizhuchun@hit.edu.cn**

Abstract

In this talk we introduce the Cucker-Smale flocking with leadership. The Cucker-Smale model was proposed to describe how the collective behavior emerges from interactions between moving agents. In most literature the agents are assumed to be all-to-all interacted. I will present our results about flocking model with leadership.

$\boxed{\text{MEMO}}$

Introduction to Thermomechanics of Continuous Media

Tommaso Ruggeri

Department of Mathematics and Research Center of Applied Mathematics

University of Bologna

Abstract: *We present the basic principles of thermomechanics of continuous media with particular regard to the general mathematical structure of balance laws and the modern theory of constitutive equations. We write down the differential system governing nonlinear thermo-elasticity and the equations governing the motion of a fluid (Euler and Navier-Stokes-Fourier). We discuss also briefly the partial differential systems of hyperbolic type and some relevant wave propagation problems.*

Lecture 1,2: Introduction and Survey of Linear Algebra: Matrix operators; Representation of an operator in an assigned basis; Operator transposed; Product of two operators; Operator identity; Complementary operator; Inverse operator; Levi-Civita symbol; Scalar product between operators; Trace of an operator; Symmetric and antisymmetric operators; Dual vector associated with an antisymmetric operator; Expression of an operator as the sum of a symmetric and an antisymmetric operator; Rotation operators and property; Characteristic polynomial of an operator; Eigenvalues and eigenvectors of an operator; Diagonalization of a symmetric matrix; Principal invariants of a matrix; Operators defined of sign; Sylvester theorem; Cayley-Hamilton theorem; Polar theorem.

Lecture 3,4: Deformation, Kinematics and Balance Laws: Deformation gradient operator; Deformation operators of Cauchy-Green and Green-Saint Venant; Eulerian and Lagrangian points of view; Cauchy Theorem and stress tensor; Transport theorem; Balance equations and conservation laws; Continuity equation; Momentum equation; Symmetry of the stress tensor; Boundary conditions; Lagrangian formulation of the balance equations; First and second Piola-Kirchhoff tensors; Galilean invariance.

Lecture 5,6: Theory of Constitutive Equations, Thermoelastic Material, Fluids and Rigid Heat conductor: General principles for selecting physical constitutive equations; Principle of material indifference; Entropy principle; Elastic and thermoelastic body; Indifference principle and entropy principle for thermoelastic body; Linear elasticity and wave equation. Perfect fluid and Euler system; Dissipative fluids of Navier-Stokes-Fourier type; Entropy principle for a fluid. Static solution of a fluid in the presence of gravity; Sound waves, Bernoulli theorem; Rigid heat conductor, Heat equation and Cattaneo equation.

Lecture 7,8: Hyperbolic Systems, Classical and Weak Solutions, Shock Waves: Euler, thermoelasticity and telegraphist equations as examples of hyperbolic systems; Wave equation and the method of characteristics; Linear waves; Burgers equation as an example of nonlinear hyperbolic equation; Critical time for the Burgers equation. Weak solutions and shock waves; Shock waves in fluid- dynamics; Riemann problem; Traffic problem of Lighthill and Whitham.

Lecture 9: A Brief Survey on Complex Materials, Mixtures and Non-Equilibrium Processes: Continuum with structure (Cosserat continuum and microstructures); Mixtures of gases; Extended thermodynamics and the connection between continuum mechanics and kinetic theory.

$\boxed{\text{MEMO}}$

Introduction to Statistical Mechanics

Masaru Sugiyama

Nagoya Institute of Technology, Nagoya 466-8555, Japan

Abstract: *Basic principles of statistical mechanics are explained with emphasis on the mathematical structure of the theory. The first part of the lectures is devoted to equilibrium statistical mechanics. Typical Gibbs ensembles are explained and their related topics are studied. The second part is a brief introduction of non-equilibrium statistical mechanics. We discuss the BBGKY hierarchy of the distribution functions and the Boltzmann equation.*

(Background knowledge of quantum mechanics is not necessarily required.)

Plan of the Lectures

Lectures 1-5

1 Introduction
- 1.1 How to describe macroscopic phenomena?
- 1.2 Three levels of description of macroscopic systems

2 Equilibrium Statistical Mechanics
- 2.1 Distribution function and the Liouville equation
- 2.2 Gibbs ensembles
  - 2.2.1 Microcanonical ensemble, and its application to ideal gas
  - 2.2.2 Canonical ensemble, and its applications to ideal gas and a system of harmonic oscillators
  - 2.2.3 Grandcanonical ensemble, and its application to ideal gas
- 2.3 Remarks
  - 2.3.1 Gibbs entropy and information entropy
  - 2.3.2 Fluctuation
  - 2.3.3 Validity range of classical statistical mechanics

3 Some Topics I
- 3.1 Phase transition; mean field approximation
- 3.2 Fermi statistics and Bose statistics

Lectures 6-9

4. Non-Equilibrium Statistical Mechanics
- 4.1 BBGKY hierarchy of the distribution functions
- 4.2 Boltzmann equation and the system of moment equations

5. Some Topics II
- 5.1 Extended thermodynamics A new non-equilibrium thermodynamics
- 5.2 Linear response theory
- 5.3 Stochastic processes

6. Concluding Remarks and Outlook

$\boxed{\text{MEMO}}$

Sparse Control of Multiagent Systems

Massimo Fornasier

Department of Mathematics

TU Munchen

Abstract: In this lecture, the following topics will be covered.

- Existence and uniqueness solutions of the Caratheodory differential equations
- Examples of multiagent dynamics
- Wasserstein distances and optimal transport
- Existence and uniqueness of mean-field equations
- Introduction to optimal control and first order optimality conditions
- Introduction to Gamma-convergence
- Sparse stabilization and optimal control of multiagent dynamics
- Smooth relaxation of sparse mean-field optimal control
- Sparse mean-field optimal control
- Mean-field Pontryagin maximum principle
- Numerical methods and open problems

- References

  - A . Bressan and B. Piccoli. Introduction to the mathematical theory of control. AIMS Series on Applied Mathematics, 2. American Institute of Mathematical Sciences (AIMS), Springfield, MO, 2007
  - A. Braides. ?-convergence for beginners. Oxford Lecture Series in Mathematics and its Applications, 22. Oxford University Press, Oxford, 2002.
  - A. F. Filippov. Differential equations with Discontinuous Righthand Sides , volume 18 of Math- ematics and its Applications (Soviet Series) . Kluwer Academic Publishers Group, Dordrecht, 1988.
  - Sparse Stabilization of Dynamical Systems Driven by Attraction and Avoidance Forces (M. Bongini and M. Fornasier), Networks and Heterogeneous Media, Volume 9, Issue 1, March 2014, pp. 1–31
  - Sparse Stabilization and Optimal Control of the Cucker-Smale Model (M. Caponigro, M. Fornasier, B. Piccoli, and E. Trlat), Mathematical Control And Related Fields, Vol. 3, No. 4, December 2013, pp. 447-466
  - Mean-field sparse optimal control (M.Fornasier, B. Piccoli and F. Rossi), Phil. Trans. Royal Soc. A, in ?Partial differential equation models in the socio-economic sciences? organised and edited by Peter Markowich, Martin Burger and Luis Caffarelli, Vol. 372, No. 2028, 2014.
  - Mean-field optimal control (M. Fornasier and F. Solombrino),ESAIM: Control, Optimization, and Calculus of Variations, Vol. 20, No. 4, 2014, pp. 1123-1152 (Un)conditional consensus emergence under perturbed and decentralized feedback controls (M. Bongini, M. Fornasier, and D. Kalise), Discrete and Continuous Dynamical Systems, Pages 4071 - 4094, Volume 35, Issue 5, September 2015
  - Sparse stabilization and control of alignment models (with M. Caponigro, B. Piccoli and E. Trelat), Math. Models Methods Appl. Sci., Vol. 25, No. 3, 2015, pp. 521-564
  - Mean field Pontryagin maximum principle (M. Bongini, M. Fornasier, F. Rossi, and F. Solombrino) submitted preprint, pp. 36

Mean Field Stochastic Control

Minyi Huang

Department of Mathematics and Statistics

Carleton University

Abstract: TBA