

HY-PDE workshop 2022

July 18th (Monday)

- 10:00 - 11:00 이동현 교수 (POSTECH)

Title: Hölder regularity of the Boltzmann equation past an obstacle

Abstract: Abstract Regularity and singularity of the solutions according to the shape of domains is a challenging research theme in the Boltzmann theory. In this paper, we prove an optimal Hölder 1/2- regularity for the Boltzmann equation of the hard-sphere molecule, which undergoes the elastic reflection in the intermolecular collision and the contact with the boundary of a convex obstacle. In particular, this Hölder regularity result is a stark contrast to the case of other physical boundary conditions (such as the diffuse reflection boundary condition and in-flow boundary condition), for which the solutions of the Boltzmann equation develop discontinuity and therefore the best possible regularity is BV.

- 11:00 - 12:00 김도현 교수 (한양대)

Title: A unified framework for distributed optimization algorithms over time-varying directed graphs

Abstract: In this talk, we propose a framework under which several decentralized optimization algorithms can be treated in a unified manner. More precisely, we show that the distributed subgradient descent algorithms, the subgradient-push algorithm, and the distributed algorithm with row-stochastic matrix can be derived by making suitable choices of consensus matrices, step-size and subgradient from a decentralized subgradient descent algorithm. As a result of such unified understanding, we provide a convergence proof that covers several algorithms under a novel algebraic condition that is strictly weaker than the conventional graph-theoretic condition. This unification also enables us to derive a new distributed optimization scheme.

- 13:30 - 14:30 옥지훈 교수 (서강대)

Title: $C^{1,\alpha}$ -regularity for general non autonomous, nonlinear equations

Abstract: We discuss on $C^{1,\alpha}$ -regularity theory for the following elliptic equations in divergence form

$$\operatorname{div} A(x, Du) = 0,$$

where the nonlinearity A satisfies a (p, q) -growth condition. In particular, we introduce a new ellipticity condition, so-called a quasi-isotropic ellipticity condition, and a continuity condition

to obtain $C^{1,\alpha}$ -continuity of weak solutions to the above equations.

- 14:30 - 15:30 김도현 교수 (성신여대)

Title: Fokker-Planck-type aggregation equations on the sphere and the unitary group

Abstract: In this talk, we introduce Fokker-Planck-type aggregation equations on the sphere and the unitary group. For both equations, we show that they admit global unique solutions and that incoherent states are stable when the diffusion effect is relatively small.

- 15:40 - 16:40 김정호 박사 (KIAS)

Title: Rigorous derivation of the Euler-alignment model with singular communication weights from a kinetic Fokker-Planck-alignment model

Abstract: We present a rigorous derivation of the isothermal Euler-alignment model with singular communication weights. We consider a hydrodynamic limit of a kinetic Fokker-Planck-alignment model, which is the nonlinear Fokker-Planck equation with the Cucker-Smale alignment force. Our analysis is based on the estimate of relative entropy between macroscopic quantities, together with careful analysis on the singular communication weights.

- 16:40 - 17:40 김성학 교수 (경북대)

Title: Polyconvex elastodynamics and a threshold conjecture

Abstract: We study the rigidity and flexibility results of polyconvex elastodynamics in space dimension 2 or 3. The rigidity part is on the measure valued-strong uniqueness result that was established in 2012 by Demoulini et al. The flexibility part deals with a working paper on the nonuniqueness of Lipschitz weak solutions. We then introduce a conjecture on the regularity threshold where the two parts can meet.

July 19th (Tuesday)

- 10:00 - 11:00 문병수 교수 (인천대)

Title: Stability of Periodic Peakons for a Nonlinear Quartic μ -Camassa–Holm Equation

Abstract: In this talk, we prove the orbital stability of periodic peaked traveling waves (peakons) for a nonlinear quartic μ -Camassa–Holm equation. The equation is a μ -version of the nonlinear quartic Camassa–Holm equation which was proposed by Anco and Recio (J Phys A Math Theor 52: 125–203, 2019). The equation admits the periodic peakons. It is shown that the periodic peakons are orbitally stable under small perturbations in the energy space by finding inequalities related to the three conservation laws with global maximum and minimum of the solution.

- 11:00 - 12:00 이태훈 박사 (KIAS)

Title: Mean curvature flow of graphs and its application to obstacle problems

Abstract: We study the evolution of complete noncompact graphs by mean curvature. The domains of definition for the graphs then evolve in time, and it turns out that this motion also follows the mean curvature flow in one less dimensional space. In this talk, we develop height independent curvature estimates which allows us to transfer information from graphs to its domains. We apply this estimates to obstacle problems for the mean curvature flow and establish the optimal regularity of solutions. This is a joint work with Hyunsuk Kang and Ki-Ahm Lee.

- 13:30 - 14:30 윤석배 교수 (성균관대)

Title: Relativistic BGK model for multi-component particle system

Abstract: The fundamental equation governing the statistical distribution of relativistic rarefied particle systems is the relativistic Boltzmann equation. As in the case of the classical Boltzmann equation, BGK-type relaxational models are introduced for numerical simulation at a cheaper cost. Unlike the classical case, however, there are two different interpretations of the macroscopic variables - Eckart and Landau FRAMES and at least three different types of BGK models are suggested. Marle type, Anderson-Witting model and Ruggeri Pennisi model. As far as we know, no extension has been made for this model to multi-component particle systems in the literature. In this talk, we propose a multi-component extension of the Marle model. We show that the equilibrium coefficient of our model is well defined, and the Newtonian limit leads to a well-known classical mixture BGK model. This is joint work with Byung-Hoon Hwang and Myung-Su Lee.

- 14:30 - 15:30 장진우 교수 (POSTECH)

Title: Magnetic confinement for the 2D axisymmetric relativistic Vlasov-Maxwell system in an annulus

Abstract: This talk deals with the mathematical analysis of the magnetic confinement of the plasma via kinetic equations. We prove the global wellposedness of the Vlasov-Maxwell system in a two-dimensional annulus when a huge (but finite-in-time) external magnetic potential is imposed near the boundary. We assume that the solution is axisymmetric. The external magnetic potential well that we impose remains finite within a finite time interval and from that, we prove that the plasma never touches the boundary. In addition, we provide a sufficient condition on the magnitude of the external magnetic potential to guarantee that the plasma is confined in an annulus of the desired thickness which is slightly larger than the initial support. Our method uses the cylindrical coordinate forms of the Vlasov-Maxwell system. This is joint work with Robert M. Strain and Tak Kwong Wong.

- 15:40 - 16:40 배한택 교수 (UNIST)

Title: Well-posedness of the two and half dimensional Hall MHD

Abstract: Recently, the Hall MHD has been studied intensively over the past 10 years. But, not much attention was paid to its two and half dimensional version. In this talk, we first formulate the two and half dimensional Hall MHD by the approach used to explain the magnetic reconnection phenomena. We then provide several results, mostly to the two and half dimensional Hall equation (without the effect of fluid). If time allows, we introduce an extended model of the Hall MHD. This is based on a joint work with Kyungkeun Kang (Yonsei University) and Jaeyong Shin (UNIST).

- 16:40 - 17:40 최범준 교수 (POSTECH)

Title: Ricci limit flows and weak solutions

Abstract: In this talk, we first introduce different notions of weak solutions to Ricci flows which are defined through singularities. Our recent result shows every noncollapsed limit of Ricci flows, as provided by Bamler's precompactness theorem, as well as every singular Ricci flow from Kleiner-Lott, is a weak solution in the sense of Haslhofer-Naber. The key step to establish these results is a new hitting estimate for Brownian motion.

July 20th (Wednesday)

- 10:00 - 11:00 고통남 교수 (가톨릭대)

Title: On the stochastic synchronization of the Winfree model with a multiplicative noise

Abstract: The long-time behaviors of stochastic oscillators mainly follows the Fokker-Planck equations, however, the detailed particle dynamics could show a kind of non-intuitive behaviors. Our focus is mainly on the stochastic Winfree oscillators under the multiplicative white noise. The additive white noise affects the dynamics as with the heat kernel, which makes the system spread its phases into the whole domain, where the ensemble cannot gather into equilibrium points. On the other hand, with the multiplicative noise, the individuals march toward regions with small noise strength, as in the geometric Brownian motion. In this talk, we establish the emergence of synchronization for the identical stochastic Winfree model. Here the main ingredient is the stochastic Barbalat's lemma, which shows the convergence of the potential or other energy functions. This analysis can be directly applied to the general gradient system with multiplicative noise. This work is a joint research with Prof. Seung-Yeal Ha from SNU and Dr. Woojoo Shim from KIAS.

- 11:00 - 12:00 김유찬 교수 (서울시립대)

Title: Recent results in regularity theory of composite materials

Abstract: In this talk, we will discuss about the recent results in regularity theory of composite materials. The geometry of a composite material which is composed of $C^{1,\gamma}$ -domains can be represented by a coordinate system called by Li-Nirenberg-Vogelius geometry. In that coordinate system, regularity results of linear elliptic systems will be obtained.

- 13:30 - 14:30 최영필 교수 (연세대)

Title: On the derivation of Euler-alignment equations with singular communication weights

Abstract: In this talk, we discuss a rigorous derivation of Euler-alignment equations with singular communication weights. We consider hydrodynamic limits of a kinetic Fokker-Planck-alignment model or a BGK-alignment model. Our analysis is based on the estimate of relative entropy between macroscopic quantities, together with careful analysis on the singular communication weights.

- 14:30 - 15:30 서이혁 교수 (성균관대)

Title: Sharp weighted Strichartz estimates and critical inhomogeneous NLS

Abstract: In this talk I will introduce weighted Strichartz estimates for the Schrodinger flow and discuss the sharpness thereof. Then I will explain how useful these estimates can be in the study of inhomogeneous NLS in the critical case. The well-posedness theory for this model has been intensively studied in recent years, but much less is understood compared to the classical NLS model. In particular, the critical case was unsolved until recently.

- 15:40 - 16:40 최경수 교수 (KIAS)

Title: 하나 부등식을 통한 양의 고대 해의 분류

Abstract: 평균 곡률 흐름은 열방정식을 만족하는 곡면의 움직임이다. 이 흐름의 특이점에서의 위상 변화를 제어하기 위해, 초기 곡면의 위상을 변화시키지 않고 바꾸어, 불안정한 특이점을 회피하여야 한다. 이를 위한 가장 널리 알려진 방식으로 초기 조건을 한 쪽 방향으로 밀어내면, 포물형 방정식의 최대값 이론으로 인하여, 교란된 흐름은 기존의 흐름과 교차하지 않는다. 이를 이용하여, 기존의 특이점에서 두 흐름을 확대하면, 기존 흐름은 자가동형흐름으로 수렴하고, 교란된 흐름은 그 자가동형흐름과 교차하지 않는다. 따라서 교란된 흐름을 자가동형해위에서 정의되는 양의 함수의 그래프로 이해할 수 있고, 하나 부등식을 적용할 수 있다. 이를 통하여 교란된 흐름의 지수 함수의 수렴성을 보일 수 있다.

- 16:40 - 17:40 최우철 교수 (성균관대)

Title: A review on the interior point method for optimal control of PDEs

Abstract: Interior point method is one most popular approach for continuous optimization problems involving inequality constraints. In this talk, I will review the algorithm and mathematical results of the interior point method applied to optimal control problems of PDEs.