International Conference on Nonlinear Partial Differential Equations 2022

Schedule

Zoom Meeting ID: 878 2444 4748 Passcode: 726749

Time：19 October, Wednesday 14:30-14:40		Opening
Chair：Maolin Zhou		
Time	Speaker	Title
14:40-15:20	Yasumasa Nishiura	Dynamics of localized patterns with oscillatory tails
Coffee break（15:20--15:30）		
Chair：Yaping Wu		
Time	Speaker	Title
15:30-16:10	Yihong Du	Free boundary problems with a source term in n-space dimension
16:10-16:50	Francois Hamel	Spreading speeds and one-dimensional symmetry for reaction-diffusion equations in R^N
Chair：Yuan Lou		
Time	Speaker	Title
19:00-19:40	Jaeyoung Byeon	Solvability for the Born-Infeld model
19:40-20:20	Masaharu Taniguchi	Axially asymmetric traveling fronts in balanced bistablereaction-diffusion equations
Coffee break（20:20--20:30）		
Chair：Jian Fang		
Time	Speaker	Title
20:30-21:10	Frank Merle	Singularity formation for 3D compressible Navier-Stokes Equation
21:10-21:50	Yoichiro Mori	Mathematical Theory of the Swimming Thin Filaments

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Time：20 October, Thursday		
Chair：Xing Liang		
Time	Speaker	Title
14:00-14:40	Peter Bates	Reacting systems with nonlocal diffusion: Some questions and a few answers
14:40-15:20	Toshiyuki Ogawa	Alien invasion into the buffer zone between two competing species
Coffee break（15:20--15:30）		
Chair：Bendong Lou		
Time	Speaker	Title
15:30-16:10	Yuan Lou	Coexistence of strains in some reaction-diffusion systems
16:10-16:50	Bernold Fiedler	Parabolic Sturm global attractors: Thom-Smale complexes, Poincare duality, and time reversal
Chair：Thomas Giletti		
Time	Speaker	Title
19:00-19:40	Hirokazu Ninomiya	Stationary solutions and dynamics of area-preserving curvature flow in an inhomogeneous medium
19:40-20:20	Hatem Zaag	A cross-shaped blow-up profile for the semilinear heat equation
Coffee break（20:20--20:30）		
Chair：Quentin Griette		
Time	Speaker	Title
20:30-21:10	Lenya Ryzhik	Quantitative steepness in reaction-diffusion equations
21:10-21:50	Peter Polacik	Large-time behavior of solutions of reaction-diffusion equation on the real line

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Time: 21 October, Friday		
Chair：Yihong Du		
Time	Speaker	Title
14:00-14:40	Tadahisa Funaki	Interface motion from stochastic systems
14:40-15:20	Yaping Wu	The spectral stability of traveling waves for some Keller-Segel chemotactic models
Coffee break（15:20--15:30**）**		
Chair：Kenichi Nakamura		
Time	Speaker	Title
15:30-16:10	Danielle Hilhorst	Singular limit of a stochastic Allen-Cahn equation with nonlinear diffusion
16:10-16:50	Henri Berestycki	The question of uniqueness of steady states for reaction–diffusion equations in general domains

Lecture title and abstract

International Conference on Nonlinear Partial Differential Equations
19-21 October 2022

Reacting systems with nonlocal diffusion: Some questions and a few answers.

Peter Bates
Michigan State University

Abstract: Hiroshi Matano's groundbreaking work in many areas has inspired generations of scientists and mathematicians, even those older than he! One of the earlier areas opened up by his work is that of pattern formation in reaction-diffusion systems. Another is the nonincrease of spatial complexity for scalar R-D equations on an interval, i.e., the nonincreasing nature of 'lap number'. However, many physical and biological processes occur with long-range interaction, giving rise to equations with nonlocal-in-space operators in place of the usual Laplacian. These operators are diffusive-like but are bounded rather than unbounded as is the case of the local diffusion operator. We study systems that include such nonlocal operators and through a spectral convergence result when a certain scaling parameter becomes small, show that Turing instabilities also occur, producing patterned stable states. In the scalar case, bifurcation is shown to occur when this parameter is small but many unanswered questions persist, including the corresponding question about lap number.

The question of uniqueness of steady states for reaction – diffusion equations in general domains.

Henri Berestycki
Ehess, Paris

Abstract: In this talk, I will report on ongoing work with Cole Graham on uniqueness of bounded positive solutions of semi-linear elliptic equations in general unbounded domains. We study a variety of reaction types, boundary conditions, and domains, and we encounter an unexpected wealth of behavior. To frame these results, I will recall some earlier works on qualitative properties of semi-linear elliptic equations in unbounded domains as well as some elements of the theory of generalized principal eigenvalues. I will also mention several open problems.

Solvability for the Born-Infeld model.

Jaeyoung Byeon
Korea Advanced Institute of Science and Technology

Abstract: I would like to introduce some recent results on the solvability of Born-Infeld equation for general source terms.

Free boundary problems with a source term in n-space dimension.

Yihong Du
University of New England

Abstract: We consider the one phase Stefan problem with a source term, which has been used to describe the spreading of species with the free boundary representing the spreading front. In high space dimension, the regularity of the free boundary is difficult to treat. I will explain how some of the techniques used to treat the classical Stefan problem can be further developed to obtain regularity results for the current problem. I will also discuss the long-time dynamics and reveal some striking differences when the initial range is changed from a bounded domain to certain unbounded domains in R^n, including the existence of families of semi-wave solutions with curved fronts for the latter case.

Parabolic Sturm global attractors: Thom-Smale complexes, Poincaré duality and time reversal.

Bernold Fiedler
Free University of Berlin

Abstract: Sturm global attractors $\mathscr{A}$ arise, for example, in dissipative scalar reaction-advection-diffusion equations $u_t = u_{xx} + f(x,u,u_x)$ on the unit interval with Neumann boundary. Forty years ago, Hiroshi Matano sparked the systematic use of linear Sturmian nodal properties of solutions $x \to u(t,x)$ in such nonlinear settings. Let all equilibria be nondegenerate, i.e., hyperbolic. Their unstable manifolds then decompose $\mathscr{A}$ as a signed regular Thom-Smale cell complex. Somewhat surprisingly, the Poincaré dual turns out to be signed and regular, as well. This fact, although related to time reversal, is an essential characterizing property of Sturmian Thom-Smale complexes, at least for $\dim\mathscr{A} \leq 3$. We also present some examples of high-dimensional Sturm balls with time-reversible flows on their sphere boundaries. This is ongoing work with Carlos Rocha.

Interface motion from stochastic systems.

Tadahisa Funaki
University of Tokyo and BIMSA

Abstract: We discuss the derivation of interface motion from stochastic systems such as interacting particle systems and stochastic partial differential equations.

Spreading speeds and one-dimensional symmetry for reaction-diffusion equations in $\mathbb{R}^N$.

Francois Hamel
Aix-Marseille University

Abstract: The talk will focus on the large-time dynamics of bounded solutions of reaction-diffusion equations in $\mathbb{R}^N$ with unbounded initial support. I will discuss the existence of spreading sets and Freidlin-Gärtner formulas for the spreading speeds of the solutions in any direction, in connection with the existence of planar traveling waves. I will also explain some results on the asymptotic one-dimensional symmetry of the elements of the Ω-limit set of the solutions, in the spirit of a famous De Giorgi conjecture on solutions of some elliptic equations in $\mathbb{R}^N$. The talk is based on joint works with Luca Rossi.

Singular limit of a stochastic Allen-Cahn equation with nonlinear diffusion.

Danielle Hilhorst
Paris-Saclay University

Abstract: We study a stochastic Allen-Cahn equation with nonlinear diffusion and a mild random noise on a bounded domain. We consider initial data which satisfy some non-degeneracy conditions, and prove that steep transition layers develop within a very short time. We then study the motion of these transition layers and derive a stochastic motion law for the sharp interface limit.

This research has been inspired upon an article written by Alfaro, Antonopoulou, Karali and Matano in the case of linear diffusion. This is joint work with Perla El Kettani, Yong Joung Kim and Hyunjoon Park.

Quantitative steepness in reaction-diffusion equations.

Lenya Ryzhik
Stanford University

TBA

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Coexistence of strains in some reaction-diffusion systems.

Yuan Lou
Shanghai Jiao Tong University

Abstract: We study the global dynamics of some reaction-diffusion systems for two strains and investigate how the coexistence of strains is impacted by the movement of populations and spatial heterogeneity of the environment. Sufficient conditions for the existence, uniqueness and stability of coexistence steady states are found. Surprisingly, when there is no coexistence of strains, it is possible for the "weak" strain to be dominant for intermediate diffusion rates, in strong contrast to small and large diffusion cases where the "weak" strain always go extinct. This talk is based on joint work with Rachidi Salako.

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Singularity formation for 3D compressible Navier-Stokes Equation.

Frank Merle
IHES and U. of Cergy

Abstract: In collaboration with Pierre Raphaël, Igor Rodnianski, Jeremie Szeftel We investigate strong singularity formation in compressible fluids, we consider the compressible three-dimensional Navier-Stokes and Euler equations. In a suitable regime of barotropic laws, we construct a set of finite energy smooth initial data for which the corresponding solutions to both equations implode (with infinite density) at a later time at a point, and completely describe the associated formation of singularity. An essential step in the proof is the existence of smooth self-similar solutions to the compressible Euler equations for quantized values of the speed. All blow up dynamics obtained for the Navier-Stokes problem are of type II (non self-similar).

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Mathematical Theory of the Swimming Thin Filaments.

Yoichiro Mori
University of Pennsylvania

Abstract: Many microorganisms can be modeled as thin filaments swimming in an underlying fluid. Here, I will introduce a few of the popular models used to model thin filamentous swimmers. We have been working to build a mathematical theory for these models. I will describe our efforts on slender body approximation and also our recent work on resistive force theory. This is joint work with Laurel Ohm, Will Mitchell and Dan Spirn.

Stationary solutions and dynamics of area-preserving curvature flow in an inhomogeneous medium.

Hirokazu Ninomiya
Meiji University

Abstract: Area-preserving curvature flows in a two-dimensional homogeneous medium have been studied for several decades. In 1986, Gage showed that an initially convex closed curve remains convex and converges to a circle as time goes to infinity. However, in many applications, the medium is not homogeneous. In this talk, we consider the area preserving flow in an inhomogeneous medium when the area enclosed by the interface is small. First I will explain about the stationary solutions and then the reduced equation of its center. The talk is based on some joint works with R. Lui.

Dynamics of localized patterns with oscillatory tails.

Yasumasa Nishiura
Hokkaido University/Chubu University

Abstract: We investigate the dynamics of localized pulses and spots with oscillatory tails in a specific three-component reaction-diffusion system, whose key feature is that the pulses and spots attract or repel each other alternatively according to their mutual distances, leading to rather complex dynamics. This is also true for the interaction with the heterogeneities (defects) in the media. We present two interesting cases: one is dynamics of 1D traveling pulse in heterogeneous media of bump type, and the other is the ring patterns in 2D. For 1D case, pinning and depinning processes appear alternatively depending on the strength of heterogeneity due to the oscillatory nature, and a

very subtle dependence on initial condition emerges, which originates from the infinitely many successive reconnections of saddle points of basin boundary between two different outputs. For 2D case, stationary or moving (i.e., traveling and rotating) N-spot rings can be observed. In order to understand the emergence of these patterns, we describe the dynamics by a set of reduced ODEs encoding the information of each location and velocity. This is a joint work with Takeshi Watanabe (1D pulse) and Shuangquan Xie (ring pattern).

Alien invasion into the buffer zone between two competing species.

Toshiyuki Ogawa
Meiji University

Abstract: Bifurcation of non-monotone traveling wave solutions of the three-species Lotka-Volterra competition diffusion system under strong competition is studied. The well-known front and back traveling wave formed by two species may lose its stability by the effect of third species and, as a result, allows the invasion. To discuss how the invasion is possible, stability change with respect to the intrinsic growth rate for the alien species are studied. Both numerical and theoretical bifurcation analysis around the bifurcation point reveal how the invasion affects the segregation of the original two species.

Large-time behavior of solutions of reaction-diffusion equation on the real line.

Peter Polacik
University of Minnesota

Abstract: The behavior of solutions of reaction-diffusion equations on the entire space is still far from being understood. In this talk, we will discuss the behavior of bounded solutions on the real line, with special focus on solutions whose initial data have finite limits at $\pm\infty$. We give nearly optimal conditions on such initial data which guarantee that the corresponding solution is quasiconvergent, that is, all its locally uniform limit profiles as time approaches infinity are steady states. The results are from a joint project with Antoine Pauthier.The behavior of solutions of reaction-diffusion equations on the entire space is still far from being understood. In this talk, we will discuss the behavior of bounded solutions on the real line, with special focus on solutions whose initial data have finite limits at $\pm\infty$. We give nearly optimal conditions on such initial data which guarantee that the corresponding solution is quasiconvergent, that is, all its locally uniform limit profiles as time approaches infinity are steady states. The results are from a joint project with Antoine Pauthier.

Axially asymmetric traveling fronts in balanced bistable reaction-diffusion equations.

Masaharu Taniguchi
Okayama University

Abstract: For a balanced bistable reaction-diffusion equation, an axisymmetric traveling front has been well studied. We prove that an axially asymmetric traveling front with any positive speed does exist in a balanced bistable reaction-diffusion equation. Our method is as follows. We use a pyramidal traveling front for an imbalanced reaction-diffusion equation whose cross section has a major axis and a minor axis. Preserving the major axis and the minor axis to be given constants and taking the balanced limit, we obtain an axially asymmetric traveling front in a balanced bistable reaction-diffusion equation. This traveling front is monotone decreasing with respect to the traveling axis, and its cross section is a compact set with a major axis and a minor axis.

The spectral stability of traveling waves for some Keller-Segel chemotactic models.

Yaping Wu
Capital Normal University

Abstract: In this talk we shall talk about our recent work on the spectral stability/instability of traveling waves for two types of Keller-Segel chemotactic models with zero chemical random diffusion. By applying special transformations, spectral analysis, Evan's function method and numerical simulation, we obtain the spectral stability/instability of the traveling waves in some weighted spaces. It' s a joint work with Shaoqi Liang and Jie Wang.

A cross-shaped blow-up profile for the semilinear heat equation.

Hatem Zaag
CNRS&Université Sorbonne Paris Nord

Abstract: We consider the semilinear heat equation with a superlinear power nonlinearity in the Sobolev subcritical range. We construct a solution which blows up in finite time only at the origin, with a completely new blow-up profile, which is cross-shaped, answering.a question by Hiroshi Matano. Our method is general and extends to the construction of other solutions blowing up only at the origin, with a large variety of blow-up profiles, degenerate or not. This is a joint work with Frank Merle.