Program and Abstracts of Talks

The 8th East Asian Conference in Harmonic Analysis and Applications

August 18 – 20, 2021

This conference is held as the 20th International Conference by Graduate School of Mathematics, Nagoya University

Organizing Committee
Joonil Kim (Yonsei University)
Sanghyuk Lee (Seoul National University)
Guozhen Lu (University of Conneticut)
Yutaka Terasawa (Nagoya University)
Naohito Tomita (Osaka University)
Lu Zhang (Shaanxi Normal University)

Program

	August 18	August 19	August 20
9:00 –9:40	Changxing Miao	Yaryong Heo	Francesco Di Plinio
10:00 –10:40	Daniel Spector	Zhifei Zhang	Guozhen Lu
11:00 –11:40	Lu Chen Seheon Ham	Akihiko Miyachi Qiaohua Yang	Hanli Tang Juyoung Lee
13:00 –13:40	Kangwei Li Youngwoo Koh	Eiichi Nakai Yonggeun Cho	Hyerim Ko Ting Chen
13:50 –14:30	Takeshi Kawazoe Danqing He	Eunhee Jeong Denny Ivanal Hakim	Jaehyeon Ryu Naoto Shida
14:40 –15:20	Guixiang Hong Yutaka Terasawa	Yoshihiro Sawano Qingying Xue	Jin Bong Lee Yohei Tsutsui
15:30 –16:10	Doowon Koh	Neal Bez	Sanghyuk Lee
16:30 –17:30	Tuomas Hytönen	Tuomas Hytönen	Tuomas Hytönen
17:40 –18:40	Free discussion	Free discussion	Free discussion

- The time is written in Japan time (same for Korea, but you need to subtract one hour for China).
- Talks are divided into three categories, i.e., Mini-Course, Plenary Talks and Invited Talks. The Mini-course is given by Professor Tuomas Hytönen and is given as three one-hour lectures. Boxes with one speaker are for Plenary Talks in Single Sessions and Boxes with two speakers are for Invited Talks in Parallel Sessions.
- Plenary talks and Invited talks are both 40 minutes long.

Abstracts of Talks

(1) **Tuomas Hytönen**
tuomas.hytonen@helsinki.fi
University of Helsinki

Advances in vector-valued harmonic analysis

General abstract for the lecture series: These lectures deal with harmonic analysis of vector-valued functions, where, by vector-valued, we understand functions taking values in an infinite-dimensional Banach spaces. One advantage of this generality is that we can, for instance, interpret functions of two variables (x, y) as functions of the variable x that take their values in a space of functions of the second variable y. This gives a convenient way of approaching complicated phenomena in several variables in a hierarchical manner.

• Lecture I: *Basic notions and examples of vector-valued harmonic* analysis
UMD spaces, R-boundedness, contraction principles. Vector-valued Fourier multipliers.
Key reference: Hytönen, van Neerven, Veraar, Weis: Analysis in Banach Spaces, Vol I-II. Springer, 2016, 2017.

• Lecture II: *Singular integrals operators of Calderón-Zygmund type*
Dyadic representation theorem and the T(1) theorem. Paraproducts and bounded mean oscillation.
Key reference: Hänninen, Hytönen: Operator-valued dyadic shifts and the $T(1)$ theorem, Monatsh Math (2016) 180:213–253.

• Lecture III: *Product space theory of singular integral*
Extension of the previous results to more singular (sometimes called Journe type) operators. Advantages of the vector-valued point of view in the product space theory.
Key reference: Hytönen, Martikainen, Vuorinen: Multi-parameter estimates via operator-valued shifts, Proc. London Math. Soc. (3) 119 (2019) 1560–1597.

(2) **Neal Bez**
nealbez@mail.saitama-u.ac.jp
Saitama University

The nonlinear Brascamp–Lieb inequality

We prove a nonlinear variant of the Brascamp–Lieb inequality. The argument is based on induction-on-scales using gaussians, and a key component of the proof is a quantitative version of Lieb's theorem concerning gaussian near-maximisers to the classical Brascamp–Lieb inequality. As an application, we will present some multilinear convolution estimates of the type which have recently appeared in the theory of Zakharov systems. Joint work with Jon Bennett, Stefan Buschenhenke, Michael Cowling and Taryn Flock.

(3) **Lu Chen**
chenlu5818804@163.com
Beijing Institute of Technology

Sharp geometric inequalities in analysis and its application in ground state of Schrödinger equation with the critical exponential growth

In this talk, I will first give a survey about the history of Trudinger-Moser inequalities and introduce our recent work on sharp Trudinger-Moser inequalities involving the degenerate potential and sharp trace type Trudinger-Moser inequalities . Then I will present some new progress on the existence of ground state solutions for Schrödinger equation with critical exponential growth. Finally, I will also give some quantization results for this kind Schrödinger equations. Some of open problem for the future will be also discussed in this talk.

(4) **Ting Chen**
t.chen@nankai.edu.cn
Nankai University

The Hardy-Littlewood-Sobolev inequality on mixed-norm Lebesgue spaces

In this talk we discuss the Hardy-Littlewood-Sobolev inequality on mixed-norm Lebesgue spaces. We give a complete characterization of indices such that the Riesz potential is bounded from one mixed-norm Lebesgue space to another.

(5) **Yonggeun Cho**
changocho@jbnu.ac.kr
Jeonbuk National University

Small data scattering of 2d Dirac equations with Yukawa type potentials

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 $s>0$ by Yang, Tesfahun, and Georgiev-Shakarov, independently. In this talk we see that the small data scattering occurs in $L^2_x(\mathbb{R}^2)$. This can be done by combining bilinear estimates and null structure.

(6) **Francesco Di Plinio**
francesco.diplinio@wustl.edu
Washington University in St. Louis

Modulation invariant operators: sharp and vector valued estimates

Modulation invariance is the principal distingushing feature of both the Carleson operator and the bilinear Hilbert transform, arising in connection with pointwise convergence of either Fourier or bilinear ergodic averages. In this talk, we will discuss two interconnected families of sharp results for modulation invariant operators. The first are new sharp and sparse bound for the maximal or r-variational Carleson operator at the endpoint of the expected range of values. The second are sparse estimates for maximal or variational bilinear ergodic averages sharpening previous work of Lacey. Both families have consequences in terms of new pointwise convergence results, and admit counterparts for functions taking values in UMD spaces. Partly joint work with A. Fragkos, K. Li, H. Martikainen, E. Vuorinen

(7) **Denny Ivanal Hakim**

dennyivanalhakim@gmail.com
Institut Teknologi Bandung, Indonesia

Fractional integral operators on various subpaces of Morrey spaces

In this talk, we discuss fractional integral operators with rough kernel on vanishing Morrey spaces and other subspaces of Morrey spaces. In particular, we show that these integral operators map vanishing Morrey spaces into themselves. We also prove the analogous results for the closure of essentially bounded functions and compactly supported functions in Morrey spaces. This is a joint work with D. Salim, Y. Soeharyadi, and W.S. Budhi.

(8) **Seheon Ham**
seheonham@snu.ac.kr
Seoul National University

Dimension of divergence set of the wave equation

In this talk, we study pointwise behaviour of the wave operator $e^{it\sqrt{-\Delta}}$. Furthermore, we consider the Hausdorff dimension of the divergence set on which $\lim_{t\to 0} e^{it\sqrt{-\Delta}} f = f$ fails for $f \in H^s(\mathbb{R}^d)$. We prove the conjecture raised by Barceló, Bennett, Carbery and Rogers in $d = 3$ and improve the previously known results in higher dimensions $d \geq 4$. For the purpose we apply the fractal Strichartz estimates for the wave equation. We also consider Strichartz estimates with respect to $dtd\mu(x)$, where μ is a positive Borel measure with fractional dimension. We will see that this type of estimate can be applied to Falconer's distance set problem as well as pinned distance set problem. This talk is based on a recent work with Herym Ko and Sanghyuk Lee.

(9) **Danqing He**
hedanqing@fudan.edu.cn
Fudan University

On multilinear Hörmander multipliers

In this talk we discuss the initial boundedness of bilinear and multilinear Hörmander multipliers of Calderón-Torchinsky type, i.e. the $L^2 \times \cdots \times L^2$ boundedness of them. For this purpose, we establish a substitute of the Plancherel identity in the multilinear setting, which turns out to be useful in obtaining the boundedness of many other multilinear operators. Some open problems will be mentioned.

(10) **Yaryong Heo**
yaryong@korea.ac.kr
Korea University

Off-diagonal estimates for the first order commutators in higher dimensions

In this talk we study natural generalizations of the first order Calderón commutator in higher dimensions $d \geq 2$. We study the bilinear operator $\mathrm{T}_{\mathbf{m}}$ which is given by

$$\mathrm{T}_{\mathbf{m}}(f,g)(x) := \iint_{\mathbb{R}^{2d}} \left[\int_0^1 \mathbf{m}(\xi + t\eta)\, dt \right] \widehat{f}(\xi)\, \widehat{g}(\eta)\, \mathrm{e}^{2\pi \mathrm{i} x\cdot(\xi+\eta)}\, d\xi d\eta.$$

Here the multiplier $\mathbf{m} \in \mathrm{C}^{d+1}\big(\mathbb{R}^d \setminus \{0\}\big)$ satisfies the Hörmander derivative conditions.

(11) **Guixiang Hong**
guixiang.hong@whu.edu.cn
Wuhan University

Maximal inequalities and pointwise convergence of noncommutative Fourier series

In this talk, I shall present the first results on maximal inequalities and pointwise convergence of Fejer type means and Bochner-Riesz means of Fourier series associated to von Neumann algebras generated by non-abelian groups. The approach heavily relies on the noncommutative ergodic theory in conjunction with abstract constructions of Markov semigroups, inspired by quantum probability and geometric group theory. Based on a joint work with S. Wang and X. Wang.

(12) **Eunhee Jeong**
eunhee@jbnu.ac.kr
Jeonbuk National University

Sharp L^p–L^q estimate for the spectral projection associated with the twisted laplacian

In this talk, we are concerned with sharp estimate for the spectral projection $\mathcal{P}_\mu$ associated with the twisted Laplacian in the Lebesgue spaces. We provide a complete characterization of the sharp L^p–L^q bound for $\mathcal{P}_\mu$ when $1 \le p \le 2 \le q \le \infty$, which is similar to that for the spectral projection associated with the Laplacian. As an application, we discuss the resolvent estimate for the twisted Laplacian. This talk is based on a joint work with Sanghyuk Lee and Jaehyeon Ryu.

(13) **Takeshi Kawazoe**
kawazoe@sfc.keio.ac.jp
Keio University

Revisiting the real Hardy space and its atomic decomposition on the Jacobi hypergroup

Let $(\mathbb{R}_+, \Delta, *)$ be the Jacobi hypergroup. Similarly as in the Euclidean space, we can define a Hardy space $H^1(\Delta)$ by using a radial maximal operator on the Jacobi hypergroup. In a series of papers the author characterizes $f \in H^1(\Delta)$ in terms of its Abel transform $\mathcal{A}(f)$ and gives a relation between $H^1(\Delta)$ and the real Hardy space $H^1(\mathbb{R})$. In this talk we revisit the process and give a more sophisticated approach to the atomic and quark decomposition of $H^1(\Delta)$.

(14) **Hyerim Ko**
kohr@snu.ac.kr
Seoul National University

Spherical maximal estimates with respect to fractal measure

The L^p improving property of the spherical maximal operator has been almost completely characterized by making use of local smoothing and Strichartz estimates for the wave operator. We will present L^p improving inequalities in a fractal setting and discuss an application to the pinned distance set. This is joint work with Seheon Ham and Sanghyuk Lee.

(15) **Doowon Koh**
koh131@chungbuk.ac.kr
Chungbuk National University

On the Mattila-Sjölin distance theorem for product sets

Let A be a compact set in $\mathbb{R}$, and $E = A^d \subset \mathbb{R}^d$. We know from the Mattila-Sjölin's theorem that if $\dim_H(A) > \frac{d+1}{2d}$, then the distance set $\Delta(E)$ contains an interval, where $\dim_H(A)$ denotes the Hausdorff dimension of the set A, and $\Delta(E) := \{|x-y| : x, y \in E\}$. In this talk, we show that the threshold $\frac{d+1}{2d}$ can be improved whenever $d \geq 5$. The parabolic distance plays an important role in proving the results. This is join work with Chun-Yen Shen and Thang Pham.

(16) **Youngwoo Koh**
ywkoh@kongju.ac.kr
Kongju National University

Introduction to the operator splitting method

In this talk, we introduce the operator splitting method for some nonlinear equations. For any time, the method gives an approximation solution depending only on initial data for the nonlinear equation. In this argument, we divide the nonlinear equation into computable parts and consist of the approximation solution by composing these computable parts. This method is widely used for numerical computation. However, it remains a very fundamental question to converge between the approximation with the original solution. In this talk, we study some convergence results which applying harmonic analysis tools to numerical analysis. This work is joint with Hyung Jun Choi and Woocheol Choi.

(17) **Jin Bong Lee**
jinblee@snu.ac.kr
Seoul National University

Trilinear Fourier multiplier operators with vanishing moment conditions on Hardy spaces

In this talk, the boundedness of trilinear Fourier multiplier operators on Hardy spaces will be considered. That is, we are interested in trilinear estimates from $H^{p_1} \times H^{p_2} \times H^{p_3}$ to H^p for $1/p = 1/p_1 + 1/p_2 + 1/p_3$. The speaker also introduces the linear L^p multiplier problem and its multilinear analogues. At the end of the talk, some difficulties of our approach in extension to m-linear case for $m \geq 4$ will be presented. This is joint work with Bae Jun Park.

(18) **Juyoung Lee**
ljy219@snu.ac.kr
Seoul National University

L^p–L^q estimates for the circular maximal operator on Heisenberg radial functions

L^p boundedness of the circular maximal function $\mathcal{M}_{\mathbb{H}^1}$ on the Heisenberg group $\mathbb{H}^1$ has recieved considerable attentions. While it still remains open, L^p boundedness of $\mathcal{M}_{\mathbb{H}^1}$ on Heisenberg radial functions was recently shown by Beltran, Guo, Hickman, Seeger.

In this talk, we extend their result considering the local maximal operator $M_{\mathbb{H}^1}$ which is defined by taking supremum over $1 < t < 2$. We prove L^p–L^q estimates for $M_{\mathbb{H}^1}$ on Heisenberg radial functions on the optimal range of p, q modulo the borderline cases. Our argument also provides a simler proof of the aforementioned result due to Beltran et al.

(19) **Sanghyuk Lee**
shklee@snu.ac.kr
Seoul National University

Maximal and regularity estimates for averages over curves in $\mathbb{R}^d$

Let γ be a smooth curve from a compact interval I to $\mathbb{R}^d$, $d \geq 3$ which satisfies the nondegeneracy condition $\det(\gamma'(s), \dots, \gamma^{(d)}(s)) \neq 0$, $s \in I$. We consider the averaging operator

$$\mathcal{A}_t f(x) = \int f(x - t\gamma(s))\psi(s)\, ds,$$

where ψ is a smooth function supported in the interior of I. Concerning the operator $\mathcal{A}_t$, the problems such as L^p improving, L^p Sobolev estimate, and L^p boundedness of the maximal function $Mf(x) = \sup_{0<t} |\mathcal{A}_t f(x)|$ have been studied. (When $d = 2$, all these problems are completely understood.) As for the first problem we have a better understanding so far. However, the other two problems turned out to be more involved. In this talk, we present recent progress regarding the aforementioned problems. First, we show the maximal operator M is bounded on L^p if and only if $p > 3$ when $d = 3$. In higher dimensions $d \geq 4$, we prove M is bounded on L^p for $p > 2(d-1)$. The result is a consequence of the new sharp local smoothing estimate for $\mathcal{A}_t$. Secondly, we prove the sharp L^p Sobolev regularity estimate for $\mathcal{A}_t$ with a fixed $t \neq 0$ when $d \geq 5$. This settles the problem of sharp L^p regularity estimate except the endpoint cases. The talk is based on joint work with Hyerim Ko and Sewook Oh.

(20) **Kangwei Li**
kli@tju.edu.cn
Tianjin University

Multilinear weighted estimates in product spaces

In the one-parameter situation, the very influential paper by Lerner et. al. introduced the Muckenhoupt weights in the multilinear setting and it was shown that one can get related weighted estimates for the maximal function and singular integrals. Around 10 years ago, such class of weights were also introduced in the multilinear multi-parameter context, however, the related weighted estimates were only known for the maximal function. In this talk, I will talk about the recent progress on the multilinear weighted estimates for singular integrals in product spaces. Our result completes the qualitative weighted theory in this setting.

(21) **Guozhen Lu**
guozhen.lu@uconn.edu
University of Connecticut

Hardy identities and inequalities on Euclidean spaces, hyperbolic spaces, Heisenberg groups and Riemannian manifolds

Hardy inequalities play an important role in PDEs, mathematical physics and geometric analysis. In this talk, we will discuss some recent developments on Hardy identities with respect to general distance functions to the origin and boundary in Euclidean spaces, hyperbolic spaces, Heisenberg groups and Riemannian manifolds using the Bessel pairs. These identities imply Hardy inequalities which sharpen substantially existing ones in the literature. These results include a series of recent joint works with N. Duy, J. Flynn, N. Lam, S. Mazumudar, L. Zhang.

(22) **Changxing Miao**
miao_changxing@iapcm.ac.cn
Institute of Applied Physics and Computational Mathematics

Local smoothing estimate for the Fourier integral operators satisfying cinematic conditions

Local smoothing conjecture which was formulated by Sogge has close relationship with other significant conjectures such as Bocher-Riesz conjecture, restriction conjecture and Kakeya conjecture, and finds its extensive applications in Harmonic analysis and PDEs. In this talk, we will present the recent improvement of local smoothing estimate of a certain class of Fourier integral operators satisfying cinematic curvature conditions. The main ingredients in our proof are wave packet decomposition, the Bourgain-Guth argument and the polynomial method, variable coefficient decoupling inequality and square function estimates. This talk is based on a series of joint works with Chuanwei Gao, Bochen Liu and Yakun Xi.

(23) **Akihiko Miyachi**
miyachi@lab.twcu.ac.jp
Tokyo Woman's Christian University

On the boundedness of multilinear pseudo-differential operators of $S_{0,0}$-type

We consider the bilinear or multilinear pseudo-differential operator in the case where the symbol and its derivatives are bounded by a fixed function $W(\xi)$ ('weight function'). We give two results about the boundedness of these operators in L^p, h^p, L^∞, and *bmo*. The first result concerns with the bilinear case with the weight function W in L^q or $L^{q,\infty}$. The second result concerns with the multilinear case with the weight function $W(\xi) = (1 + |\xi|)^m$ (the case of Hörmander symbol class).

This talk is based on joint works with Tomoya Kato (Gunma Univ.) and Naohito Tomita (Osaka Univ.).

(24) **Eiichi Nakai**
eiichi.nakai.math@vc.ibaraki.ac.jp
Ibaraki University

Operators on function spaces and their weak versions

In this talk, I will introduce some recent work on the boundedness of several operators on function spaces and their weak versions like Orlicz and weak-Orlicz spaces. We consider the Hardy-Littlewood maximal, fractional maximal, Calderón-Zygmund and fractional integral operators and their generalizations. Moreover, we consider the pointwise multipliers. This talk is based on joint work with Ryutaro Arai, Ryota Kawasumi and Minglei Shi.

(25) **Jaehyeon Ryu**
miro21670@snu.ac.kr
Seoul National University

Bochner-Riesz means for the Hermite and special Hermite expansions

In this talk, we consider the Bochner-Riesz means for the Hermite and special Hermite expansions and study the problem of determining the possible range of p and the summability index for their L^p boundedness. Concerning the boundedness on a restricted domain, we settle the corresponding problem except for endpoint cases in two dimensions and extend the previously known range in higher dimensions. We also present a new necessary condition on the summability index for the L^p boundedness of the Hermite Bochner-Riesz means, which invalidates the conventional conjecture expected to be true.

(26) **Yoshihiro Sawano**
yoshihiro-sawano@celery.ocn.ne.jp
Chuo University

Domination of Littlewood-Paley operators via sparse operators

We get a precise linear dependence on the Dini constant for Littlewood-Paley operators. In fact, we relax the log-Dini condition in the pointwise bound to the classical Dini condition. By a short and new proof, this proves a well-known open problem by Yabuta. A similar argument can be used to obtain the general multilinear case. This is a joint work with Hormozi Mehdi at Iran.

(27) **Naoto Shida**
u331453f@ecs.osaka-u.ac.jp
Osaka University

Boundedness of bilinear pseudo-differential operators with $S_{0,0}$-type symbols

In this talk, we discuss the boundedness of bilinear pseudo-differential operators with symbols in the bilinear Hörmander class $BS^m_{0,0}$. In particular, we generalize the $L^2 \times L^2 \to L^1$ boundedness by using Besov spaces. This talk is based on a joint work with Naohito Tomita (Osaka University) and Naoki Hamada.

(28) **Daniel Spector**
daniel.spector@oist.jp
Okinawa Institute of Science and Technology Graduate University

A coarea substitute for solenoidal charges

The strongest known form of the Sobolev inequality for functions of bounded variation is a trace inequality due to Maz'ya and Meyers and Ziemer. Its proof utilizes the coarea formula, and as a result, whether similar inequalities hold for other constrained spaces of measures has not been established in the literature. The goal of this talk is to introduce a newly established approximation result for divergence free measures that provides one with a sort of substitute of the coarea formula and to show how it yields trace inequalities for such objects. The talk is based on joint work with Felipe Hernandez, Jesse Goodman, Bogdan Raita, and Dima Stolyarov.

(29) **Hanli Tang**
hltang@bnu.edu.cn
Beijing Normal University

Classification of solutions of an equation related to a conformal log Sobolev inequality

We classify all finite energy solutions of an equation which arises as the Euler–Lagrange equation of a conformally invariant logarithmic Sobolev inequality on the sphere due to Beckner. Our proof uses an extension of the method of moving spheres from R^n to S^n and a classification result of Li and Zhu. Along the way we prove a small volume maximum principle and a strong maximum principle for the underlying operator which is closely related to the logarithmic Laplacian. This is a joint work with Prof. Frank and Dr. Konig.

(30) **Yutaka Terasawa**
yutaka@math.nagoya-u.ac.jp
Nagoya University

Asymptotic properties of steady solutions to the 3D axisymmetric Navier-Stokes equations with no swirl

We study the asymptotic behavior of axisymmetric solutions with no swirl to the steady Navier-Stokes equations in the outside of the cylinder. We prove an a priori decay estimate of the vorticity under the assumption that the velocity has a generalized finite Dirichlet integral. As an application, we obtain a Liouville-type theorem in the whole space. This talk is based on a joint work with Hideo Kozono (Waseda University/Tohoku University) and Yuta Wakasugi (Hiroshima University).

(31) **Yohei Tsutsui**
ytsutsui@math.kyoto-u.ac.jp
Kyoto University

Fractional medians and its maximal function

In this talk, we introduce a fractional median and its maximal function, and give the boundedness of the fractional maximal operator. The boundedness is related to restricted weak type estimates of the standard maximal function.

(32) **Qingying Xue**
qyxue@bnu.edu.cn
Beijing Normal University

On the boundedness of rough bilinear operators

In this talk, I will introduce some recent results about the boundedness of rough bilinear operators, including bilinear sigular integral operators and maximal singular integral operators.

(33) **Qiaohua Yang**
qaohyang@163.com
Wuhan University

Geometric inequalities on complex hyperbolic spaces

In this talk, I'll give a factorization theorem for the operators on complex hyperbolic space which is closely related to Geller's operator, as well as the CR invariant differential operators on Heisenberg group and CR sphere. By using, among other things, the Kunze-Stein phenomenon on the closed linear group $SU(1,n)$ and Fourier analysis techniques on complex hyperbolic space, we establish the Hardy-Sobolev-Maz'ya inequalities and Trudinger-Moser-Adams inequalities on Siegel domain and the unite ball. The talk is based on a recent joint work with Guozhen Lu.

(34) **Zhifei Zhang**
zfzhang@math.pku.edu.cn
Peking University

Enhanced dissipation for the linearized Navier-Stokes equations around the Kolmogorov flow

The enhanced dissipation is an important mechanism influencing the transition from laminar flow to turbulent flow. In this talk, I will introduce three approaches to establish the enhanced dissipation for the linearized Navier-Stokes equations around the Kolmogorov flow.