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<논 문 초 록>

- 특별 초청 강연 -

[LEC - 1] 채동호(중앙대) : 유체역학에서의 수학문제들

Dongho Chae (Chung-Ang University)

Mathematical problems in the Fluid Mechanics

In this lecture we discuss some mathematical problems in the fluid mechanics.

Many of the physical systems are described partial differential equations, and the mathematical study of these equations could have important and direct physical significances.

In general, in the cases when the equations are nonlinear and nonlocal systems the study of solutions to the equations are much more difficult than the other cases. The fluid equations we are interested in corresponds to these cases. Among others we are particularly interested in the problem of singularities in the incompressible Navier-Stokes and the Euler equations. We emphasize that singularities in the solution of partial differential equations has direct physical importance in many cases. One fashionable example is the singularity of the Einstein field equation, which is nothing but the black hole. The other one is the singularities in the compressible Euler equations, which correspond to the shock waves. The singularities in the Navier-Stokes and the Euler equations are less understood than the two above cases.

In the first part of this lecture we introduce, in general terms, the problem of singularities in the fluids. In the second part we focus on some of the recent studies on the problem, related to the scenario of Type I singularities. Another problem we could also discuss is the Liouville type problem in the fluids, which can also be understood as the uniqueness problem in the

stationary equation.

[LEC - 2] 김현민(NIMS) : 국가수리과학연구소 소개와 미래 비전

Kim, Hyun-Min (National Institute for Mathematical Sciences)
Introduction and Future Vision of the National Institute for Mathematical Sciences

국가수리과학연구소의 기관 개요와 연구소의 역점 사업인 산업수학 그리고 연구소에서 진행되고 있는 주요 사업을 소개한다. 또한 국가수리과학연구소의 중점 연구 내용을 공유하고 연구소의 미래 비전도 함께 논의한다.

- 학술상 수상 기념 강연 -

[LEC - 3] 김대열(전북대) : Iterated arithmetic functions

Kim, Daeyeoul (Jeonbuk National University)
Iterated arithmetic functions

We define amicable pairs and iterated stable numbers obtained by iteration of a restricted divisor function.
The purpose of this study is to explain the relationship between Mersenne primes, extended Mersenne primes, and multi-perfect numbers.

[LEC - 4] 홍성금*(조선대), 허야용(고려대), 양찬우(고려대) : 고차원상의 일차 칼드론 교환자에 대한 대각선 밖에서의 계측

Sunggeum Hong* (Chosun University)
Yaryong Heo (Korea University)
Chan Woo Yang (Korea University)
Off-diagonal estimates for the first order commutators in higher dimensions

In this paper we study natural generalizations of the first order Calderón commutator in higher dimensions $d \geq 2$. We study the bilinear operator T_m which is given by

$$T_m(f,g)(x) = \int\int_{\mathbb{R}^{2d}} \left[\int_0^1 m(\xi + t\eta)\, dt \right] \hat{f}(\xi)\hat{g}(\eta) e^{2\pi i x \cdot (\xi+\eta)} d\xi d\eta \ .$$

Our results are obtained under two different conditions of the multiplier m. The first result is that when $K \in S' \cap L^1_{loc}(\mathbb{R}^d \setminus \{0\})$ is a regular Calderón-Zygumund convolution kernel of regularity $0 < \delta \leq 1$, the operator $T_{\hat{K}}$ maps $L^p(\mathbb{R}^d) \times L^q(\mathbb{R}^d)$ into $L^r(\mathbb{R}^d)$ for all $1 < p, q \leq \infty$, $1/p + 1/q = 1/r$ as long as $r > \frac{d}{d+1}$. The second result is that when the multiplier $m \in C^{d+1}(\mathbb{R}^d \setminus \{0\})$ satisfies the Hörmander derivative conditions $\left| \partial_\xi^\alpha m(\xi) \right| \leq D_\alpha |\xi|^{-|\alpha|}$ for all $\xi \neq 0$, and for all multi-indices α with $|\alpha| \leq d+1$, T_m maps $L^p(\mathbb{R}^d) \times L^q(\mathbb{R}^d)$ into $L^r(\mathbb{R}^d)$ for all $1 < p, q \leq \infty$, $1/p + 1/q = 1/r$ as long as $r > \frac{d}{d+1}$. These two results are sharp except for the endpoint case $r = \frac{d}{d+1}$. In case $d = 1$ and $K(x) = 1/x$, it is well-known that $T_{\hat{K}}$ maps $L^p(\mathbb{R}^d) \times L^q(\mathbb{R}^d)$ into $L^r(\mathbb{R}^d)$ for all $1 < p, q \leq \infty$, $1/p + 1/q = 1/r$ as long as $r > \frac{1}{2}$. In higher dimensional case $d \geq 2$, in 2016, when $\hat{K}(\xi) = \xi_j / |\xi|^{d+1}$ is the Riesz multiplier on $\mathbb{R}^d$, P. W. Fong, in his Ph.D. Thesis [1], obtained

$$\| T_{\hat{K}}(f,g) \|_r \leq C \| f \|_p \| g \|_q$$

for $1 < p, q \leq \infty$ as long as $r > \frac{d}{d+1}$. As far as we know, except for this special case, there has been no general results for the off-diagonal case $r < 1$ in higher dimensions $d \geq 2$. To establish our results we develop ideas of C. Muscalu and W. Schlag [2,3] with new methods.

<참고문헌>

[1] P. W. Fong, Smoothness properties of symbols, calderon commutators and generalizations, Ph.D. Thesis, Cornell University (2016).

[2] C. Muscalu, W. Schlag, Classical and multilinear harmonic analysis. Vol. I, Vol. 137 of Cambridge Studies in Advanced Mathematics, Cambridge University Press, Cambridge, 2013.

[3] _____, Classical and multilinear harmonic analysis. Vol. II, Vol. 138 of Cambridge Studies in Advanced Mathematics, Cambridge University Press, Cambridge, 2013.

응용수학(Applied Mathematics) 분야

[APP - 1] 문현서*(전남대), 진홍성(전남대), 위윤주(전남대), 오규진(전남대) : 코로나 19 방역에 따른 로지스틱 방정식의 최대 수용 환자수 분석

Hyeonseo Mun(Chonnam National University)
Hong Sung Jin(Chonnam National University)
Yunju Wi(Chonnam National University)
Gyujin Oh(Chonnam National University)
Intervention dependent Carrying Capacity of Covid-19

We analyzed the outbreak patterns of Covid-19 using a logistic equation when carrying capacity varies on a weekly basis. The carrying capacity of the present week is determined by the number of infected cases and the transmission conditions of the last week. The conditions include viral nature and interventions. Present interventions determine the number of cases for the following week.

To prevent mass outbreaks we need more solid interventions for at least two weeks when the carrying capacity coefficient increases very fast. The carrying capacity coefficients(ccc) can be used as an appropriate indicator of the effectiveness of interventions. If the interventions are not adequate or new mutations are coming the ccc increases very fast following new infected cases are increasing steeply. The ccc can be controlled with appropriate interventions. When the vaccine is unavailable and the ccc value rises, we need to implement more stringent interventions, such as legally mandating wearing a mask or providing a high level of social distancing for at least a few weeks.

Key words :: Covid-19, logistic equation, interventions, carrying capacity coefficients,

[APP - 2] Zhao Pan*(전남대), 신병춘(전남대) : 오목한 지점을 기반으로 HSV 색 공간을 사용하여 실제 사진에서 민들레 꽃을 감지 및 카운팅

Pan, Zhao* (Chonnam National University)
Byeong-Chun, Shin (Chonnam National University)

Dandelion flowers detection and counting in natural scene using HSV color space based on concave points.

Abstract

The number of dandelion flowers taken at the same time interval by a digital camera that is installed in a specific place is a major factor to quantify disturbances factors in the domestic ecosystem and to predict biological seasonal changes in the long-term monitoring study. However, it will take a lot of manual labour and time to check the number of flowers with the naked eye and most likely, human errors may exist. Using digital image processing technology to accurately detect and count dandelion flowers in natural scene, an automatic flower-counting algorithm is proposed in this paper to obtain dandelion growth information. The algorithm for detection and counting uses these following steps: (1) Color space of dandelion flower image is converted from RGB (red green blue) to HSV (hue saturation brightness/luminance) for the sake of improving the uniformity of image color. (2) Hue component of dandelion flower image is extracted from the HSV color space. (3) The binary image of the hue component image is obtained by using image binary algorithm, morphological opening operation and removing of small regions algorithm. (4) The edge of binary image is smoothed by using nonlinear median filtering algorithm and then boundary profiles are extracted. (5) Concave points on these boundary profiles are obtained by using an improved Curvature Scale Space (CSS) algorithm. Then adhesive dandelion flowers are detected by connecting concave points. (6) Adhesive and non-adhesive dandelion flowers are marked respectively by image labeling algorithm. Then the total number of dandelion flowers in image is obtained by summing the number of adhesive and non-adhesive dandelion flowers. In the last, the results demonstrate high success rate between the algorithm counts and the manual (image-based) dandelion flower counts, and precision, with a low standard deviation, which can provide a reliable reference for the disturbances factors estimation and

the biological seasonal changes prediction in the long-term domestic ecosystem monitoring study.

Keywords: Digital image processing, Dandelion flower detection and counting, HSV color space, Binary image, Target edge smoothing and extraction, Concave points detection, Improved CSS algorithm

[APP - 3] 오규진*(전남대), 강희진(전남대), 천승주(전남대), 위윤주(전남대), 진홍성(전남대) : 셀룰러 오토마타 규칙 분류 및 기계학습을 이용한 외래 생물 확산 예측

Gyujin Oh* (Chonnam National University)
Hee-Jin Kang (Chonnam National University)
Seung-ju Cheon (Chonnam National University)
Yunju Wi (Chonnam National University)
Hong Sung Jin (Chonnam National University)

Analysis of the invasive species spread using cellular automata classification and machine learning

외래침입종이 한국에 들어와 정착후 확산하는 양상을 분석하였다. 분석 도구로는 1차원 셀룰라 오토마타의 규칙성을 활용하였다. 먼저 규칙을 일정세대가 지난 후 세대별로 같은 분포를 가지는 것끼리 분류하였다. 먼저 짝수 규칙에 대하여 짝수세대와 홀수세대별로 분류를 하였고, 또한 모든 세대에서 같은 결과를 가지는 37가지 그룹으로 분류 하였다.

분류된 규칙을 두가지 방법으로 훈련 데이터를 만들어 기계학습을 시켰다. 첫 번째 방법으로는 분류된 37가지 규칙에 대하여 초깃값 100, 200, 300의 값을 가지는 20x20행렬을 만들고, 한 세대 후의 행렬을 만들어 규칙을 분류하는 머신러닝 모델(CNN)을 만들었다. 추가적으로 모든 규칙에 대하여 분류하는 모델과 3개의 스텝을 가지는 모델을 만들었다. 두 번째 방법으로는 5개의 초기값을 주고 200세대 후의 분포를 20x20행렬로 만들어 37가지 규칙을 분류하는 모델을 만들었다. 그리고 외래 생물의 예시로 황소개구리 분포를 가지고 각 방법에 대하여 규칙을 학습하고 확산을 예측해 보았다.

This work was supported by Korea Environment Industry & Technology Institute(KEITI) through the Project for the Development of Biological Diversity Threats Outbreak

Management Technology (2018002270004), funded by Korea Ministry of Environment(MOE).

[APP - 4] 위윤주*(전남대), 진홍성(전남대), 문현서(전남대), 오규진(전남대) : 코로나19의 시간에 따른 전염률 변화 분석

Yunju Wi* (Chonnam National University)
Hong Sung Jin (Chonnam National University)
Hyeonseo Mun (Chonnam National University)
Gyujin Oh (Chonnam National University)
Analysis of transmission rate of Covid19.

SEIR 모델을 이용하여 시간에 따른 코로나19의 전염률 변화를 분석하였다.
전염률을 분석할 때는 보통 미분 방정식(SEIR)을 풀어서 계수를 추정하는 방법을 사용한다. 본 연구에서는 확진자 데이터만을 이용하여 전염률을 추정하였다. 데이터는 일별 데이터를 가우시안 프로세스 회귀 과정을 거쳐 사용하였다.
SEIR에서의 R 개체를 removed cases로 보고 양성판정을 받은 모든 사람을 이 개체에 포함 시켰다. 계수 gamma는 전체 환자(실제 환자=양성+잠재(미검사))중에서 양성으로 확진돤 환자의 비를 나타내며 gamma는 상수로 가정하고 몇 가지 경우로 나누어 시뮬레이션하였다. 전염률 곡선은 잠복기에 따라 변하는데 잠복기에 관계없이 지나는 점을 찾았고 그 점을 CP(Cross Point)라고 정한 후 유효 재생지수(R_t)가 1이 되는 지점과의 관계를 분석하였다.

keyword : SEIR, 가우시안 프로세스 회귀, 코로나19, CP, R_t

[APP - 5] 임현철(전남대) : 주가지수시장의 내재 위험 중립 확률 분포를 생성하는 개선된 방법

Hyuncheul Lim (Chonnam National University)
Improved Methods for Implied Volatility Surface and Distributions.

논문은 주가지수시장의 희박한 변동성 조건하에서 내재 변동성 곡

면을 생성하고 내재된 위험 중립 확률 분포를 구하는 실용적이면서 정밀한 방법을 제시한다.

박판 스플라인 (TPS)함수를 이용 하여 희박한 데이터 문제와 캘린더(월물간) 차익거래 불가능의 조건을 해결하는 내재 분산 곡면을 생성한다.

분산 곡면을 보조 데이터로 사용하여 만기에 따른 위험 중립 내재 확률 분포 함수들을 생성하는 연결된 선형계획법 문제를 구성한다.

가격의 복구조건을 목적함수로 두고 무위험 차익거래 불가능의 조건, 선도위험중립조건 그리고 확률 분포 함수임을 만족할 조건을 갖고 구성된 내재 확률 분포 함수는 주가지수 옵션시장에서 관측된 콜옵션 가격을 정밀하게 복구할 수 있는 구간 선형 함수이다.

[APP - 6] 홍영준(샌디에고주립대) : 딥러닝의 수치해석적 연구

Youngjoon Hong (San Diego State University)

Deep neural network and numerical analysis

Deep neural networks have achieved state-of-the-art performance in a variety of fields. The exponential growth of machine learning models and the extreme success of deep learning have seen application across a multitude of disciplines. Recent works observe that a class of widely used neural networks can be viewed as the Euler method of numerical discretization. From the numerical discretization perspective, Total Variation Diminishing (TVD) Runge-Kutta methods are more advanced techniques than the explicit Euler method that produce both accurate and stable solutions. Motivated by the TVD property and a generalized Runge-Kutta method, we proposed new networks which improve robustness against adversarial attacks. If time permits, we explore a deep learning methodology that can be applied to the data-driven discovery of numerical PDEs.

[APP - 7] 지정민(University of Louisville/UNIST) : 유체역학의 특이섭동에 관한 해석과 계산

Gung-Min Gie (University of Louisville/UNIST)

Singular perturbations in fluid mechanics: Analysis and computations

Singular perturbations occur when a small coefficient affects the highest order derivatives in a system of partial differential equations. From the physical point of view, singular perturbations generate thin layers near the boundary of a domain, called boundary layers, where many important physical phenomena occur. In fluid mechanics, the Navier-Stokes equations, which describe the behavior of viscous flows, appear as a singular perturbation of the Euler equations for inviscid flows, where the small perturbation parameter is the viscosity. In general, verifying the convergence of the Navier-Stokes solutions to the Euler solution (known as the vanishing viscosity limit problem) remains an outstanding open question in mathematical physics. Up to now, it is not known if this vanishing viscosity limit holds true or not, even in 2D for which the existence, uniqueness, and regularity of solutions for all time are known for both the Navier-Stokes and Euler. In this talk, we discuss a recent result on the boundary layer analysis for the Navier-Stokes equations under a certain symmetry where the complete structure of boundary layers, vanishing viscosity limit, and vorticity accumulation on the boundary are investigated by using the method of correctors. We also discuss how to implement effective numerical schemes for slightly viscous fluid equations where the boundary layer correctors play essential roles.

[APP - 8] 이민구*(군산대), 김시우(연세대), 김정훈(연세대) : 베리언스스왑 가격 도출을 위한 이계도 근사

Min-Ku, Lee* (Kunsan National University)
See-Woo, Kim (Yonsei University)
Jeong-Hoon, Kim (Yonsei University)

Second Order Approximation for Variance Swap

This research is about the price of variance swap under stochastic volatility model with volatility of volatility and derives the second order approximation solution obtained by asymptotic analysis.

[APP - 9] 전영목(아주대) : Immersed 혼합차분법

Youngmok Jeon (Ajou University)
The immersed hybrid difference method

We propose the immersed hybrid difference (IHD) method for elliptic interface problems. When deriving the IHD method we consider a virtual overlapping of two solutions on interface cells. To recover the real solution from the virtually extended solutions we introduce the VR(virtual to real) transformation. The VR transformation is consisting of the interface conditions in addition to the consistency equations, which are derived from the governing equation. The method is easy to be implemented and high order methods are conveniently derived. Numerical tests on several types of interfaces with low and high order methods are presented, which demonstrate efficiency of the suggested method. Some numerical analysis is provided for the one dimensional case.

[APP - 10] 박재현(군산대) : 비선형 다중에이젼트 시스템

Park Jea-Hyun (Kunsan National University)
Fully Nonlinear Multi-Agent systems

In this talk, we discuss fully nonlinear multi-agent systems with nonlinear interactions that form the desired spatial pattern without collision. We first introduce a singular Cucker-Smale model, which contains a discrete p-Laplacian (p>1) and external

control signals. Then, we introduce a range of properties for the energy functional of our model, and show that the model supports non-collision, flocking, and pattern formation. In addition, through numerical simulations, we show that, depending on the initial data and the discrete p-Laplacian, various significant effects exist, such as the speed control of pattern positioning, amplitude adjustment of damped oscillation, and smoothness regulation of agents' trajectories.

[APP - 11] 김수현*(성균관대), 문환표(동국대), 권성화(가톨릭대) : 가우스-르장드르 제어 다각형을 이용한 평면 피타고리안 호도그래프 곡선의 형상 해석

Kim Soo Hyun* (Sung Kyun Kwan University)
Moon Hwan Pyo (Dongguk University)
Kwon Song-Hwa (Catholic University)

Shape analysis of planar PH curves with the Gauss-Legendre control polygons

Kim and Moon have recently proposed rectifying control polygons as an alternative to Bézier control polygons and a way of controlling planar PH curves by the rectifying control polygons. While a Bézier control polygon determines a unique polynomial curve, a rectifying control polygon gives a multitude of PH curves. This multiplicity of PH curves naturally raises the selection problem of the "best" PH curves, which is the main topic of this paper.

To resolve the problem, we first classify PH curves of degree $2n+1$ into 2^n subclasses by defining the types of PH curves, and propose the absolute hodograph winding number as a topological index to characterize the topological behavior of PH curves in shape. We present a lower bound of the topological index of a PH curve which is given solely by its type, and prove the uniqueness of the best PH curve by exploiting it. The existence theorems are also proved for cubic and quintic PH curves. Finally, we propose a selection rule of the best PH curve only based on its type.

[APP - 12] 최우철*(성균관대), 김도헌(고등과학원), 윤석배(성균관대) : NEAR DGD방법의 볼록 함수들에 대한 수렴성 증명

Woocheol Choi* (Sung Kyun Kwan University)
Doheon Kim (Korea Institute for Advanced Study, KIAS)
Seok-Bae Yun (Sung Kyun Kwan University)
Convergence of NEAR-DGD for non-strongly convex problems

We are concerned with the convergence of NEAR DGD$^+$ (Nested Exact Alternating Recursion Decentralized Graident Descent) method introduced to solve the distributed optimization problems. Under the assumption of strong convexity and Lipschitz continuous gradient, the linear convergence is established in Berahas et al (2018). In this work, we investigate convergence of NEAR DGD$^+$ when the strong convexity assumption is missing. More precisely, we establish the convergence result in the case where only the convexity or the quasi-strong convexity is assumed on the objective function in place of the strong convexity.

[APP - 13] 정주영*(성균관대), 정윤모(성균관대), 윤상운(성균관대) : Elastic Trend Filtering

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Jeong, Juyoung* (Sung Kyun Kwan University)
Jung, Yoon Mo (Sung Kyun Kwan University)
Yun, Sangwoon (Sung Kyun Kwan University)
Convergence of NEAR-DGD for non-strongly convex problems

Trend filtering aims to estimate underlying trends in time series data, which is necessary to investigate data in a variety of disciplines. We propose a new method called elastic trend filtering. The proposed method combines L2 and L1 norm penalties to exploit the benefits and strengths of Hodrick-Prescott and L1 trend filterings. We apply the alternating direction method of multipliers for its efficient computation and numerical experiments show the soundness and efficiency of the proposed method. We further apply the proposed method to

graph cases for potential applications and suggest variation trend filtering for its variance estimate.

[APP - 14] Bataa*(전남대), 곽민규(전남대), 진홍성(전남대), 서규원(GIST), 봉성율(GIST), 이재영(GIST) : A variable-length window-wise parameter-dependent state of charge estimation by Kalman filters.

Bataa Lkhagvasuren* (Chonnam National University)
Minkyu Kwak (Chonnam National University)
Hong Sung Jin (Chonnam National University)
Gyuwon Seo (Gwangju Institute of Science and Technology)
Sungyool Bong (Gwangju Institute of Science and Technology)
Jaeyoung Lee (Gwangju Institute of Science and Technology)

A variable-length window-wise parameter-dependent state of charge estimation by Kalman filters.

This work proposes a new window-wise state of charge (SOC) estimation algorithm based on Kalman filters (KF).
In the first stage, the equivalent circuit model's parameters are estimated by a least square estimation window-wise, assuming a linear SOC and open-circuit voltage (OCV) relation. The algorithm accurately estimates the parameters and observes the changes that depend on SOC. Moreover, based on the estimated parameters, the OCV values are identified.
In the next stage, window-wise linear Kalman filter(ES-LKF) without hysteresis and extended Kalman filter (ES-EKF) and sigma-point Kalman filter (ES-SPKF) algorithm with hysteresis are executed to estimate SOC. Having fewer state equations and hysteresis parameters tuned up in an off-line way, the ES-EKF and ES-SPKF perform better than the conventional algorithms. The algorithms are validated by experiments with real data obtained from lab tests and compared with state-of-art methods.

[APP - 15] 조광현*(군산대), 곽도영(KAIST), 권인 : 구조 격자를 기반으로한 Poisson-Boltzmann-Nerst-Plank 무델의 수치 시뮬레이션

Gwanghyun Jo* (Kunsan National University)
Do Young Kwak (Korea Advanced Institute of Science and Technology)
In Kwon

Numerical simulation of Poisson-Boltzmann-Nerst-Plank model based on structured grids

We develop a structured grid based numerical methods for solving Poisson-Boltzmann-Nerst-Plank model. To solve Poisson-Boltmann equation, we use the discontinuous bubble - immersed finite element method (DB-IFEM). Since, DB-IFEM can be implemented on a structured grids, the resulting algebraic system has simple data structure. Moreover, resulting solutions is stable regardless of the location of ion charges. Once, potential is obtained via DB-IFEM, Nerst-Plank equation is solved by control volume methods. We show the numerical simulation of ion-channeling. The results are robust regardless of the shapes of solute-solvent interface and numbers/locations of ions.

[1] I. Kwon, D.-Y. Kwak, G. Jo, "*Discontinuous bubble immersed finite element method for Poisson-Boltzmann-Nernst-Planck model*", Journal of Computational Physics, V. 418, 2021.

해석학(Analysis) 분야

[ANA - 1] 권도용(전남대) : 악마의 계단의 푸리에 급수

DoYong Kwon (Chonnam National University)

Fourier series of a devil's staircase

Given $\beta>1$, we consider real numbers whose β-expansions are Sturmian words. When the slope of Sturmian words varies, their behaviors have been well studied from analytical point of view. The regularity enables us to find the Fourier series expansion, while the singularity at rational slopes yields a new kind of trigonometric series representing π.

[ANA - 2] 조동현(경기대) : 유한측도 공간에서 Radon-Nikodym 도함수 계산공식

Cho, Dong Hyun (Kyonggi University)

A formula to evaluate Radon-Nikodym derivatives on a finite measure space

Let $C[0,T]$ denote the space of real-valued continuous functions on the interval $[0,T]$. For a partition $0=t_0<t_1<\cdots<t_n=T$ of $[0,T]$, define $X: C[0,T]\to\mathbb{R}^{n+1}$ by

$$X(x)=(x(t_0),x(t_1),...,x(t_n))$$

In this talk we derive an evaluation formula for Radon-Nikodym derivatives similar to the conditional expectations of functions on $C[0,T]$ with the conditioning function X. As applications of the formula, we evaluate the Radon-Nikodym derivatives of generalized time integrals.

[ANA - 3] 김세정(충북대) : 양자 발산함수에 의한 Renyi 평균

Sejong Kim (Chungbuk National University)

Barycenter for Renyi's quantum divergence

A new quantum divergence induced from the alpha-z Renyi relative entropy has been recently introduced. The right Renyi mean is a unique minimizer of the weighted sum of such quantum divergences. We investigate in this paper properties of the right Renyi mean with other matrix means. Many interesting operator inequalities of the right Renyi mean with the matrix power mean including the weighted arithmetic and harmonic means are presented. Moreover, we verify the trace inequality with the Wasserstein mean and provide bounds for the Hadamard product of two right Renyi means.

[ANA - 4] 홍석창*(서울대), 조용근(전북대), 이기연(전북대) : 하트리 타입 비선형 디락 방정식의 낮은 정칙성 문제

Hong, Seokchang* (Seoul National University)
Cho, Yonggeun (Jeonbuk National University)
Lee, Kiyeon (Jeonbuk National University)

Low regularity problem for the Hartree-type nonlinear Dirac equation

We consider Cauchy problem of the Hartree-type nonlinear Dirac equation with potentials given by $V_b(x) = ₩frac1{4₩pi}₩frac{e^{-b|x|}}{|x|}₩, (b ₩ge 0)$. In previous works, a standard argument is to utilise null form estimates in order to prove global well-posedness for H^s-data, $s>0$. However, the null structure inside the equations is not enough to attain the critical regularity. We impose an extra regularity assumption with respect to the angular variable. Firstly, we prove global well-posedness and scattering of Dirac equations with Hartree-type nonlinearity for $b>0$ for small L^2_x-data with additional angular regularity.

[ANA - 5] 이기연(전북대) : 2,3 차원에서 하트리 타입 디렉방정식의 낮은 정칙성 문제

Kiyeon Lee (Jeonbuk National University)

Low regularity well-posedness of Hartree type Dirac equations in 2,3-dimensions

In this talk, I consider the Cauchy problem of d-dimension Hartree type Dirac equation with nonlinearity $c|x|^{-₩gamma} * ₩langle ₩psi, ₩beta ₩psi₩rangle$, where $c₩in ₩mathbb R₩setminus₩{0₩} $, $0 < ₩gamma < d$($d=2,3$). The aim is to show the local well-posedness in H^s for $s > ₩frac{₩gamma-1}2$ with mass-supercritical cases($1 < ₩gamma<d$) and mass-critical case($₩gam=1$). I establish the well-posedness via bilinear estimates and angular decomposition for which I use the null structure of nonlinear term effectively. In particular, I extend the range of well-posedness than the previous results [Cho-Lee-Ozawa, 2020]. I also provide the flow of Dirac equations cannot be C^3 at the origin for H^s with $s < ₩frac{₩gamma-1}2$. These results lead us that the Sobolev index $₩frac{₩gamma-1}{2}$ is almost optimal for local well-posedness.

위상수학(Topology) 분야

[TOP - 1] 김민훈*(전남대), Matthew Hedden(Michigan State University), Thomas E. Mark(University of Virginia), 박경배(강원대) : 매듭의 0-프레임 수술로 얻어지지 않는 3차원 기약다양체들

Min Hoon Kim* (Chonnam National University)
Matthew Hedden (Michigan State University)
Thomas E. Mark (University of Virginia)
Kyungbae Park (Kangwon National University)

Irreducible 3-manifolds that cannot be obtained by 0-surgery on a knot

We discuss infinitey many examples of closed, orientable, irreducible 3-manifolds M such that $b_1(M)=1$ and $\pi_1(M)$ has weight 1, but M is not the result of Dehn surgery along a knot in the 3-sphere. This answers a question of Aschenbrenner, Friedl, and Wilton and provides the first examples of irreducible manifolds with $b_1=1$ that are known not to be surgery on a knot in the 3-sphere.

[TOP - 2] 김준형*(충남대), Ioannis Platis(University of Crete) : Heisenberg 군의 등거리 차원

Kim, Joonhyung* (Chungnam National University)
Ioannis Platis (University of Crete)

Equilateral dimension of the Heisenberg group

Let H be the first Heisenberg group equipped with the Koranyi metric d. We prove that there can be no more than 4 equidistant points in (H, d) and we study the conguration spaces of 3 and 4 equidistant points, respectively.

[TOP - 3] 이정훈(전북대) : 2-케이블 매듭의 교각 표현에 관하여

Jung Hoon Lee (Jeonbuk National University)

On bridge positions of 2-cable knots

A bridge position of a knot (or link) is said to be *perturbed* if it is obtained from a lower index bridge position by introducing a new local maximum and adjacent local minimum. Otherwise, it is *unperturbed*.

In this talk, we study the relationship between such notions and cabling operation: If every non-minimal bridge position of a knot J is perturbed, then every non-minimal bridge position of a 2-cable link L of J is also perturbed. On the other hand, if a bridge position of a knot J is strongly irreducible, then a 2-cable position of it (of a 2-cable knot K of J) is unperturbed.

[TOP - 4] 안병희*(경북대), Gabriel C. Drummond-Cole, Ben Knudsen (Northeastern University) : Asymptotic homology of graph braid groups

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Byung Hee An* (Kyungpook National University)
Gabriel C. Drummond-Cole
Ben Knudsen (Northeastern University)

Asymptotic homology of graph braid groups

We give explicit formulas for the asymptotic Betti numbers of the unordered configuration spaces of an arbitrary finite graph over an arbitrary field.

[TOP - 5] 조영진*(경북대), 안병희(경북대) : CLTTF 아틴군의 자기동형군의 구조

Youngjin Cho* (Kyungpook National University)
Byung Hee An (Kyungpook National University)

The structure of automorphism groups of CLTTF Artin groups

우리는 꼭지점으로 나뉘지 않는 CLTTF 아틴군의 자기동형군의 표현을 얻었다. 사실, 이것은 반전, 부분 공액화들, 그래프 동형사상과 꼬인 부분공액화들의 합성들에 의해 생성된다. 아틴군을 정의하는 그래

프의 비유일성 때문에 생기는 어려움을 놀랍게도 특별한 형태의 그래프 동형사상과 꼬인 부분공액화들의 합성만으로 해결할 수 있다. 대부분의 관계자는 한 유형의 자기동형사상들의 다른 유형의 자기동형사상에 대한 공액 작용에 의해 부여된다.

[TOP - 6] 송민경(IBS) : Homology cobordism group of homology cylinders and invariants related to lower central series

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Minkyung Song (Institute for Basic Science)

Homology cobordism group of homology cylinders and invariants related to lower central series

The homology cobordism group of 3-dimensional homology cylinders is an enlargement of both the mapping class group of a surface and the concordance group of string links. All of Johnson homomorphisms and Morita homomorphisms of a mapping class group of a surface, Milnor invariants and Orr invariants of (string) links are related to lower central series of a free group. We consider extension of those invariants to homology cylinders and filtrations via their kernels. We determine the images of the filtrations under the invariants and get relations of quotients of the filtration to automorphism groups of free nilpotent groups, and free Lie algebras. We also conclude the numbers of linearly independent invariants.

[TOP - 7] 이현희*(충남대), 구남집(충남대) : On the existence of hyper N-expansivity on compact manifolds

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Hyunhee Lee* (Chungnam National University)
Namjip Koo (Chungnam National University)

On the existence of hyper N-expansivity on compact manifolds

In this talk, we study existence of hyper N-expansivity in discrete dynamical systems. We show that C^0-generically, any homeomorphism on compact manifolds is not hyper N

-expansive for any $N \in \mathbb{N}$. Furthermore, we give some examples to illustrate our results.

수학교육(Mathematics Education) 분야

[EDU - 1] 김부미(원광대) : 협력적 문제해결을 위한 수학 학습 어플리케이션의 토론 활동 분석

Bumi, Kim (Wonkwang University)

Analysis of Discussion activity for Collaborative problem-solving using Application of the Mathematics Learning

The new educational paradigm of collaborative problem-solving(CPS) emerged in response to the times and social changes represented by the Fourth Industrial Revolution. In this study, we consider the meaning of cooperative problem solving in the subject of mathematics and its activity elements. In addition, this study analyzed the process of solving a given problem through group discussion activities of the math learning app.

The concrete learning activity is to express CPS in the process of exploring the graph of trigonometric functions by high school students. This learning activity was developed as a hybrid application, which was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2017S1A5A2A01024762). As a result of the analysis, it was necessary to strengthen the metacognitive factor in CPS in order to promote collaborative problem solving of students.

[EDU - 2] 이효경*(순천대), 강윤수(순천대) : 공교육과 사교육에서의 수학교육 만족도

Lee, Hyo Kyung* (Sunchon National University)
Kang, Yun Soo (Sunchon National University)

Satisfaction of Mathematics Education on Public and Private Education

본 연구에서는 초,중학교 학생과 학부모를 대상으로 공교육과 사교육에서의 수학교육 만족도를 알아보고자 한다. 수학교육에 영향을 미치는 변인은 매우 다양하지만 가장 중요한 변인으로 교사 변인, 교육환경 변인, 학생 변인을 꼽을 수 있다.

김승연(2007)은 공교육과 사교육에 대한 교육만족도를 조사하기 위해 교사관련 영역, 수업관련 영역, 교수학습 환경 조성 영역(교육환경 및 시설), 수학학습 태도 영역(교육성과) 등 네 영역으로 구분한 설문지를 작성하였다. 이러한 영역 구분은 본 연구에서 확인하고자 하는 세 개의 변인과 밀접하게 관련된다. 즉, 교사관련 영역과 수업관련 영역은 교사 변인, 교수학습 환경 조성 영역은 교육환경 변인, 수학학습 태도 영역은 학생 변인을 대표할 수 있다고 판단하여 이러한 영역 구분을 따르기로 했다.

하지만, 일반적인 교육만족도를 조사한 김승연(2007)의 검사도구를 활용하기 어려워 이 연구에서는 미래교수역량 변인을 확인한 김용삼(2018)과 박숙현(2015)의 검사도구를 이 연구의 목적에 맞게 수정하였다. 즉, 교사관련 영역과 수업관련 영역은 김용삼(2018)의 검사도구, 교수학습 환경 조성 영역과 수학학습 태도 영역은 박숙현(2015)의 검사도구를 참조하여 구성하였다.

한편, 김승연(2007)은 하나의 질문으로 공교육과 사교육 만족 정도를 동시에 확인하는 형식의 설문지를 구성하였는데, 이 연구에서도 이런 형식을 채택하여 5단 리커트 척도로 설문지를 구성하였다.

김승연(2017), 공교육과 사교육의 학생 만족도를 비교를 통한 공교육 발전 방향 탐색, 중앙대학교 교육대학원 교육학과 석사학위 논문.

김용삼(2018), 초등학교 교사의 자아개념 및 자기주도학습능력, 수업환경조절전략 활용능력과 미래교수역량 간의 구조적 관계, 숭실대학교 대학원 평생교육학과 박사학위 논문.

박숙현(2015), 여중생이 지각한 수학교사의 실천적 교수역량이 교육성취도에 미치는 영향-수학학습태도의 매개효과를 중심으로-, 서울대학교 대학원 교육학과 석사학위 논문.

[EDU - 3] 홍영석*(전북대), 손홍찬(전북대) : 중학교 수학 영재아의 수학적 정당화에 대한 인식과 특성에 관한 연구

Hong, young Suk* (Jeonbuk National University)

Son, Hong Chan (Jeonbuk National University)

A Study on the Characteristics of Mathematical Justification of Gifted Students in Middle School

The purpose of this study was to identify the characteristics of mathematical justification of middle school gifted students. We analyzed 17 middle school mathematics gifted students' perceptions of the types of mathematical justifications, the types of justifications revealed when performing actual justifications in algebra and geometry, and the reasons for satisfaction and dissatisfaction.

대수학(Algebra) 분야

[ALG - 1] 김상욱*(전남대), 안수형(연세대), 정지윤(Marshall University) : Enumeration of Fuss-Catalan paths by type and blocks

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Sangwook Kim* (Chonnam National University)
Suhyung An (Yonsei University)
JiYoon Jung (Marshall University)

Enumeration of Fuss-Catalan paths by type and blocks

Armstrong enumerated the number of Fuss-Catalan paths with a given type and Rhoades provided the number of Dyck paths with a given type and a given number of blocks.

In this talk we generalized those results to enumerate the number of Fuss-Catalan paths with a fixed type and a fixed number of blocks. We provide two proofs of this result. The first one uses Chung-Feller style proof and a certain polynomial, while the second one is bijective.t

[ALG - 2] 송석준(제주대) : 부울 행렬의 극 계수를 보존하는 선형사상

Seok-Zun Song (Jeju National University)

Linear maps that preserve arctic ranks of Boolean matrices

A Boolean rank-1 matrix is factored as xy^t for vectors x and y of suitable orders. The arctic rank of this Boolean rank-1 matrix is $\frac{1}{2}(|x|+|y|)$ where $|x|$ is the number of nonzero entries in x. Every Boolean matrix A can be written as a sum of Boolean rank-1 matrices, a Boolean rank-1 decomposition. The arctic

rank of A is the least value of sums of arctic ranks of Boolean rank-1 matrices over all Boolean rank-1 decompositions of A. In this article we study some properties of arctic ranks of Boolean matrices. Furthermore, we characterize the linear maps which preserve arctic ranks between dierent Boolean matrix spaces.

[ALG - 3] 쾨니히 요아힘*(한국교원대), 임보해(KAIST) : Rank gain of elliptic curves over G-extensions

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Joachim Koenig* (Korea National University of Education)
Bo-Hae Im (Korea Advanced Institute of Science and Technology)

Rank gain of elliptic curves over G-extensions

Many important problems in algebraic number theory and arithmetic geometry are directly related to questions about the rank of elliptic curves over number fields. In particular, the behavior of the rank of the quadratic twists of a given elliptic curve E (say, over Q) has been studied extensively, and is directly linked to the question over which quadratic number fields the rank of the curve E grows. We ask more generally about the rank of E over extensions K/Q whose Galois closure has a prescribed Galois group G. We provide a general criterion ensuring rank gain of E over infinitely many G-extensions, conditional on (the BSD conjecture and) the existence of G-extensions of Q(t) with certain local conditions. We give concrete applications for some interesting groups G.

[ALG - 4] 주형관*(전남대), 심규철(전남대) : 그래프 초다면체의 연속체적과 이산체적

Hyeong-Kwan Ju* (Chonnam National University)
Kyu-Chul Shim (Chonnam National University)

Continuous Volumes and Discrete Volumes for Certain Types of Graph Polytopes

Path-type의 그래프 초다면체 (참고문헌 참조)와 거기서 파생되는 초다면체의 연속체적과 이산체적을 구하고 이 초다면체들과 관련되는 몇 가지 특징을 생각해본다. 특히, face-vector에 대한 정보를 알아내고 이 데이타에 대한 생성함수를 구해본다.

참고문헌
Hyeong-Kwan Ju, Sangwook Kim, and Daeseok Lee, Different Volume Computation Methods of Graph Polytopes, Bull. KMS 55(2018), No.5, pp1405-1417.

[ALG - 5] 백형태*(경북대), 임정욱(경북대) : 다항식환의 특수한 형태의 몫환에 대하여

Hyungtae Baek* (Kyungpook National University)
Jungwook Lim (Kyungpook National University)
On a special type of quotient rings of the polynomial rings

Let R be a commutative ring with identity and let $R[X]$ be the polynomial ring over R. Let $C=\{f\in R[X]$ the coefficient of the least degree term of f is $1\}$. Then the quotient ring $R[X]_C$ is obviously a subring of the Nagata ring which contains $R[X]$. In this talk, we investigate the ideal theoretical properties of $R[X]_C$

기하학(Geometry) 분야

[GEO - 1] 김진홍(조선대) : On toric Hamiltonian T-spaces with anti-symplectic involutions

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Jin Hong Kim (Chosun University)
On toric Hamiltonian T-spaces with anti-symplectic involutions

The aim of this talk is to address the realization problem of a given Lagrangian submanifold of a symplectic manifold as the fixed point set of an anti-symplectic involution. To be more

precise, let $(X, ₩omega, ₩mu)$ be a toric Hamiltonian T-space, and let $₩Delta=₩mu(X)$ denote the moment polytope. Let $₩tau$ be an anti-symplectic involution of X of X such that $₩tau$ maps the fibers of $₩mu$ to (possibly different) fibers of $₩mu$, and let p_0 be a point in the interior of $₩Delta$. If the toric fiber $₩mu^{-1}(p_0)$ is real Lagrangian with respect to $₩tau$, then we explain how to show that p_0 should be the origin and, furthermore, $₩Delta$ should be centrally symmetric.

[GEO - 2] 김동수(전남대) : 타원의 특성과 쉬나이더 정리

Dong-Soo Kim (Chonnam National University)

Some Characterizations of Ellipsoids and Schneider's Theorem

Suppose that M is a strictly convex and closed hypersurface in E^{n+1} with the origin O in its interior. We consider the homogeneous function g of positive degree d satisfying $M=g^{-1}(1)$. Then, for a positive number h the level hypersurface $g^{-1}(h)$ of g is a homothetic hypersurface of M with respect to the origin O.

In this talk, for tangent hyperplanes Φ_h to $g^{-1}(h)(0<h<1)$ we study the $(n+1)$-dimensional volume of the region enclosed by Φ_h and the hypersurface M, etc..

As a result, with the aid of the theorem of Blaschke and Deicke for proper affine hypersphere centered at the origin, we establish some characterizations for ellipsoids in E^{n+1}. As a corollary, we extend Schneider's characterization for ellipsoids in E^3. Finally, for further study we raise a question for elliptic paraboloids which was originally conjectured by Golomb.

[GEO - 3] 이지은(전남대) : 점별경사곡선의 정의와 그의 특성

Lee, Ji-Eun (Chonnam National University)
Pointwise slant curves and its characteristics

As a generalization of the slant curve, Sood, Srivastava and Srivastava introduced the pointwise slant curve as following :
A unit speed curve in a normal almost paracontact metric 3-manifold M is said to be pointwise slant curve (briefly, PS curve) if there exists a smooth function $₩rho$ on M satisfying $$₩eta(₩gamma')=₩rho$$.
In particular, $₩rho$ is a non-zero constant, then $₩gamma$ is a slant curve and if $₩rho=0$, then $₩gamma$ is called Legendre curve.
Moreover, if $₩rho$ is non-constant then it is called a proper PS curve.
In this talk, we will talk about its characteristics.

[GEO - 4] 김인천*(전남대), 김동수(전남대) : 볼록곡선의 넓이 성질과 포물선의 특성

Incheon Kim* (Chonnam National University)
Dong-Soo Kim (Chonnam National University)
Area properties associated with strictly convex curves

Archimedes proved that for a point P on a parabola X and a chord AB of X parallel to the tangent of X at P, the area of the region bounded by the parabola X and chord AB is four thirds of the area of triangle $\triangle ABP$. This property was proved to be a characteristic of parabolas, so called the Archimedean characterization of parabolas.

In this talk, we study strictly convex curves in the plane R^2. As a result, first using a functional equation we establish a characterization theorem for quadrics. With the help of this characterization we give another proof of the Archimedean characterization of parabolas. Finally, we present two related conditions which are necessary and sufficient for a strictly convex curve in the plane to be an open arc of a parabola.

특별세션(PDE) 분야

[PDE - 1] 조용근*(전북대), 이기연(전북대) : 유카와포텐셜을 가지는 2차원 디랙방정식의 산란성

Yonggeun Cho* (Jeonbuk National University)
Kiyeon Lee (Jeonbuk National University)

Small data scattering of Dirac equations with Yukawa type potentials in $L_x^2(₩mathbb R^2)$

We revisit the Cauchy problem of nonlinear massive Dirac equation with Yukawa type potentials $₩mathcal F^{-1}₩left[(b^2 + |₩xi|^2)^{-1}₩right]$ in 2 dimensions. Recently small data scattering and large data global well-posedness are obtained in H^s for $s > 0$. In this paper we show that the small data scattering occurs in $L_x^2(₩mathbb R^2)$. This can be done by combining bilinear estimates and modulation estimates.

[PDE - 2] 심우주*(서울대), 안현진(서울대), 하승열(서울대), 김도헌(고등과학원), Franz Wilhelm Schlöder : 완비다양체 위의 쿠커-스메일 모델의 평균장극한 방법

Woojoo Shim* (Seoul National University)
Hyunjin Ahn (Seoul National University)
Seung-Yeal Ha (Seoul National University)
Doheon Kim (Korea Institute for Advanced Study, KIAS)
Franz Wilhelm Schlöder

A mean-field limit of the Cucker-Smale model on complete Riemannian manifolds

We study a mean-field limit of the Cucker-Smale(C-S) model for flocking on complete smooth Riemannian manifolds. For this, we first formally derive the kinetic manifold C-S model on manifolds using the BBGKY hierarchy and derive several a priori estimates on emergent dynamics. Then, we present a rigorous mean-field limit from the particle model to the corresponding

kinetic model by using the generalized particle-in-cell method. As a byproduct of our rigorous mean-field limit estimate, we also establish a global existence of a measure-valued solution for the derived kinetic model. Compared to the corresponding results on Rd, our procedure requires additional assumption on holonomy and proper a priori bound on the derivative of parallel transports. As a concrete example, we verify that hyperbolic space Hd satisfies our proposed standing assumptions.

[PDE - 3] 안현진*(서울대), 김정호(한양대), 하승열(서울대) : 상대론적 Cucker-Smale 모형의 균일한 안정성 및 평균 장 극한에 적용

Hyunjin Ahn* (Seoul National University)
Jeongho Kim (Hanyang University)
Seung-Yeal Ha(Seoul National University)
Uniform stability of the relativistic Cucker-Smale model and its application to a mean-field limit

We present a uniform(-in-time) stability of the relativistic Cucker-Smale (RCS) model in a suitable framework and study its application to a uniform mean-field limit which lifts earlier classical results for the CS model in a relativistic setting. For this, we first provide a sufficient framework for an exponential flocking for the RCS model in terms of the diameters of state observables, coupling strength and communication weight function, and then we use the obtained exponential flocking estimate to derive a uniform lq,p-stability of the RCS model under appropriate conditions on initial data and system parameters. As an application of the derived uniform lq,p-stability estimate, we show that a uniform mean-field limit of the RCS model can be made for some admissible class of solutions uniformly in time. This justifies a formal derivation of the kinetic RCS equation in a rigorous setting.

[PDE - 4] C.A. Morales*(Federal University of Rio de Janeiro), 이건희 : Generalized hyperbolic fixed points for diffeomorphisms on Banach spaces

Carlos Morales* (Federal University of Rio de Janeiro)
Keonhee Lee

Generalized hyperbolic fixed points for diffeomorphisms on Banach spaces

We show that every compact invariant set close to a generalized hyperbolic fixed point of a diffeomorphism of a Banach space is generalized hyperbolic. This allows us to study the dynamics around generalized hyperbolic fixed points for diffeomorphisms of Banach spaces. More precisely, in the non-hyperbolic case, we show that these points are surrounded not only by homoclinic points but also by generalized hyperbolic periodic points of arbitrary period. In particular, a non-hyperbolic but generalized hyperbolic fixed point of a diffeomorphism of a Banach space cannot be dynamically isolated.

* *This is joint work with Keonhee Lee.*

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[PDE - 5] Nguyen Ngoc Thach*(충남대), 이건희 : Gromov-Hausdorff Stability of Semilinear Parabolic Equations under Lipschitz Perturbations of the Domain and Equation

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Nguyen Ngoc Thach* (Chungnam National University)
Keonhee Lee

Gromov-Hausdorff Stability of Semilinear Parabolic Equations under Lipschitz Perturbations of the Domain and Equation

In this talk, we discuss the Gromov-Hausdorff stability of the global attractors induced by the following semilinear parabolic equations under Lipschitz perturbations of the domain and equation.

$$\begin{cases} \partial_t u - \Delta u = f(u) & in\ \Omega \times (0,\infty), \\ u = 0 & on\ \partial\Omega \times (0,\infty), \end{cases} \tag{1}$$

where Ω is an open bounded domain in $\mathbb{R}^N$, and $f : \mathbb{R} \to \mathbb{R}$ is locally Lipschitz and dissipative.

In general setting, we prove the followings.

Theorem 1. Let $\{T_\eta\}_{\eta \in [0,1]}$ be a family of semiflows on Banach spaces X_η with the global attractors A_η. Suppose for each $\eta \in [0,1]$, there exist a linear isomorphism $i_\eta : X_\eta \to X_0$ such that

(i) $i_\eta A_\eta \to A_0$,

(ii) for any $r > 0$ and $0 < \tau_0 < \tau_1$,

$\| i_\eta T_\eta(t) u_\eta - T_0(t) i_\eta u_\eta \|_{X_0} \to 0$ uniformly on $u_\eta \in X_\eta$ with $\| u_\eta \|_{X_\eta} < r$, and $t \in [\tau_0, \tau_1]$.

Then T_0 is Gromov-Hausdorff stable.

Corollary 2. Generically, the semiflow T_0 on the Hilbert space $H_0^1(\Omega)$ induced by the system (1) is Gromov-Hausdorff stable under Lipschitz perturbations of the domain and equation.

(*) This is joint work with K. Lee.

[PDE - 6] 배형옥*(아주대), 소형석(삼성전자), 윤영훈(영남대) : Regularity to the Steady Fluids with non-Standard Growth Viscosity

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Hyeong-Ohk Bae* (Ajou University)
Hyoungsuk So (Samsung Electronics)
Younghoon Yun (Yeungnam University)

Generalized hyperbolic fixed points for diffeomorphisms on Banach spaces

We consider weak solutions to the equations of stationary motion of a class of non-Newtonian fluids which includes the power law model.

The power depends on the spatial variable, which is motivated by electrorheological fluids.

We prove the existence of second order derivatives of weak solutions in the shear thinning cases.

[PDE - 7] 이지훈*(중앙대), 김준하 : 층화 부시네스크 방정식의 시간에 따른 감소

Jihoon Lee* (Chung-ang Univeristy)
Junha Kim

Temporal decay of the stratified Boussinesq equations

In this talk, we consider n-dimensional stratified Boussinesq equations, which describes the dynamics of the large-scale motion. We consider the damped Boussinesq equations and the small data global-in-time existence and temporal decay of the solutions.

[PDE - 8] 김현석*(서강대), 오지수(서강대), 변재성(서강대) : 로렌츠공간을 이용한 개선된 Gagliardo-Nirenberg부등식에 대하여

Hyunseok Kim* (Sogang University)
Jisu Oh (Sogang University)
Jaeseong Byeon (Sogang University)

On refined Gagliardo-Nirenberg inequalities via Lorentz spaces

It has been recently shown that the classical Gagliardo-Nirenberg interpolation inequalities can be refined by using weak L^p-norms. The goal of the talk is to present further refinements via general Lorentz spaces. We provide interpolation inequalities in Sobolev-Lorentz spaces of arbitrary orders, as special cases of more general results on Triebel-Lizorkin-Lorentz spaces.

[PDE - 9] 정은희*(전북대), 이상혁(서울대), 유재현(서울대) : 트위스트 라플라시안에 대한 스팩트럴 프로젝션 연산자의 최적 유계

Jeong, Eunhee* (Jeonbuk National University)
Lee, Sanghyuk (Seoul National University)
Ryu, Jaehyeon (Seoul National University)

Sharp estimate for the spectral projection associated with the twisted Laplacian

We are concerned with sharp estimate for the spectral projection operator associated with the twisted Laplacian in the Lebesgue spaces, which has been of interest related to L^p-convergence of the Bochner-Riesz means. In this talk, we provide a complete characterization of the sharp L^p-L^q bounds for the spectral projectoin. As an applicaton, we discuss resolvent estimate for the twisted Laplacian. This talk is based on a joint work with Sanghyuk Lee and Jaehyeon Ryu at Seoul National University.

[PDE - 10] 김정호*(한양대), 문보라(한양대) : 천-사이먼-슈뢰딩거 방정식의 유체극한

Jeongho Kim* (Hanyang University)
Bora Moon (Hanyang University)

Hydrodynamic limits of the nonlinear Schrodinger equation with the Chern-Simons Gauge fields

We present two types of the hydrodynamic limit of the nonlinear Schrodinger-Chern-Simons (SCS) system. We consider two different scalings of the SCS system and show that each

SCS system asymptotically converges towards the compressible and incompressible Euler system, coupled with the Chern-Simons equations and Poisson equation respectively, as the scaled Planck constant converges to 0. Our method is based on the modulated energy estimate. In the case of compressible limit, we observe that the classical theory of relative entropy method can be applied to show the hydrodynamic limit, with the additional quantum correction term. On the other hand, for the incompressible limit, we directly estimate the modulated energy to derive the desired asymptotic convergence.

[PDE - 11] 고동남*(가톨릭대), Umberto Biccari(University of Deusto), Enrique Zuazua(FAU Erlangen-Nürnberg) : 다입자 네트워크 동역학계의 제어 방법: 유한차분 접근

Dongnam Ko* (The Catholic University)
Umberto Biccari (University of Deusto)
Enrique Zuazua (FAU Erlangen-Nürnberg)
Dynamics and control for multi-agent networked systems: a finite difference approach

We analyze the dynamics of multi-agent collective behavior models and their control theoretical properties. We first derive a large population limit to parabolic diffusive equations and then address the control problem in the linear setting, linking the multi-agent model with the spatial semi-discretization of parabolic equations. This allows us to use the existing techniques for parabolic control problems in the present setting and derive explicit estimates on the cost of controlling these systems as the number of agents tends to infinity. Our approach, inspired on the existing results for parabolic equations, possibly of fractional type, and in several space dimensions, shows that the formation of consensus may be understood in terms of the underlying diffusion process described by the heat semi-group.

[PDE - 12] 변재형(KAIST) : Pattern formation in elliptic systems by competition of attractive and repulsive forces

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Jaeyoung Byeon (Korea Advanced Institute of Science and Technology)

Pattern formation in elliptic systems by competition of attractive and repulsive forces

I would like to explain how nontrivial patterns by the vector solutions of an elliptic system arise when attractive forces and repulsive forces compete each other.

[PDE - 13] 배수현(한밭대) : 준선형 타원 초임계 방정식의 특이해

Soohyun Bae (Hanbat University)

Singular solutions of semilinear elliptic supercritical equations

Semilinear elliptic equations have singular solutions with asymptotic self-similarity. I discuss the existence and uniqueness of radially symmetric equation when the nonlinearity is supercritical.

[PDE - 14] 윤창욱(충남대) : The diffusive farmers and hunter-gatherers model with a free boundary in a heterogeneous environment

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Changwook Yoon (Chungnam National University)

The diffusive farmers and hunter-gatherers model with a free boundary in a heterogeneous environment

Ecologically, the evolutionary advantage of farmers over hunter-gatherers has led to their worldwide spreading. In this work, we study a free boundary problem of a farmers and hunter-gatherers model featuring a type of prey-predator dynamics. The nonlinear diffusion of farmers is determined by the density of farmers in a way that higher population density accelerates the migration. We establish a spreading-vanishing dichotomy and provide some sufficient conditions in a

heterogeneous environment. Moreover, in a homogeneous environment, we achieve exact asymptotic convergence to the constant equilibrium. Thereby, we verify that a strong sedentary lifestyle of farmers is advantageous for the spreading of farmers.

[PDE - 15] 배기찬*(서울대), 윤석배(성균관대) : 평형 근처에서의 샤코브 모델

Gi-Chan Bae* (Seoul National University)
Seok-Bae Yun (Sung Kyun Kwan University)
Shakhov model near a global Maxwellian

Shakhov model is a relaxation approximation of the Boltzmann equation proposed to overcome the deficiency of the original BGK model, namely, the incorrect production of the Prandtl number.
In this talk, we address the existence and asymptotic stability of the Shakhov model when the initial data is a small perturbation of global equilibrium.
We derive a dichotomy in the coercive estimate of the linearized relaxation operator between zero and non-zero Prandtl number and observe that the linearized relaxation operator becomes more degenerate in the former case. To fill out such degeneracy and recover the full coercivity, we consider a micro-macro equation that involves non-conservative quantities.

[PDE - 16] 권재룡(POSTECH) : Interior jump and regularity of compressible viscous Navier-Stokes flows through a cut

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Kweon, Jae Ryong (Pohang University of Science and Technology)
Interior jump and regularity of compressible viscous Navier-Stokes flows through a cut

We study the stationary compressible Navier-Stokes equations in a domain containing an interior cut. The cut is an internal boundary having the vertices with $2₩pi$ angle at the tip

points. It is a non-Lipshitz boundary. We prove existence and piecewise regularity by splitting the corner singularity functions at the cut tips and show that the continuity equation is solved by the density function having an interior jump discontinuity across the curve emanating from the rear tip. The piecewise regularity results from a vector function corresponding to the gradient of the jump density. The integral curve through the cut has the curvature that blows up at the cut tips, with the singularity order $-1/2$, which is the inverse to the corner singularity order at the cut tips.

[PDE - 17] 이용훈*(부산대), Rui Yang : A mean curvature problem on an exterior domain in Minkowski space

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Yong-Hoon Lee* (Pusan National University)
Rui Yang

A mean curvature problem on an exterior domain in Minkowski space

We study the existence of positive radial solutions for a mean curvature problem in Minkowski space on an exterior domain. Based on C^1-regularity of solutions, which is closely related to the property of nonlinearity f near 0, we make use of the global bifurcation theory to establish some existence results of positive radial solutions when f is sublinear at ∞.