One-day Online Workshop on Chemotaxis

31st of July 2021.

Time table in "Beijing" hour

9.55 – 10.00 Welcoming issue

10.00 – 10.50 Yong Jung KIM (KAIST)
Turing patterns from a chemotaxis model with motility suppressing signal

11.00 – 11.50 Yuxiang Li (Southeast University)
Finite-time blow-up in a 2D Keller-Segel System with rotation

12.00 – 13.30 Lunch break

13.30 – 14.20 Jing LI (Minzu University of China)
Some recent results for a class of nonlocal Fisher-KPP models and the density-suppressed motility model with Fisher-KPP source

14.30 – 15.20 Sachiko ISHIDA (Chiba University)
Weak stabilization of the quasilinear parabolic equations in divergence form

15.30 – 16.20 Jaewook AHN (Dongguk University)
Asymptotics of PDEs arising from chemotaxis

16.30 – 16.50 Takeshi SUGURO (Tohoku University)
Well-posedness of the Cauchy problem of a Keller–Segel system in uniformly local spaces

16.50 – 17.10 Jianlu Yan (Nanjing University of Aeronautics and Astronautics)
Global generalized solutions to a Keller-Segel system with nonlinear diffusion and singular sensitivity

17.10 – 17.15 Closing issue

Organizers: Kentaro Fujie and Jie Jiang

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List of Abstract

Yong Jung KIM (KAIST)

Turing patterns from a chemotaxis model with motility suppressing signal

We do a stability analysis of a chemotaxis model and present criteria for pattern formation. The critical cell density that determines the cell aggregation is obtained. The three classical Turing patterns are obtained from the model. In particular, if there is a positive lower bound of the motility, cells may form hot spots, cold spots, and stripes depending on the population size. If not, cells develop peaks.

Yuxiang LI (Southeast University)

Finite-time blow-up in a 2D Keller-Segel System with rotation

We consider in this talk the Neumann problem for 2D Keller-Segel system with rotation flux given by

$$\begin{cases} u_t = \Delta u - \nabla \cdot (u S_\theta \nabla v), & x \in \Omega,\ t > 0 \\ 0 = \Delta v - v + u, & x \in \Omega,\ t > 0 \end{cases} \tag{0.1}$$

where Ω is a bounded domain in $\mathbb{R}^2$ with smooth boundary $\partial\Omega$, and the rotation matrix

$$S_\theta = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}, \qquad \theta \in (-\frac{\pi}{2}, \frac{\pi}{2}). \tag{0.2}$$

Let Ω be a general bounded domain. We show that: (i) If $m > 8\pi/\cos\theta$, there exists nonnegative initial datum u_0 satisfying $\int_\Omega u_0 \mathrm{d}x = m$ such that the corresponding nonradial solution of (0.1) blows up in finite time and the blow-up point lies in Ω. (ii) Let $\partial\Omega$ contain a line segment and $m > 4\pi/\cos\theta$, there exists nonnegative initial datum u_0 satisfying $\int_\Omega u_0 \mathrm{d}x = m$ such that the nonradial solution of (0.1) blows up in finite time and the blow-up point lies in the line segment of $\partial\Omega$.

Let $\Omega = B_L(0)$ be a ball in $\mathbb{R}^2$. We show that: (i) If the nonnegative radially symmetric initial datum u_0 satisfies $\int_\Omega u_0 \mathrm{d}x < 8\pi/\cos\theta$, then the radial solution of (0.1) exists globally in time. (ii) If the nonnegative radially symmetric initial datum u_0 satisfies $\int_\Omega u_0 \mathrm{d}x < 4\pi/\cos\theta$, then the radial solution of (0.1) is globally bounded. This talk is based on joint work with Wanwan Wang.

Jing LI (Minzu University of China)

Some recent results for a class of nonlocal Fisher-KPP models and the density-suppressed motility model with Fisher-KPP source

In this talk, we will firstly give a survey on our results on a class of nonlocal Fisher-KPP problem, including the existence of travelling wave solutions, the long time behavior for solutions of the Cauchy problem, and pattern formation driven by the parametrization. Secondly, we will introduce our recent results on the travelling wave solutions of the density-suppressed motility model with Fisher-KPP source.

Sachiko ISHIDA (Chiba University)

Weak stabilization of the quasilinear parabolic equations in divergence form

We consider the initial-boundary value problem for the parabolic equations in divergence form in a smooth bounded domain under the no-flux boundary condition. It is known that, in the case of the degenerate diffusion, a weak solution exists globally by parabolic theory. We will show that this problem possesses a globally bounded weak solution which approaches a steady state in time.

Jaewook AHN (Dongguk University)

Asymptotics of PDEs arising from chemotaxis

As the formation of singularity or instability in the chemotaxis PDEs can be seen as a prototype of a spontaneous biological pattern, it might be worthy to determine which conditions will cause the patterns to either persist or disappear. In this talk, we consider two types of logarithmic chemotaxis models featuring aggregation and pattern formation. As for the first model, a global weak solution is constructed using a Lyapunov structure. The constructed solution becomes smooth after some waiting time and stabilizes to a constant steady-state under further assumptions on the domain and the system parameters. As for the second model, we construct a global classical solution using a convenient energy method and find the condition on system parameters that make a constant steady-state globally stable or linearly unstable. Related works on the non-existence of non-constant steady states would be also discussed.

Takeshi SUGURO (Tohoku University)

Well-posedness of the Cauchy problem of a Keller–Segel system in uniformly local spaces

The Keller–Segel system is known for describing a model of chemotactic aggregation of microorganisms. As a simplification, we consider the Cauchy problem of the parabolic-elliptic Keller–Segel system on Euclidean space. This system is one of the diffusion equations involving a nonlocal term. It is interesting whether this problem is well-posed on a function space containing the non-decaying function. We show that the Cauchy problem of a Keller–Segel system is well-posed in uniformly local Lebesgue spaces.

Jianlu Yan (Nanjing University of Aeronautics and Astronautics)

Global generalized solutions to a Keller-Segel system with nonlinear diffusion and singular sensitivity

We consider the chemotaxis system with nonlinear diffusion and singular sensitivity in a smooth bounded domain $\Omega \subset \mathbb{R}^n$, $n \geq 2$. In this work it is shown that for all reasonably regular initial data $u_0 \geq 0$ and $v_0 > 0$, the corresponding Neumann initial-boundary value problem possesses a global generalized solution provided that diffusion exponent $m > 1 + \frac{n-2}{2n}$. This is joint work with Yuxiang Li.
