VIASM-HUS-HNUE-KAIST JOINT MATHEMATICAL MEETING

Vietnam Institute for Advanced Study in Mathematics

Hanoi, December 13-14, 2019

Organizing Committee: LE Minh Ha (VIASM) NGO Hoang Long (HNUE) PHO Duc Tai (HUS) Yongnam LEE (KAIST)

Scientific Committee: LE Minh Ha (VIASM) DO Duc Thai (HNUE) VU Hoang Linh (HUS) Sijong KWAK (KAIST) Chang-Ock LEE (KAIST)

Program

December 13th, 2019: Workshop - Avenue: VIASM

8:45	*Registration*	
9:25	*Opening section*	
9:40	*Plenary talk*	*Chair: LE Minh Ha*
	Sijong KWAK	
10:20	*Photo session*	
10:25	*Coffee Break*	
	Pure Math section	*Applied Math section*
Chair	*PHO Duc Tai*	*LE Van Hien*
10:40	NGUYEN Thac Dung	Hoang Nam Dung
11:10	Hyungryul BAIK	Do Young KWAK
11:40	SI Duc Quang	Chang-Ock LEE
12:10	Lunch Break	
14:00	*Plenary talk*	*Chair: JongHae KEUM*
	NINH Van Thu	
14:40	*Coffee Break*	
	Pure Math section	*Applied Math section*
Chair	*Sijong KWAK*	*Chang-Ock LEE*
14:55	Soonsik KWON	LE Van Hien
15:25	Sang Geun HAHN	Gang Uk HWANG
15:55	PHAM Anh Minh	NGO Hoang Long
16:25	*Coffee Break*	
	Pure Math section	*Applied Math section*
Chair	*NINH Van Thu*	*NGO Hoang Long*
16:40	Dongsu KIM	Yong Jung KIM
17:10	DO Viet Cuong	NGUYEN Tien Dung
19:00	*Reception*	

December 14th, 2019: Lectures

Venue	**HUS** : 334 Nguyen Trai Room 419 Building T3	**HNUE** : 136 Xuan Thuy Room 304 Building C
9:30-10:30	Jaekyoung KIM	NGUYEN Ngoc Cuong
10:50-11:50	Jinhyun PARK	Donghwan KIM

List of Abstracts

Plenary Talks

Recent Progress on Castelnuovo-Mumford-Eisenbud-Goto Problem

Sijong Kwak

Department of Mathematical Sciences, KAIST
Email: skwak@kaist.ac.kr

I will introduce basic notions and conjectures on Castelnuovo-Mumford regularity of projective varieties, coherent sheaves and finitely generated graded modules to participants with modest backgrounds. These are related to the complexity of generators and relations and have long history in Algebra and Geometry. There are various approaches to these problems according to the categories. There is a mysterious dichotomy between singular cases and smooth cases. In my talk, I explain why we can get the positive results for smooth varieties and also the negative results for singular cases by showing the counterexamples due to McCullough and Peeva.

Characterization of models in $\mathbb{C}^n$ by their automorphism groups

Ninh Van Thu

Faculty of Mathematics - Mechanics - Informatics, VNU University of Sciences

Email: thunv@vnu.edu.vn

In this talk, we consider a pseudoconvex domain $\Omega \subset \mathbb{C}^{n+1}$ with noncompact automorphism group. The purpose of this talk is to prove that if Ω is of finite type, then Ω is biholomorphically equivalent to a domain of the form

$$M_P = \{(w,z) \in \mathbb{C} \times \mathbb{C}^n \colon \mathrm{Re}(w) + P(z) < 0\},$$

where P is a plurisubharmonic real-valued polynomial containing no pluriharmonic monomials.

References

[1] J. P. D'Angelo, *Real hypersurfaces, orders of contact, and applications*, Ann. Math. **115** (1982), 615–637.

[2] F. Berteloot, *Characterization of models in $\mathbb{C}^2$ by their automorphism groups,* Internat. J. Math. 5(1994), 619-634.

[3] Do Duc Thai and Ninh Van Thu, *Characterization of domains in $\mathbb{C}^n$ by their noncompact automorphism groups*, Nagoya Math. J. 196 (2009), 135–160.

[4] A. Isaev and S. G. Krantz, *Domains with non-compact automorphism group: A survey*, Adv. Math. **146** (1999), 1–38.

[5] K. -T. Kim and Ninh Van Thu, *On the tangential holomorphic vector fields vanishing at an infinite type point*, Trans. Amer. Math. Soc. **367** (2015), no. 2, 867885.

[6] J.Yu, *Weighted boundary limits of the generalized Kobayashi-Royden metrics on weakly pseudoconvex domains*, Trans. Amer. Math. Soc. 347(2) (1995), 587–614.

Invited Talks on Pure Mathematics

The Role of Hyperbolic Geometry in Low-dimensional Topology

Hyungryul Baik

Department of Mathematical Sciences, KAIST

Email: hrbaik@kaist.ac.kr

As we know from the uniformization theorem, "most" closed orientable surfaces admit hyperbolic metrics. In this talk, we discuss the case in dimension 3 and by giving short survey on various result in last 3 decades (in particular many beautiful theorems of Thurston), we will demonstrate that the same holds for 3-manifolds as well.

On the relative trace formulas

Do Viet Cuong

Faculty of Mathematics - Mechanics - Informatics, VNU University of Sciences

Email: vcuong.do@hus.edu.vn

One of the main tool in the Langlands beyond endoscopy is relative trace formulas (RTF).

The first part of this talk is devoted to roughly introduce this tool.

If there is enough time, I shall explain my work (in progress) on the Jacquet's conjecture that automorphic representations of GL_r distinguished by an orthogonal subgroup can be classified by automophic representations of its metaplectic cover. To prove this conjecture, I need to establish a comparison between two relative trace formulas: one on the group GL_r and the other one on its metaplectic cover.

A Report on Post-Quantum Cryptography Standardization Process

Sang G. Han

Department of Mathematical Sciences, KAIST

Email: ock@kaist.ac.kr

In this is introductory survey we will talk about post-quantum cryptography (which is also called quantum resistant cryptography or quantum safe cryptography) meaning cryptography which must be safe even if quantum computer is available in near future, and on-going standardization process initiated by American NIST. We will try to give mathematical and commercial overview of this interesting area as of December 2019.

A combinatorial bijection on k-noncrossing partitions

Dongsu Kim

Department of Mathematical Sciences, KAIST

This talk is meant to give a combinatorial experience to noncombinatorialists.

For any integer $k \geq 2$, we prove combinatorially the following transformation identity

$$\mathrm{NC}_{n+1}^{(k)}(t) = t \sum_{i=0}^{n} \binom{n}{i} \mathrm{NW}_{i}^{(k)}(t),$$

where $\mathrm{NC}_{m}^{(k)}(t)$ (resp. $\mathrm{NW}_{m}^{(k)}(t)$) is the enumerative polynomial on partitions of $\{1, \ldots, m\}$ avoiding k-crossings (resp. enhanced k-crossings) by number of blocks.

It is based on the preprint (arXiv:1905.10526) with Zhicong Lin.

Global behaviors of nonlinear dispersive waves

Soonsik Kwon

Department of Mathematical Sciences, KAIST

Email: soonsikk@kaist.edu

I will introduce a research direction in the analysis of nonlinear dispersive equations. We are interested in the dynamical behaviour of global solutions to nonlinear dispersive equation, such as nonlinear Schrödinger equations, KdV equations or wave type equations. Due to the presence of nonlinear feedback, solutions may not disperse out as linear solutions, but there are various sceinarios on global behaviours of solutions. Also, it is believed that stable ground state solitons are central figures in the dynamics. At the end of the talks, I will announce recent results of mine on the scattering and blow up construction problems.

Gradient estimates for nonlinear heat equations

Nguyen Thac Dung

Faculty of Mathematics - Mechanics - Informatics, VNU University of Sciences

Email: dungmath@gmail.com

In this talk, I first recall three type of gradient estimate on Riemannian manifolds, namely Li-Yau's, Hamilton's, and Souplet-Zhang's gradient estimate. Then I show gradient estimates for nonlinear heat equations on such manifolds and as their consequences, I point out Liouville properties for positive solutions of several nonlinear equations including the Schrödinger equation, the Yamabe equation, and Lichnerowicz-type equations.

On the partition function of the Ising model on graphs embedded in the Klein bottle

Pham Anh Minh

Department of Mathematics, Hanoi National University of Education

Email: phamanhminh87@gmail.com

Given a weighted graph G, the partition function of the graph with respect to a particular model on G is the sum of the weights of certain subgraphs of G. When the graph is extended infinitely, the behaviour of the partition function reveals interesting long-range properties of the model. In this talk we will focus on the Ising model, one of the most famous models in probability and mathematical physics. We will show that the Ising partition function of a graph embedded in the Klein bottle contains a "universal quantity" called the finite-size correction. This quantity is given by Jacobi theta functions and nearly independent from the underlying graph.

Degeneracy second main theorem for meromorphic mappings and hypersurfaces

Si Duc Quang

Department of Mathematics, Hanoi National University of Education

Email: quangsd@hnue.edu.vn

In 1933, H. Cartan established a second main theorem for linearly nondegenerate meromorphic mappings with a family of hyperplanes in general position. This second main theorem of H. Cartan plays an important role in Nevanlinna theory, with many applications to Algebraic or Analytic geometry. By introducing the notion of Nochka weight, in 1983 Nochka generalized the result of H. Cartan to the case where the family of hyperplanes is in subgeneral position.

In 2004, M. Ru firstly proved a second main theorem for algebraically nondegenerate meromorphic mappings into $\mathbb{P}^n(\mathbb{C})$ with hypersurfaces in general position of $\mathbb{P}^n(\mathbb{C})$. In 2009, M. Ru generalized his previous result to the case of meromorphic mappings into projective varieties. However, all these results need an assumption that the family of targets (hyperplanes or hypersurface) must be in general position. The difficulty comes from the fact that there is no Nochka weight for the case of hypersurfaces.

Recently we gave a generalization of Nochka weight for the case of hypersurfaces in subgeneral position of a projective variety. Applying that new Nochka weight, we have established a generalization of the result of H. Cartan and Nochka to the case of meromorphic mappings with families of hypersurfaces in subgeneral position. Our re-

sult implies some applications in study trucated multiplicity problem of meromorphic mappings.

In another direction, in 2019, we proposed a method, so-called "replacing hypersurface", to establish second main theorem for the case of meromorphic mappings into projective varieties intersecting hypersurface without using Nochka weight. Using our method, we have generalized all results of M. Ru to the case of hypersurfaces in subgeneral position. Actually, our method is a principle which allows us to reduced the case of hypersurfaces in subgeneral position to the case of hypersurface in general position.

In this talk, we will present the above two methods for establishing "Degeneracy second main theorem for meromorphic mappings into projective varieties intersecting hypersurfaces" in Nevanlinna theory.

Invited Talks on Applied Mathematics

Flight trajectory optimization problem

Hoang Nam Dũng

Faculty of Mathematics - Mechanics - Informatics, VNU University of Sciences

Email: hoangnamdung@hus.edu.vn

A few hours before each flight takes place a dispatcher computes and submits a route between departure and arrival airports to Air Traffic Control. In order to maximize profit airline companies want to minimize the cost of the submitted route. It is exactly the goal of the trajectory planning problem, an optimization problem with many constraints. Although in recent decades, there are various software packages designed to particularly solve this problem, which have been used by many large airline companies, these packages still reveal many limitations. Trajectory optimization is a difficult problem because each of its special cases is already NP-hard. In addition, from the practical requirements of the airline companies, we need to find solutions for a route within the time limit of 1 minute.

In this talk we introduce the flight trajectory optimization problem and present the results obtained from the cooperation project between Zuse Institute Berlin and Lufthansa System, the market leader in software for trajectory planning. Our collaboration has delivered software prototype VOLAR, which is planned to replace the current software in the coming years.

Adaptive Network Bandwidth Allocation with Gaussian Process Regression

Ganguk Hwang

Department of Mathematical Sciences, KAIST

Email: guhwang@kaist.edu

Gaussian Process Regression (GPR) is a nonparametric Bayesian machine learning approach that places a flexible prior distribution over the space of functions and returns a predictive distribution through a combination of the prior and the data. Due to its analytical tractability and practical advantages, GPR is widely used as a powerful tool in inference, learning, and prediction. In this talk, we focus on how GPR can be utilized with the help of domain knowledge for the design and analysis of intelligent network bandwidth allocation.

This is a joint work with Jeongseop Kim (KAIST).

Model for heterogeneous diffusion

Yong-Jung Kim

Department of Mathematical Sciences, KAIST

Email: ykimamath@kaist.ac.kr

Diffusivity alone is not enough to decide a diffusion phenomenon in a heterogeneous environment. In this talk we show that turning frequency or jumping time is also needed. We will derive a diffusion law with diffusivity and turning frequency as the two coefficients. To do that, a revertible kinetic equation of Stratonovich type is introduced. A thought experiment is also introduced to test the validity of diffusion laws. Numerical computations, Monte-Carlo simulations, and radial solutions are compared.

A New Development of Immersed Finite Element Methods

Do Young Kwak

Department of Mathematical Sciences, KAIST

Email: kdy@kaist.ac.kr

We give a survey of new class of discretization methods, called IFEM, for elliptic interface problems using structured grids then present a recent development also. For scalar problems we consider using Lagrangian type P_1, Crouzeix-Raviart nonconforming P_1, bilinear and Rannacher Turek element for rectangle grids. We point out that some of the earlier version of IFEMs does not yield optimal order of convergence. As a remedy for this, we consider two variants. One is to add line integrals to the bilinear forms to make the scheme consistent. Another is to us CR(or RT) nonconforming $P_1(Q_1)$ basis functions. We note that the convergence of IFEM with nonconforming elements are guaranteed with an additional regularity assumption that Darcy velocity belongs to H^1. Applications to mixed methods, and multigrid convergence is also discussed. We also discuss the IFEM for elasticity problems, using CR nonconforming P_1 basis functions. In this case, the bilinear forms are modified by adding the stability terms to guarantee the Korn's inequality. Several numerical examples are provided which support the theory.

Stability analysis and control of time-delay systems: Perspectives and results

Le Van Hien

Department of Mathematics, Hanoi National University of Education

Email: hienlv@hnue.edu.vn

Time-delay phenomena are used to model a large number of engineering systems and industrial processes. Typical examples can be found in networked control systems, transmission lines or telecommunication networks. The presence of time delays usually leads to unpredictable system behaviors, degradation of system performance even jeopardize system stability. Thus, the study of time-delay systems is essential in the field of control engineering, which has attracted significant research attention in the past few decades. The aim of this talk is to give a brief introduction to perspectives and our recent results on modeling, analysis and control of time-delay systems.

Three-Dimensional Volume Reconstruction Using Two-Dimensional Parallel Slices

Chang-Ock Lee

Department of Mathematical Sciences, KAIST

Email: colee@kaist.edu

In this talk, we present a partial differential equation model for three-dimensional (3-D) volume reconstruction from 2-D slices. The proposed method is based on the modified Cahn–Hilliard equation for 3-D binary inpainting. In order to accurately satisfy the constraints while obtaining a smooth result, we apply a presmoothing procedure based on anisotropic diffusion to the slices. We discuss the justification for our inpainting model using a Γ-convergence analysis. After splitting a grayscale image into binary channels, we perform multichannel Cahn–Hilliard inpainting. Then we adopt smoothing and a shock filter as postprocessing to combine the binary inpainting results. We then employ our method to reconstruct a 3-D human body from parallel slices of CT images.

This is a joint work with Dr. Junwoo Kim (Korean Minjok Leadership Academy).

Drifted Radial Dunkl processes and their numerical approximation

Ngo Hoang Long

Department of Mathematics, Hanoi National University of Education

Email: ngolong@hnue.edu.vn

A Dunkl process is a Markov process whose infinitesimal generator is defined by the Dunkl Laplacian based on a root system in $\mathbb{R}^d$. In 2007, Schapira showed that a Dunkl process can be represented as a solution to a stochastic differential equation with singular coefficients. The class of Dunkl processes contains many important members such as Bessel processes, Dyson's Brownian motions, and the square root of Wishart processes. In this talk, we consider a class of drifted Dunkl process defined by systems of stochastic differential equations. We show that these systems have a unique strong solution that stays in a Weyl chamber. We then introduce an implicit Euler–Maruyama approximation, which also takes values in the Weyl chamber, for drifted radial Dunkl processes, and study its rate of convergence in L^p-sup norm and path-wise sense.

This is a joint work with Dai Taguchi (Okayama University).

Continuity in the Hurst index of some fractional Brownian functionals

Nguyen Tien Dũng

Faculty of Mathematics - Mechanics - Informatics, VNU University of Sciences

Email: dung@hus.edu.vn

In recent years, the continuity in law with respect to Hurst index of the functionals of fractional Brownian motion has been studied by several authors. In this talk, based on the techniques of Malliavin calculus, we introduce an explicit method to bound the Kolmogorov distance between two functionals with different Hurst indexes.

Invited Lectures at HUS

Mathematics, 21st Century Microscope for Complex Biological Systems

Jae Kyoung Kim

Department of Mathematical Sciences, KAIST

Email: jaekkim@kaist.ac.kr

The revolution of molecular biology in the early 1980s has revealed complex network of non-linear and stochastic biochemical interactions underlying biological systems. To understand this complex system, mathematical models have been widely used. In this talk, I will introduce the typical process of mathematical modelling including mathematical representation, model fitting to data, analysis and simulations, and experimental validation with an example of circadian rhythms. Across each step of modelling process, I will also describe our efforts to develop new mathematical tools and point to the parts of current tool box of mathematical biology that need further mathematical development.

K-theory of schemes via formal schemes

Jinhyun Park

Department of Mathematical Sciences, KAIST

Email: jinhyun@kaist.edu

In this talk, I will present a new way to understand algebraic K-theory of schemes over a field via some formal schemes. This description is particularly useful when the schemes admit singularities. I will discuss its connection to a classical problem in algebraic geometry on vector bundles, and explain how this is related to the studies of motivic cohomology of schemes. This talk is based on a joint work with Pablo Pelaez of Universidad Nacional Autónoma de México.

Invited Lectures at HNUE

First-order methods and their acceleration for large-scale optimization

Donghwan Kim

Department of Mathematical Sciences, KAIST

Email: donghwankim@kaist.ac.kr

Many modern applications, such as machine learning, require solving large-dimensional optimization problems. First-order methods, such as a gradient method, are widely used to solve such large-scale problems, since their computational cost per iteration mildly depends on the problem dimension. However, they suffer from slow convergence rates, compared to second-order methods such as Newton's method. Therefore, accelerating first-order methods has received a great interest, particularly via the momentum technique, and we will review such topic in this talk.

An introduction to the subsolution problem for complex Monge-Ampère equations

Nguyen Ngoc Cuong

Department of Mathematical Sciences, KAIST

Email: cuongnn@kaist.ac.kr

We survey recent results on the subsolution problem for the complex Monge-Ampère equation, which is an effective way to obtain the solution for the equation once we are given a *very rough* solution to the equation. This rough solution or subsolution is often easily constructed from the datum (the right hand side, the boundary data). We will discuss the problem in classical sense and in the generalized sense as well.