Abstracts of Talks

Positive solutions for quasilinear elliptic equations with critical growth and subcritical perturbation

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Abstract: In this talk, we discuss the following quasilinear elliptic equation

$$-\mathrm{div}(g^2(u)\nabla u) + g(u)g'(u)|\nabla u|^2 + V(x)u = h(u), \quad x \in \mathbb{R}^N,$$

where $N \geq 3$, $g : \mathbb{R} \to \mathbb{R}^+$ is an even differentiable function and $g'(t) \geq 0$ for all $t \geq 0$, $h \in C^1(\mathbb{R}, \mathbb{R})$ is a nonlinear function including critical growth and subcritical perturbation, the potential $V(x) : \mathbb{R}^N \to \mathbb{R}$ is positive. Since the subcritical perturbation does not satisfy the corresponding (AR) condition, the standard variational method can not be used directly. Combining the change of variables and the monotone method developed by Jeanjean, we obtain the existence of positive solutions for the given problem.

An introduction to nonlinear diffusion equations with variable exponents

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Abstract: In this talk, recent developments about some problems related to nonlinear diffusion equations with variable exponents will be presented. The talk will start with some background to the corresponding problems. and then give some examples to illustrate the difference between constant and non-constant exponent cases, at the end, some results about such problems, such as existence, blow-up, extinction, non-extinction etc. will be mentioned.

Traveling wave solutions and periodic solutions to Allen-Cahn equations with fractional Laplacians

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Abstract: In this talk, I will discuss the existence of special solutions such as traveling wave solutions and periodic solutions to Allen-Cahn equations with fractional Laplacians. For traveling wave solutions, we study the existence and asymptotic behavior when the double well potential has unequal depths. A key ingredient is the estimate of the speed of the traveling wave in terms of the potential. For periodic solutions, we show the existence of periodic solutions with large periods. Estimates of the energy of the periodic solutions are also established. Both variational methods and bifurcation methods are used.

Negative power nonlinear integral equations on bounded domains

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Abstract: We introduce and study some negative power nonlinear integral equations on bounded domains that are related to the sharp reversed Hardy-Littlewood-Sobolev inequality obtained recently by Dou and Zhu. The existence results are obtained. Blowup behavior of the minimizing energy solutions to the subcritical problem is also studied. This is a joint work with Prof. Jingbo Dou and Prof. Meijun Zhu.

Spatial Decay and Stability of Traveling Fronts for Degenerate Fisher Type Equations in Cylinder

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Abstract: In this talk, we consider the multidimensional traveling fronts of the degenerate Fisher type equation in an unbounded cylinder. A particular attention is paid on the spatial decay of traveling fronts with all speeds, especially for the p-degree Fisher type equation we get the precise algebraic decaying rates and the higher order expansion of traveling fronts with non-critical speeds. Furthermore, we show the local exponential stability of all traveling fronts in some exponentially weighted spaces and the Lyapunov stability of traveling fronts with noncritical speeds in some polynomially weighted spaces. Extensive asymptotic behavior results are investigated to illustrate the asymptotic spreading speed of the solution for more general initial data, which are determined by the spatial decay of the initial data at one end. Our main techniques are the spectral analysis and sub-super solution method. This is a joint work with Prof. Yaping Wu.

Spatial Heterogeneity and Time periodicity in Lotka-Volterra Competition-Diffusion Systems

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Abstract: In this talk I shall report some of the recent progress on the 2 by 2 Lotka-Volterra competition-diffusion systems when spatial heterogeneity and/or temporal periodicity are present. This is a joint work with Dr. Xueli Bai and Prof. Wei-Ming Ni.

On the Nonplanar Travelling Fronts in a Periodic Shear Flow

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Abstract: In this talk, I will give some results on the nonplanar travelling fronts in a periodic shear flow, including the existence, nonexistence, monotonicity, stability, asymptotic behaviors of the conical minimal speed et al.

Conformal metrics in $\mathbb{R}^{2m}$ with constant and nonconstant Q-curvature

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Abstract: In this talk, we will report the polyharmonic problem $\Delta^m u = \pm e^u$ in $\mathbb{R}^{2m}$, with $m \geq 2$. In particular, we prove that *for any* $V > 0$, there exist radial solutions of $\Delta^m u = -e^u$ such that

$$\int_{\mathbb{R}^{2m}} e^u dx = V.$$

It implies that for m odd, given any $Q_0 > 0$ and arbitrary volume $V > 0$, there exist conformal metrics g_u on $\mathbb{R}^{2m}$ with constant Q-curvature equal to Q_0 and $\mathrm{vol}(g_u) = V$. The second part we will introduce some recent new results on the *nonconstant* Q-curvature in $\mathbb{R}^4$. This is based on joint work with Prof. Dong Ye and Feng Zhou.

Qualitative analysis on a diffusive SIS epidemic model with mass action infection mechanism

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Abstract: We are concerned with a diffusive SIS epidemic model with mass action infection mechanism and linear recruitment for the susceptible population. We study the stability of the disease-free equilibrium, uniform persistence property in terms of the basic reproduction number, and global stability in homogeneous environment. We are particularly interested in the asymptotic profile of the endemic equilibrium (when it exists) as one of the motility rate of the susceptible and infected populations is small. Our results, together with those on other closely related models, suggest that infection mechanism, variation of total population and population movement play subtle roles in the transmission dynamics of disease. This is a joint work with Rui Peng and Zhi-An Wang.

Stability of traveling fronts for a chemotaxis model with logarithmic sensitivity

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Abstract: In this talk, we first review some results on the asymptotic stability of traveling fronts for a chemotaxis model with logarithmic sensitivity on the whole space. And then, we discuss the boundary effect, i.e. the asymptotic profiles of the chemotaxis model on the half space. The difficulty arises from the singularity caused by vacuum at the far field, which is overcome by the Hopf-Cole transformation and the weighted energy estimates.

Propagation Dynamics of Asymmetric Nonlocal Dispersal Equations

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Abstract: This talk is concerned with entire solutions of the asymmetric nonlocal dispersal equation $u_t = J * u - u + f(u)$ with monostable, bistable and ignition nonlinearity, respectively, where the kernel function J is **asymmetric**. Compared with symmetric case, the asymmetry of the dispersal kernel function makes more different types of entire solutions since it can affect the range and sign of the wave speeds, which further leads to no symmetry between the corresponding nonincreasing and nondecreasing waves. For the KPP, bistable and ignition nonlinearities, We establish respectively some new entire solutions and obtain its qualitative properties by constructing proper supersolution and subsolution and by classifying the sign and size of the wave speeds. In particular, if f is the KPP nonlinear term and the kernel J is **symmetric**, then the entire solutions are proved to be 5-dimensional, 4-dimensional, and 3-dimensional manifolds, respectively. This is the joint work with Yu-Juan Sun, Zhi-Cheng Wang and Li Zhang.

Blow-up and global existence of attraction-repulsion chemotaxis systems

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Abstract: We consider an attraction-repulsion chemotaxis system

$$\begin{cases} u_t = \Delta u - \chi\nabla\cdot(u\nabla v) + \xi\cdot(u\nabla w) + f(u) & x\in\Omega,\ t>0,\\ 0 = \Delta v + \alpha u - \beta v & x\in\Omega,\ t>0,\\ 0 = \Delta w + \gamma u - \delta w & x\in\Omega,\ t>0, \end{cases}$$

under homogeneous Neumann boundary conditions in a smooth bounded domain in $\mathbb{R}^2$. First we study the system without logistic term, obtaining the finite-time blowup of nonradial solutions in the parameters values $\chi\alpha - \xi\gamma > 0$ and $\beta \neq \delta$. Secondly, under a growth restriction on logistic source and suitable assumptions on the positive parameters $\chi,\ \xi,\ \alpha,\ \beta,\ \gamma$ and δ, we show the existence of global bounded classical solutions. The global weak solution is also constructed if the logistic damping effect is rather mild. Furthermore, we obtain the asymptotic behavior of solutions for the logistic source $f(u) = \mu u(1-u)$.

Entire Solutions of the Fisher-KPP Equation on the Half Line

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Abstract: We study the entire solutions of the Fisher-KPP equation $u_t = u_{xx} + f(u)$ on the half line $[0,\infty)$ with Dirichlet boundary condition at $x = 0$. (1). For any $c \geq 2\sqrt{f'(0)}$, we show the existence of an entire solution $\mathcal{U}^c(x,t)$ which connects the traveling wave solution $\phi^c(x+ct)$ at $t = -\infty$ and the unique positive stationary solution $V(x)$ at $t = +\infty$; (2). We also construct an entire solution $\mathcal{U}(x,t)$ which connects the solution of $\eta_t = f(\eta)$ at $t = -\infty$ and $V(x)$ at $t = +\infty$. Our result presents a rather complete description on the relationship among the entire solutions.

A nonlocal logistic model from conservation biology

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Abstract: We study a mathematical model arising from crop raiding of largebodied mammals living in the bio-diversity-rich tropics. The topic is important because it involves highly threaten species that can cause significant economic damage and be killed in retribution. The mathematical model consists of a nonlocal spatially heterogeneous parabolic problem of logistic type. Our main analytical result characterizes the existence of positive solutions of the model, and it provides us with some multiplicity results.

Global Existence and Finite Time Blow-up of Solutions of the Gierer-Meinhardt System

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Abstract: In this talk, we are concerned with the Gierer-Meinhardt system with zero Neumann boundary condition:

$$\begin{cases} u_t = d_1\Delta u - a_1 u + \frac{u^p}{v^q} + \delta_1(x), & x \in \Omega,\ t > 0, \\ v_t = d_2\Delta v - a_2 v + \frac{u^r}{v^s} + \delta_2(x), & x \in \Omega,\ t > 0, \\ u(x,0) = u_0(x), \quad v(x,0) = v_0(x), & x \in \Omega, \end{cases}$$

where $p > 1$, $s > -1$, q, r, d_1, d_2, a_1, a_2 are positive constants, δ_1, δ_2, u_0, v_0 are nonnegative smooth functions, $\Omega \subset \mathbb{R}^N$ $(N \geq 1)$ is a bounded smooth domain. We obtain new sufficient conditions for global existence and finite time blow-up of solutions, especially in the critical exponent cases: $p - 1 = r$ and $qr = (p-1)(s+1)$. This is joint work with Fang Li (East China Normal University) and Xianfa Song (Tianjin University).

Toward a Chemotaxis Model with Indirect Signal Production

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Abstract: This talk addresses a chemotaxis system with indirect signal production, which models the aggregation behavior of the Mountain Pine Beetle in forest habitat. It is shown that this system exhibits a novel type of critical mass phenomenon with regard to the formation of singularities, which drastically differs from the well-known threshold property of the classical Keller-Segel system, in that it refers to blow-up in infinite time rather than in finite time. Moreover, a recent result on this system with generalized logistic source is presented, and a possible future problem is proposed. This talk is mainly based on a joint work with Michael Winkler (Paderborn).

Simons cone and saddle solutions of the Allen-Cahn equation

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Abstract: Simons cone plays an important role in the study of the Bernstein problem for minimal hypersurfaces. For the Allen-Cahn equation, a similar conjecture of De Giorgi states that monotone solutions or minimizers in low dimensions are one dimensional, a property similar to the flatness of minimal hypersurfaces in the Bernstein problem. As in the minimal surfaces, it is also believed that in dimension 8 and higher there are minimizers which are not one dimensional. Some examples will be discussed in this talk. We will also discuss some properties of saddle solutions, a direct counterpart of Simons cone in the Allen-Cahn problem. This is a joint work with Yong Liu and Juncheng Wei.

On Delaunay solutions of a biharmonic elliptic equation with critical exponent

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Abstract: We are interested in the qualitative properties of positive entire solutions $u \in C^4(\mathbb{R}^n \backslash \{0\})$ of the equation

$$\Delta^2 u = u^{\frac{n+4}{n-4}} \text{ in } \mathbb{R}^n \backslash \{0\} \text{ and } 0 \text{ is a non-removable singularity of } u(x). \tag{0.1}$$

It is known that any positive entire solution u of (0.1) is radially symmetric with respect to $x = 0$, i.e. $u(x) = u(|x|)$, and equation (0.1) also admits a special positive entire solution $u_s(x) = \left(\frac{n^2(n-4)^2}{16}\right)^{\frac{n-4}{8}} |x|^{-\frac{n-4}{2}}$. We first show that $u - u_s$ changes signs infinitely many times in $(0, \infty)$ for any positive singular entire solution $u \not\equiv u_s$ in $\mathbb{R}^N \backslash \{0\}$ of (0.1). Moreover, equation (0.1) admits a positive entire singular solution $u(x)$ $(= u(|x|)$ such that the scalar curvature of the conformal metric with conformal factor $u^{\frac{4}{n-4}}$ is positive and $v(t) := e^{\frac{n-4}{2}t} u(e^t)$ is $2T$-periodic with suitably large T. It is still open that $v(t) := e^{\frac{n-4}{2}t} u(e^t)$ is periodic for any positive entire solution $u(x)$ of (0.1).

This is a joint work with Z.Guo, X. Huang and J. Wei.

Global Stability in Keller–Segel Models with Logarithmic Sensitivity

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Abstract: In Keller–Segel chemotaxis models, a sensitivity function, sometimes called chemotactic potential, describes the variation of chemotactic intensity due to the change of chemical concentration. Though the choice of sensitivity functions depends on biological relevance that one tries to model, logarithmic function arises as a natural and suitable candidate in the spirit of the experimental Weber–Fechner law which states that, the perceived physical stimulus is proportional to logarithm of its actual intensity. In this talk, we present our recent results on the global stability in several Keller–Segel models with logarithmic sensitivity. To be precise, we show that the equilibrium is globally stable under one of the following conditions: i) chemotaxis rate is negative (chemo–repulsion), ii) chemotaxis rate is small (weak chemo–attraction) or iii) cellular population decays linearly (for both repulsion and attraction). Therefore, cellular aggregation is impossible in each of the three cases. This talk is based on joint works with Lin Chen and Fanze Kong.

半导体漂流扩散方程的拟中性极限问题

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Abstract: 本报告将谈论半导体理论中一些宏观动力学模型拟中性的数学理论。半导体拟中性是一种基本的物理假设，首先由美国贝尔实验室W. Van Roosbroeck提出。这一性质也是等离子体物理的一种基本特征。本报告将从数学上建立拟中性理论，给出半导体拟中性假设的数学理论。将介绍半导体漂流扩散方程组的拟中性极限方面的基本数学问题，建立边界层初始层混合层等多尺度结构稳定性理论，也讨论相关的一些模型如PNP-NS模型、溶解液中的生物趋化模型、雾霾模型和空气污染模型的适定性与小参数极限问题。我们将总述这些问题的研究状况，并给出这些问题的最新研究进展，重点介绍我们在这些领域的研究成果。

Spatial Heterogeneity in Host-Parasite Models

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Abstract: It is now widely believed that spatial heterogeneity plays an important role in the transmission and control of diseases. In this talk, I will give a survey of our recent work on complex dynamics of host-parasite models in spatial heterogeneous environment. More interesting findings are that spatial heterogeneity tends to enhance the persistence of the infected hosts with uninfected ones. As a consequence, our work suggests that, in order to control the invasion of the parasite, different preventive measures can be implemented in different regions. This is a joint work with Dr. Yongli Cai.

Well-posedness on a Generalized Poisson-Nernst-Planck-Navier-Stokes Equations

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Abstract: We use an energetic variational approach to derive a new hydrodynamic model, which could be called a generalized Poisson-Nernst-Planck-Navier-Stokes system. Such the system could describe the dynamics of the compressible conductive fluid with the dilute charged particles and be used to analyze the interactions between the macroscopic fluid motion and the microscopic charge transportation. Then, we develop a general method to obtain the unique local classical solution, the unique global solution under small perturbations and the optimal decay rates of the solution and its derivatives of any order.

Existence and Stability of Some Steady States for the SKT Competition Model with Cross-diffusion

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Abstract: This talk will be focused on the existence and stability of some nontrivial steady states for the SKT competition model when one of the cross-diffusion parameters is large enough, and the two types of limiting systems will be more focused on. In this talk I will first give a brief review of some pioneering works on the investigation of some limiting systems of the SKT model, and then talk about our recent works on the detailed structure and stability/instability of some types of steady states as well as the asymptotic behavior of the solution with more general initial data. The talk is based on some joint work with Qian Xu and Qing Li.

Chemotaxis effect vs logistic damping in the minimal Keller-Segel model

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Abstract: We study chemotaxis effect (χ) vs logistic damping (μ) on boundedness (and large time behavior) for the minimal Keller-Segel model with logistic source in 2- and 3-D smooth and bounded domains. We obtain qualitative boundedness on χ and μ: up to a scaling constant depending only on initial data and the underlying domain, we provide explicit upper bounds for the solution components of the corresponding initial-boundary value problem. These bounds are increasing in χ and decreasing in μ.

In 2-D, the corresponding upper bounds have only one singularity in μ at $\mu = 0$. In contrast, in 3-D, the upper bounds, holding under a critical explicit relation between χ and μ (which has been shown to guarantee boundedness), are defined for all χ and $\mu > \text{const.}\chi$, and, have two singularities in μ at $\mu = 0$ and $\mu = \text{const.}\chi$. It is worthwhile to mention that, in the absence of logistic source, the corresponding classical KS model is well-known to possess blow-ups for even small initial data. We hope that these qualitative findings presented here would produce some new principles on finite-time blow-up to chemotaxis systems with weak logistic damping sources.

Global solutions to the chemotaxis-Navier-Stokes system

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Abstract: In this talk, I will first review some recent results on the global well-posedness of the chemotaxis-fluids system. Then I will present our recent work on the 2D Keller-Segel-Navier-Stokes system. Our main results assert that parallel to the case of the

corresponding Keller-Segel system obtained on neglecting the fluids, any arbitrarily small algebraic saturation effect in the chemotactic sensitivity at large densities is sufficient to rule out any blow-up phenomenon. Our analysis is based on the consecutive identification of three energy-like functionals, the first among which involves a certain sublinear Lp seminorm of the cell density. This is a joint work with Professor Yulan Wang and Professor Michael Winkler.

Dynamics of Competition-Diffusion-Advection System with Heterogeneous vs Homogeneous Resources

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Abstract: In this talk we shall present some recent results on the dynamics of a Competition-Diffusion-Advection model for two competing species which disperse by both random diffusion and advection along environmental gradient. In this model, the species are assumed to be identical except spatial resource distribution: heterogeneity vs homogeneity. It is shown that that the species with heterogeneous resources distribution is always in a better position, that is, it can always invade when rare. The ratio of advection strength and diffusion rate of the species with heterogeneous distribution plays a crucial role in the dynamics behavior of the system. Some conditions of invasion, driving extinction, and coexistence are given in term of this ratio and the diffusion rate of its competitor. Some open problems will be presented.

On the uniqueness of L_p-Minkowski problems

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Abstract: In this talk we will introduce the L_p-Minkowski problem and focus on the uniqueness results. We will show that in dimension two, either when $p \in [-1, 0]$ or when $p \in (0, 1)$ in addition to a pinching condition, the solution must be the unit ball. This partially answers a conjecture of Lutwak, Yang and Zhang about the uniqueness of the L_p-Minkowski problem in dimension two. This is a joint work with Yong Huang and JiaKun Liu.

Existence of Positive Solutions for a Class of Nonlinear Algebraic Systems

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Abstract: In this talk, I will introduce four things: 1. What do we discuss this system? 2. The positive solutions are important. 3. Our main idea. 4. The main results.

Basic Semiconductor Physics and the Semiconductor SHE Model

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Abstract: In this talk we first briefly introduce some basic semiconductor physics and then the semiconductor SHE model is obtained from the semiconductor supperlattices framework. The related results of mathematical analysis on the SHE model are also presented. The open problem related to the SHE model will be discussed.

Zero Extension Problems for Poisson Equation and Heat Equation

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Abstract: In this talk I will introduce the zero extension problems for Poisson equation and heat equation, and correct some misunderstanding in these problems. First, I will a present necessary and sufficient condition to guarantee that the extended function of a solution for Poisson equation in a smaller domain by zero extension is still the solution of the corresponding extension problem in a larger domain. Second, I also present a necessary and sufficient condition to guarantee that the extended function of a solution for the heat equation in a smaller cylinder by zero extension is still the solution of the corresponding extension problem in a larger cylinder. We will study the zero extension problems under the frameworks of classical solutions, strong solutions and weak solutions. The first part of talk is a joint work with Prof. Yongyong Cai in Beijing Computational Science Research Center. The second part is a joint work with Dr. Qiang Xu in Peking University.