First Franco-Japanese Workshop on Chemotaxis Models
– Macroscopic and Microscopic Viewpoints –

Date : 22nd of October 2022

Venue : Science Complex A, Room 801, Aobayama campus, Tohoku University

Web : `http://www.math.tohoku.ac.jp/~fujie/FJW.html`

9.45 – 10.00 Welcoming issue

10.00 – 10.50 Milica Tomasevic (CNRS & École Polytechnique)
Stochastic particle approximation of Keller-Segel model for chemotaxis (Part 1)

11.00 – 11.10 Coffee Break

11.10 – 11.40 Tatsuya Hosono (Tohoku University)
Global existence of solutions to the 4D attraction-repulsion chemotaxis system and applications of Brezis–Merle inequalities

11.50 – 13.30 Lunch Break

13.30 – 14.20 Milica Tomasevic (CNRS & École Polytechnique)
Stochastic particle approximation of Keller-Segel model for chemotaxis (Part 2)

14.30 – 15.00 Coffee Break

15.00 – 15.50 Hiroshi Ohtsuka (Kanazawa University)
On a microscopic view of the stationary states of the elliptic-parabolic chemotaxis model

16.00 – 16.10 Coffee Break

16.10 – 16.40 Ashot Aleksian (Université Jean Monnet)
Exit-time for McKean-Vlasov diffusion

16.50 – 17.20 Hironari Miyoshi (Saitama University)
Derivation of Brownian motion from Goldstein-Taylor model in the sense of distributions

17.30 – 17.45 Closing issue

Organizers:

Julian Tugaut (Université Jean Monnet) and Kentaro Fujie (Tohoku University)

List of Abstract

Milica Tomasevic

Stochastic particle approximation of Keller-Segel model for chemotaxis

In these two talks we will first review the links between (non) linear stochastic diffusion processes and (non) linear Fokker-Planck Equations ((N)LFP). We will then see how one can derive a microscopic description of the non-linear equation in terms of interacting particle systems and introduce the notion of propagation of chaos. In the case of constant diffusion coefficient and bounded and continuous drift, we will show the propagation of chaos holds (using the technique described in Sznitman's notes of Saint Flour School). Then, we will give some physical examples of NLFP equations with singular drift coefficients and discuss the difficulties that arise from such setting. Finally, we will arrive to the probabilistic interpretation of the parabolic-parabolic version of the minimal Keller-Segel model. This will lead us to singularly interacting non-Markovian particle system. We will prove well-posedness and propagation of chaos for this system : in the case of $d = 1$ for all the parameters of the model; and in the case of dimension $d = 2$ for small chemotactic sensitivity.

This talk is based on a series of works among which one joint work with J-F. Jabir (HSE, Moscow) and D. Talay (Inria, Paris Saclay) and one ongoing work with N. Fournier (Sorbonne Université, Paris).

Hiroshi Ohtsuka

On a microscopic view of the stationary states of the elliptic-parabolic chemotaxis model

It is well-know that similarity in the structure exists between the two dimensional chemotaxis model of elliptic-parabolic type and the model of motion of two dimensional incompressible fluid. Actually they share some stationary states. In this talk, we will review several facts of the above similarity and the equilibrium statistical mechanics of point vortices. We will also discuss the recent study concerning the linear response of the common stationary states of the two models with respect to the ‘microscopic’ perturbation of the system.

Tatsuya Hosono

Global existence of solutions to the 4D attraction-repulsion chemotaxis system and applications of Brezis–Merle inequalities

We consider the Cauchy problem for an attraction-repulsion chemotaxis system in the whole space, which corresponds to the Keller–Segel system with an additional repulsive stimulus. One of main topics in the study of such a system is the presence of the L^1 threshold. Indeed, critical mass phenomena which should be called “8π-problem” are well-known in 2-dimensional setting. In this talk, using the Brezis–Merle type inequality and rearrangement arguments, we will show that the solution exists globally in time when the initial mass is less than 4-dimensional L^1 threshold value $(8\pi)^2$. This talk is based on a joint work with Professor Takayoshi Ogawa.

Ashot Aleksian

Exit-time for McKean-Vlasov diffusion

In this talk we discuss the small-noise limit for exit time from a stable domain of diffusion – the exit-time problem. The formal definition of the exit-time problem will be given as well as some classical assumptions on domain and diffusion itself using Ito diffusion as an example. Next, we will present the main result of the exit-time problem for Ito diffusion, which is given in the form of the so-called Kramers' type (or Arrhenius) law. In conclusion, we will discuss existing results for exit-time problem in the case of McKean-Vlasov diffusion, which also appears to be in the form of the Kramers' type law, and how and why the case of McKean-Vlasov diffusion is similar to Ito diffusion.

Hironari Miyoshi

Derivation of Brownian motion from Goldstein-Taylor model in the sense of distributions

We start from the Goldstein-Taylor model. The Goldstein-Taylor model is considered as a one-dimensional system for a rarefied gas composed of two kinds of particles moving parallel to the x-axis with constant and equal speeds. A solution of the Goldstein-Taylor model is a pair of the densities of particles moving parallel. By using the parabolic scaling, we derive the scaled Goldstein-Taylor model, which has the mean free path of size ε. An equation of the total density of particles derived from the Goldstein-Taylor model converges to a heat equation for a scaling limit. Then, we will propose a random walk associated with the Goldstein-Taylor model. We will prove that the cumulative distribution associated with this random walk will converge to a solution of a heat equation.