<Abstract> KAIST CMC PDE/역문제 워크샵

Name	강현배
Title	Spectral theory of the Neumann Poincare operator and analysis of plasmonic resonance
Abstract	The Neumann Poincare (NP) operator is a boundary integral operator which appears naturally when solving classical Neumann boundary value problems using layer potentials. The theory of the NP operator is a classical subject as the name suggests. Recently there is a rapidly growing interest in the spectral properties of the NP operator in relation to the plasmonic structure. I will discuss about recent development on the spectral theory of the NP operator and plasmonic resonance.

Name	권오상
Title	The effects of starvation driven diffusion on the dynamics of populations
Abstract	The dispersal strategies of biological organisms are key ingredients in their ecological evolution. It is well-accepted that spatial and temporal heterogeneities of environments occur in all scales and such heterogeneities play a key role in the evolutional selection of dispersal rates. Recently, starvation driven diffusion has been introduced by Cho and Kim (Bull. Math. Biol.,75 (2013) 845-870), which is a random dispersal strategy with a motility increase on starvation. In this talk, we will discuss properties of the single species model and 2× 2 competition model with starvation driven diffusion, including the global asymptotic stability and the acquisition of the ideal free distribution. We show that such a dispersal strategy has fitness property and that the evolutional selection favors fitness but not simply slowness. This is the joint work with Y.-J. Kim and F. Li.

Name	**김성환**
Title	A Calder\'on problem with frequency-differential data in dispersive media
Abstract	We consider the problem of identifying a complex valued coefficient $\gamma(x,\omega)$ in the conductivity equation $\nabla\cdot\gamma(\cdot,\omega)\nabla u(\cdot\omega)=0$ from knowledge of the frequency differentials of the Dirichlet-to-Neumann map $\frac{d^k}{d\omega^k}\Lambda_{\gamma(\cdot,\omega)}\Big|_{\omega=\omega_0}$. In three dimensions and higher, for a frequency analytic $\gamma=\sum_{j=0}^{\infty}(\sigma_j+i\epsilon_j)\omega^j$ we show that $\frac{d^k}{d\omega^k}\Lambda_{\gamma(\cdot,\omega)}\Big|_{\omega=0}$ uniquely determines a specific relation between σ_0 and σ_k, and another between σ_0 and ϵ_k. In particular $\left|.\frac{d^j}{d\omega^j}\Lambda_{\gamma(\cdot,\omega)}\right|_{\omega=0}$ for $j=1,...,k$ recovers $\sigma_0,\cdot,\sigma_k$ and $\epsilon_1,\cdots,\epsilon_k$. This problem arises in frequency differential electrical impedance tomography of dispersive media.

Name	**박원광**
Title	A study on the topological derivative-based imaging of thin electromagnetic inhomogeneities in limited-aperture problem
Abstract	The topological derivative-based non-iterative imaging algorithm has demonstrated its applicability in limited-aperture inverse scattering problems. However, this has been confirmed through many experimental simulation results, and the reason behind this applicability has not been satisfactorily explained. In this paper, we identify the mathematical structure and certain properties of topological derivatives for the imaging of two-dimensional crack-like thin penetrable electromagnetic inhomogeneities that are completely embedded in a homogeneous material. To this end, we establish a relationship with an infinite series of Bessel functions of integer order of the first kind. Based on the derived structure, we discover a necessary condition for applying topological derivatives in limited-aperture inverse scattering problems, and thus confirm why topological derivatives can be applied. Furthermore, we analyze the structure of multifrequency topological derivative, and identify why this improves the single-frequency topological derivative in limited-aperture inverse scattering problems. Various numerical simulations are conducted with noisy data, and the results support the derived structure and exhibit certain properties of single- and multi-frequency topological derivatives. This is a joint work with Chi Young Ahn, Kiwan Jeon, and Yong-Ki Ma.

Name	윤석배
Title	Ellipsoidal BGK model near a global Maxwellian
Abstract	The BGK model has been widely used in place of the Boltzmann equation because of the qualitatively satisfactory results it provides at relatively low computational cost. But there is a major drawback to the BGK model: The hydrodynamic limit at the Navier-Stokes level is not correct. One evidence is that the Prandtl number computed using the BGK model does not agree with what is derived from the Boltzmann equation. To overcome this problem, Holway introduced the ellipsoidal BGK model where the local Maxwellian is replaced by a non-isotropic Gaussian. In this talk, we consider the existence of classical solutions of the ES-BGK model when the initial data is a small perturbation of the global Maxwellian. The key observation is that, even though the linearized relaxation operator for the ES-BGK model takes the more complicated form, the degeneracy is comparable to the original BGK model or the Boltzmann equation.

Name	이옥균
Title	Solving nonlinear inverse problem with joint sparsity
Abstract	Inverse problems of many imaging applications are nonlinear since the objective of recovery is coupled with the unknown internal data. Conventionally, linear approximation or iterative approaches are widely used to resolve the non-linearity, however, they suffer from the approximation error or computational burden, respectively. Recently, a clue for solving nonlinear inverse problem is provided by a joint sparsity which comes from the compressed sensing theory. Using the joint sparsity, the nonlinear inverse problem can be changed to the joint sparse recovery problem and neither approximation nor iterative procedure is required during the reconstruction process. We will show how it works for specific imaging techniques such as diffuse optical tomography and electrical impedance tomography, and compare the simulation results with conventional approaches.

Name	전기완
Title	Vortex Flow Reconstruction using Ultrasound
Abstract	Vortex flow imaging has recently been proposed as a new medical imaging modality for cardiac functional assessment. It is based on the velocity computation of intra-ventricular blood flow fields. In this project, we propose a new method to restore the blood flow velocity fields inside left ventricle (LV) using Doppler echocardiography. For the successful reconstruction of the velocity fields, there are several challenging issues mathematically. In this talk, we talk about what we did and discuss about our next issues in the project.

Name	정소연
Title	Pointwise nonlinear stability of periodic traveling reaction-diffusion waves
Abstract	We discuss, under standard spectral stability assumptions, pointwise nonlinear stability and asymptotic behavior of perturbations with detailed rates of decay of spatially periodic traveling waves $u(x, t) = \bar{u}(x - at)$ of systems of reaction-diffusion equations. We first estimate pointwise bounds on the Green function of the linearized operator about $\bar{u}$ by working with the periodic resolvent kernel and Bloch decomposition. With our linearized estimates together with a nonlinear iteration scheme developed by Johnson-Zumbrun, we show the perturbations of periodic traveling reaction-diffusion waves converge to the heat kernel under small initial perturbations with the Gaussian decay and the algebraic decay, respectively. Here, we emphasize again that it is the pointwise description that is the main new aspect of our research.

Name	정재우
Title	On the Fokker-Planck equation in multi-dimensional bounded domains
Abstract	In this talk, we study the kinetic Fokker-Planck equation in general multi-dimensional bounded domains with absorbing boundary condition. In particular, there has been not many results on the regularity of solutions when the spatial domain has a boundary. We will discuss the global well-posedness, regularity and decay estimate for the Fokker-Planck case and compare it with some other kinetic equations, e.g. Vlasov-Poisson system.

Name	**정재환**
Title	Biological Advection induced from Starvation Driven Diffusion
Abstract	Dispersal of organisms has been studied extensively because it plays an important role for their survival. Among other things, we starts with a dispersal strategy called the starvation driven diffusion (SDD), which was suggested by E. Cho and Y.-J. Kim. In it, if there are too many organisms for the amount of resource, the organisms move faster. By simplifying the SDD, we obtain a diffusion-advection equation. One of the most interesting property of the equation is that when the diffusivity and the strength of advection are the same, the steady state matches the resource distribution exactly. If they are not the same, some parameters are relevant to the SDD (SDD case) but some are not (non-SDD case). We may expect that the SDD case has advantages over the non-SDD case because it is based on a resonable dispersal strategy. In this talk, we survey some known properties of the advection and discuss some advantages of the SDD case over the non-SDD case.

Name	**최선호**
Title	A lower dimensional inertial manifold for the Lohe system with uniform time delay
Abstract	We study the asymptotic behavior of an ensemble of identical Lohe oscillators on the unit sphere $\bbs^d$ in the presence of small time delay interaction effects. When there is no time delay, the ensemble of identical Lohe oscillators collapses asymptotically to a one-cluster ensemble on the sphere; its asymptotic dynamics are governed by linear motion on the unit sphere with a constant natural velocity. We show that the presence of a small time delay can induce rich dynamical features such as asymptotic changes in the velocity and asymptotic low-dimensional dynamics in high-dimensional cases. For $d = 1$, the Lohe dynamics is equivalent to the Kuramoto dynamics via polar coordinates. In this case, the modified asymptotic frequency is uniquely determined by an implicit relation based on the natural frequency, coupling strength, and time delay. For $d= 3$, we show that the dynamics of identical Lohe oscillators converges to the Kuramoto dynamics for properly chosen initial configurations.

Name	**하승렬**
Title	Some mathematical problems related to synchronization
Abstract	In this talk, I will review recent progress on mathematical problems such as the emergence of complete synchronization, stability and instability of incoherent states for the Winfree, Kuramoto and Lohe models.

Name	**황형주**
Title	Mathematical Analysis of Electrified Thin films
Abstract	We consider a viscous thin film surrounded by the outer fluid above and a flat horizontal insulator-coated electrode surface below. Our assumption is that the film is completely wetting and conducting. We discuss the global existence of unique solutions perturbed around positive constant solutions whenever applied voltage is sufficiently small after a finite time, and the asymptotic behavior of the solutions. Conversely, when applied voltage is sufficiently large, we show that the solutions around the constant positive solutions are unstable. Moreover, we find the existence of infinitely many bifurcation branches of solutions around positive constant solutions at certain applied voltage and show the stability of nonconstant steady-state solutions.