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and Applications**

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ABSTRACTS

(Alphabetically ordered by last names)

EXISTENCE AND NONEXISTENCE FOR EXTREMALS OF CRITICAL TRUDINGER-MOSER-ADAMS INEQUALITIES IN BOUNDED AND UNBOUNDED DOMAIN

Lu Chen

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In this talk, I will first recall classical existence results of Trudinger-Moser inequality in ball and whole space. Then I will present our new progress on the existence and Nonexistence of extremals for critical Trudinger-Moser-Adams inequalities in bounded and unbounded domain, especially, we will show that the lower perturbation term can affect the existence and nonexistence for extremals due to concentration phenomenon and vanishing phenomenon. Furthermore, we also will develop rearrangement-free blow-up technique to give the existence of extremals for critical Trudinger-Moser and perturbed Trudinger-Moser inequality under the weighted Sobolev norm involved with the trapping potential. Finally, uniqueness problems for extremals of Trudinger-Moser inequalities in two-dimensional disk will also be discussed. This is a joint work with Prof. Lu and Prof. Zhu.

POINTWISE CONVERGENCE OF SEQUENTIAL SCHRÖDINGER MEANS

Chuhee Cho

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We study pointwise convergence of the fractional Schrödinger means along sequences t_n which converge to zero. Our main result is that bounds on the maximal function $\sup_n |e^{it_n(-\Delta)^{\alpha/2}} f|$ can be deduced from those on $\sup_{0 < t \leq 1} |e^{it(-\Delta)^{\alpha/2}} f|$ when $\{t_n\}$ is contained in the Lorentz space $\ell^{r,\infty}$. Consequently, our results provide seemingly optimal results in higher dimensions, which extend the recent work of Dimou-Seeger, and Li-Wang-Yan to higher dimensions. Our approach based on a localization argument also works for other dispersive equations and provides alternative proofs of previous results on sequential convergence. This talk is based on joint work with Hyerim Ko, Youngwoo Koh and Sanghyuk Lee.

THE EXISTENCE OF WAVE OPERATORS FOR MULTI-CHANNEL PROBLEM

Qingquan Deng

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We consider the nonlinear Schrödinger equation

$$i\psi_t = -\Delta\psi + F(|\psi|^2)\psi$$

in dimension 3. we prove the existence of wave operators for multi-channel problem with large final state. That is, for given final state $(E^+, \gamma^+, \varphi^+)$, we can find initial data φ_0 such that its corresponding solution $\psi(t)$ is asymptotically give by

$$\psi(t) \approx e^{it\Delta}\varphi^+ + e^{itE^+ + i\gamma^+}\phi(E^+).$$

THE BOUNDEDNESS OF OPERATORS ON WEIGHTED MULTI-PARAMETER LOCAL HARDY SPACES

Wei Ding

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Atomic decomposition is a very useful tool to study the boundedness on Hardy spaces for some sublinear operators. Up to now, most of the boundedness of operators on weighted multi-parameter Hardy spaces are established only by almost orthogonality estimates. In this talk, we discuss the bounded theory on weighted multi-parameter local Hardy spaces via atomic decomposition.

$W^{\ell,p}$ SOLVABILITY FOR HIGHER ORDER ELLIPTIC EQUATIONS ON NONSMOOTH DOMAINS

Jun Geng

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For higher order inhomogeneous elliptic systems (polyharmonic equations and biharmonic equations) with real constant coefficients on a bounded Lipschitz domain, we investigate sufficient conditions that the ranges of p must satisfy in order for the $W^{\ell,p}$ estimates for weak solutions of Dirichlet problems to be true.

FRACTIONAL OPERATORS WITH HOMOGENEOUS KERNEL ON THE CALDERON PRODUCT OF MORREY SPACES

Denny Ivanal Hakim

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We investigate fractional operators with homogeneous kernel in Morrey spaces. In particular, we prove that fractional integral operators and fractional maximal operators with homogeneous kernel are bounded from the Calderón product of Morrey spaces to certain Morrey spaces. Our results can be seen as a generalization of the recent result on the relation between boundedness of (classical) fractional operators and interpolation of Morrey

spaces. This is a joint work with D. Salim, Moch. Taufik Hakiki, and M. Jamaludin.

SPARSE NON-SMOOTH ATOMIC DECOMPOSITION OF QUASI-BANACH
LATTICES

Naoya Hatano

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A theory of non-smooth atomic decomposition is obtained for a large class of quasi-Banach lattices. As an application, an inequality comparing the fractional maximal operator and the fractional integral operator is considered.

UNIQUE CONTINUATION FOR THE HEAT OPERATOR

Eunhee Jeong

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We consider strong unique continuation property for the differential inequality $|(\partial_t + \Delta)u(x, t)| \leq V(x, t)|u(x, t)|$ with unbounded potential V . It has been studied by obtaining special form of Carleman inequality for the heat operator, which was derived by Escauriaza. In this talk, we extend the Carleman inequality for the heat operator in Lorentz space. As a result, we establish the strong unique continuation property with V in weak space, which has been left open since the works of Escauriaza and Escauriaza–Vega. This talk is based on a joint work with Sanghyuk Lee and Jaehyeon Ryu.

ILL-POSEDNESS FOR INCOMPRESSIBLE EULER EQUATIONS AT CRITICAL
REGULARITY

In-Jee Jeong

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We consider the incompressible Euler equations in scaling critical Sobolev spaces, which are also critical for local well-posedness. We show that the initial value problem for the equations is ill-posed at critical regularity. We show some applications of the ill-posedness, including a proof of enhanced dissipation for the dissipative counterpart. Then, we describe how similar results can be obtained for more general fluid equations. This is based on joint works with Tarek Elgindi, Tsuyoshi Yoneda, and Junha Kim.

POINTWISE MULTIPLIERS ON ORLICZ-MORREY AND WEAK
ORLICZ-MORREY SPACES

Ryota Kawasumi

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In this talk, we give Orlicz-Morrey spaces with variable growth condition on spaces of homogeneous type in the sense of Coifman and Weiss in 1971 and 1977 and characterize the pointwise multipliers from an Orlicz-Morrey space to another one. We also give weak Orlicz-Morrey spaces with variable growth conditions.

To show the pointwise multipliers, we first prove a generalized Hölder's inequality for the (weak) Orlicz-Morrey space and we use the fact that all pointwise multipliers from a (weak) Orlicz-Morrey space to another (weak) Orlicz-Morrey space are bounded operators to characterize the pointwise multipliers.

Now then, the pointwise multipliers on Musileck-Orlicz-Morrey spaces have been already studied by Nakai in 2017. However, Our assumption can get weaker and simpler than Nakai's result.

HAUSDORFF OPERATORS ASSOCIATED WITH
CHANGE OF VARIABLES AND WEIGHTS

Takeshi Kawazoe

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Multivariate Hausdorff operators associated with linear transformations on $L^p(\mathbb{R}^n)$ are investigated by Brown and Moricz. We replace the linear transformation with a general change of variables. We introduce modified Hausdorff operators \mathcal{H}_ψ associated with the change of variables and weights, which cover the Hausdorff operators defined on the Euclidean space, the Dunkl hypergroup and the Jacobi hypergroup. In each case, we obtain a condition of ψ under which the operators are bounded from L^p to L^p and from H^1 to H^1 . This is a joined work with Radouan Daher and Faouaz Saadi.

SPHERICAL MAXIMAL AVERAGES ON NILPOTENT GROUPS

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Consider a group \mathbb{G} identified with \mathbb{R}^{d+1} endowed with the group law

$$(x, x_{d+1}) \cdot (y, y_{d+1}) = (x + y, x_{d+1} + y_{d+1} + \langle A(x), y \rangle).$$

Associated with the measure $d\sigma_t$ along the sphere $tS^{d-1} \subset \mathbb{R}^d$ and the Dirac mass δ , one can set the spherical maximal function $\mathcal{M}_A(f) = \sup_{t>0} f *_A (d\sigma_t \otimes \delta)$ on the nilpotent group \mathbb{G} . The range of its L^p boundedness is known to be $p > d/(d-1)$ when \mathbb{G} is the Heisenberg group for $A = J$ and

$d = 2n \geq 4$ as well as the Euclidean space for $A = \mathbf{0}$. Given a diagonalizable A with $d \geq 3$, we proved that the L^p range is determined by the **maximal algebraic multiplicity** of the real eigenvalues of A .

THE LOCAL WELL-POSEDNESS OF THE PERIODIC ZAKHAROV SYSTEM

Shinya Kinoshita

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In this talk, we consider the Cauchy problem of the Zakharov system on the multidimensional torus \mathbb{T}^d . The aim is the well-posedness of the Zakharov system in low regularity Sobolev spaces. In the 2 and the higher dimensional cases, Kishimoto established the well-posedness results. In particular, he proved the sharp well-posedness result on \mathbb{T}^2 . We improve his results when $d \geq 3$ by showing new trilinear estimates. This talk is based on the joint work with Shohei Nakamura (Osaka) and Akansha Sanwal (Bielefeld).

HARMONIC ANALYSIS ON LATTICES AND ITS APPLICATIONS

Chulkwang Kwak

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Abstract In this talk, we are going to consider the Fermi–Pasta–Ulam (FPU) system with infinitely many oscillators. We particularly see that Harmonic analysis approaches allow us to observe dispersive properties of solutions to a reformulated FPU system, and with this observation, solutions to the FPU system can be approximated by counter-propagating waves governed by the Korteweg de-Vries (KdV) equation as the lattice spacing approaches zero. Comparing to this result, we also see different phenomena detected in the periodic FPU system.

ON THE BLOW-UP DYNAMICS OF THE SELF-DUAL CHERN-SIMONS-SCHRÖDINGER EQUATION UNDER EQUIVARIANT SYMMETRY.

Soonsik Kwon

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In this talk, I will present joint works with Kihyun Kim and Sung-jin Oh on the self-dual Chern-Simons-Schrödinger equation (CSS) within equivariant symmetry. CSS is a gauge-covariant 2D cubic nonlinear Schrödinger equation. It also enjoys the mass-critical scaling/pseudoconformal invariance and soliton solutions. I will discuss recent results on finite time blow-up constructions, with emphasis on an interesting rotational instability mechanism. If time allowed, I will also discuss soliton resolution for this model, which is a remarkable consequence of the self-duality and non-local nonlinearity.

UNIQUE CONTINUATION FOR THE POLYHARMONIC OPERATORS

Yehyun Kwon

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We obtain a complete characterization of the $L^p - L^q$ Carleman inequalities with weights $e^{v \cdot x}$ for the polyharmonic operators. Consequently, we obtain new unique continuation properties of the higher order Schrödinger equations relaxing the integrability assumption on the solution spaces. Closely tied toolkits from harmonic analysis are the Stein–Tomas restriction estimate and estimates for the Bochner–Riesz operators of negative indices. This is joint work with Eunhee Jeong and Sanghyuk Lee.

SYMMETRY OF SOLUTIONS TO HIGHER ORDER SEMILINEAR EQUATIONS WITH CRITICAL GROWTH ON HYPERBOLIC SPACES

Jungang Li

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The moving plane method plays a key role in the study of the symmetry of solutions. Unlike the case of second order equations, due to the lack of maximum principle, the classical moving plane method fails for higher order equations. In this talk we will discuss some recent progress of moving plane methods for higher order and fractional order semilinear equations on hyperbolic spaces. To overcome the aforementioned difficulty, we applied the Helgason–Fourier analysis technique and Hardy–Littlewood–Sobolev inequalities and developed a moving plane argument towards the integral forms. Moreover, we applied our method to study the overdetermined problem of some integral equations. These results are joint work with Guozhen Lu, Qiaohua Yang and Jianxiong Wang.

ROTH’S TYPE THEOREMS ON POLYNOMIAL PROGRESSION.

Xiaochun Li

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We present some progress on polynomial progression in finite fields and/or in real line. Many questions are still open in this field.

EXISTENCE OF FOURIER SERIES ON EUCLIDEAN SUBSETS

Bochen Liu

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Fourier series is a very powerful tool in nature. In this talk we will introduce different types of Fourier basis, such as orthogonal basis, Riesz basis, frames, etc., and discuss about their existence on Euclidean subsets.

THE KHAVINSON CONJECTURE AND THE SCHWARZ-PICK INEQUALITY
FOR HARMONIC FUNCTIONS

Congwen Liu

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In this talk, we present a proof of the Khavinson conjecture which states that, for bounded harmonic functions on the unit ball of \mathbb{R}^n , the sharp constants in the estimates for their radial derivatives and for their gradients coincide. As a consequence, we also establish an inequality of Schwarz-Pick type for harmonic functions on the unit ball of \mathbb{R}^n .

DIVERGENCE AND CURL WITH FRACTIONAL ORDER

Liguang Liu

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Based on a joint work with Professor Jie Xiao at Memorial University, we will talk about some analysis results for function space norms and PDEs within the fractional-nonlocal pair $\{\operatorname{div}^s \mathbf{v}, \operatorname{curl}^s \mathbf{v}\}$ that extends the classical-local pair $\{\operatorname{div} \mathbf{v}, \operatorname{curl} \mathbf{v}\}$.

MULTIPLE FOURIER SERIES AND SINGULAR PHENOMENA

Eiichi Nakai

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On the Fourier series, the Gibbs-Wilbraham phenomenon is well known. In 1993, Pinsky, Stanton and Trapa showed that, for the Fourier series of the indicator function of a d -dimensional ball with $d \geq 3$, the spherical partial sum diverges at the center of the ball. In 2010, the third phenomenon was discovered by Kuratsubo. Namely, for the Fourier series of the indicator function of a d -dimensional ball with $d \geq 5$, the spherical partial sum diverges at all rational points, while it converges almost everywhere. In this talk we give the convergence properties and singular phenomena on the spherical partial sum for the Fourier series of some radial functions. This is a joint work with Professor Shigehiko Kuratsubo (Hirosaki University).

INVERSE BRASCAMP-LIEB INEQUALITIES VIA FLOW APPROACH

Shohei Nakamura

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This talk is based on the joint work with Neal Bez (Saitama) and Hiroshi Tsuji (Osaka). The main object in this talk is "inverse type" of Brascamp–Lieb inequalities which is recently introduced and studied by Chen–Dafnis–Paouris and Barthe–Wolff. In particular, Barthe–Wolff established the counterpart of Lieb’s fundamental theorem for the inverse type which states that the sharp constant of the inequality is exhausted by centered gaussians. Their proof is based on the mass-transport technique and hence it was expected that there should be some flow monotonicity proof. We provide the alternative proof of Barthe–Wolff’s theorem by flow monotonicity and moreover derive certain improvement by restricting inputs into some regularised class by heat equation. Applying our result, we in particular derive some stability type estimate for the hypercontractivity inequality.

DECOUPLING INEQUALITIES FOR QUADRATIC FORMS

Changkeun Oh

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In this talk, I will present some recent progress on decoupling inequalities for some translation- and dilation-invariant systems (TDI systems in short). In particular, I will emphasize decoupling inequalities for quadratic forms. Joint work with Shaoming Guo, Pavel Zorin-Kranich, and Ruixiang Zhang.

MAXIMAL OPERATOR ASSOCIATED WITH FAMILIES OF FLAT CURVES

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Let γ be a convex curve satisfying $\gamma(0) = \gamma'(0) = 0$ and $t\gamma''(t) \geq \varepsilon\gamma'(t)$.

We consider the L^p boundedness of maximal operator associated with families of flat curves $(t, 2^k\gamma(t))$.

We will discuss the history of problems and explain the difficulties occurred when considering flat curves.

This talk is based on a joint work with Joonil, Kim.

MAXIMAL AVERAGES OVER CURVES IN HIGHER DIMENSIONS

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In this talk, we are concerned with maximal operators associated to averages over nondegenerate curves. We discuss the L_p boundedness of the maximal operators. For this purpose, we investigate local smoothing estimates of averages over curves. We obtain the local smoothing estimate of sharp order for averages over curves. As a consequence, we establish L_p boundedness of maximal operators. This is a joint work with Hyerim Ko and Sanghyuk Lee.

EIGENFUNCTION RESTRICTION ESTIMATES OF THE LAPLACE-BELTRAMI
OPERATOR AND THEIR APPLICATIONS TO THE SCHRODINGER SETTING

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Studying the eigenfunctions of the Laplace-Beltrami operator has been an interesting topic in Harmonic Analysis and PDEs. One way to study the topic is to consider the concentration of eigenfunctions of the Laplace-Beltrami operator along submanifolds of the compact Riemannian manifolds. Ever since Burq, Gerard, and Tzvetkov, and Hu found eigenfunction restriction estimates for submanifolds, there have been studies to improve the estimates with additional assumptions. One of the assumptions is that the ambient manifolds have nonpositive sectional curvatures. In this talk, we will review the known improved eigenfunction restriction estimates of the Laplace-Beltrami operator and will discuss how these estimates can help us to understand analogous estimates of the Schrodinger operator with singular potentials, which is still an ongoing project. This is a joint work with Matthew Blair.

ON THE FUNCTIONAL INEQUALITY $f \geq f * f$

Yoshihiro Sawano

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Leeb et al. established that any real-valued integrable function satisfying $f \geq f * f$ is non-negative and have integral 1/2 (not 1). In this talk, we discuss their proof first and then consider its generalization to nilpotent Lie groups. Also we discuss the analogous equation $f \geq f * f * \dots * f$, where the convolution is m -fold. This is a joint work with Shohei Nakamura.

BOUNDEDNESS OF BILINEAR PSEUDO-DIFFERENTIAL OPERATORS ON
SOBOLEV SPACES

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In this talk, we consider the boundedness of bilinear pseudo-differential operators with symbols in the bilinear Hörmander classes $BS_{0,0}^m$. In particular, we discuss the boundedness of these operators on Sobolev spaces. I will introduce that, in contrast to the linear case, we need some restrictions on the exponents of Sobolev spaces to assure the boundedness.

BILINEAR BOCHNER-RIESZ MEANS AND APPLICATIONS

Kalachand Shuin

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In this talk we shall discuss L^p boundedness properties of bilinear Bochner-Riesz means and the corresponding bilinear square function. Further, we shall discuss several applications of the square function in the context of bilinear multipliers. In particular, we obtain results for maximal function associated with generalised bilinear Bochner-Riesz means. This extends the results proved in [1]. Another application concerns the L^p estimates for bilinear fractional Schrödinger multipliers. Finally, we improve upon a result of Grafakos, He and Honzík [2] in the context of bilinear radial multipliers and provide a dimension free sufficient condition on the bilinear multipliers for $L^2 \times L^2 \rightarrow L^1$ boundedness of the associated maximal function. The generalised bilinear spherical maximal function is a particular example of such maximal functions.

REFERENCES

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- [2] L. Grafakos, D. He and P. Honzík, *Maximal operators associated with bilinear multipliers of limited decay*. J. Anal. Math. 143(2021), no. 1, 231-251

DISCRETE DOUBLE HILBERT TRANSFORM ALONG POLYNOMIALS.

Hoyoung Song

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We obtain a necessary and sufficient condition on a polynomial $P(t_1, t_2)$ for L^p boundedness of the discrete double Hilbert transforms along polynomial surfaces $(t_1, t_2, P(t_1, t_2))$ for $1 < p < \infty$. This is joint work with Joonil Kim.

THE ENERGY DECAY OF THE DAMPED FRACTIONAL KLEIN-GORDON EQUATION

Soichiro Suzuki

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We study the energy decay of the s -fractional Klein-Gordon equation with space-dependent damping on \mathbb{R} . W. Green (2020) showed that if $s \geq 2$, then the so-called geometric control condition (GCC) of the damping is necessary and sufficient for the exponential decay of the energy. On the other hand, in the case $s < 2$, GCC is enough for the polynomial decay but not for the exponential decay. In fact, he also proved that if the energy decays exponentially for $s < 2$, then the damping coefficient function must be positive almost everywhere, in addition to GCC. In this talk, we will give

a necessary and sufficient condition for the exponential decay in the case $s < 2$. This is joint work with Kotaro Inami.

CHOQUET INTEGRALS, HAUSDORFF CONTENT AND SPARSE OPERATORS

Hitoshi Tanaka

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Let H^d , $0 < d < n$, be the dyadic Hausdorff content of \mathbb{R}^n . It is shown that H^d counts Cantor set of the interval $[0, 1]$ as 1, which implies unboundedness of the sparse operator S on $L^p(H^d)$, $p > 0$. In this talk we prove that the sparse operator S maps $L^p(H^d)$, $1 \leq p < \infty$, into an associate space of certain Orlicz-Morrey type spaces. We also give some another characterizations of those associate spaces using the tiling of \mathbb{R}^n .

CONVERGENCE OF A NONLOCAL TO A LOCAL DIFFUSE INTERFACE
MODEL FOR TWO-PHASE FLOW WITH UNMATCHED DENSITIES

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We prove convergence of suitable subsequences of weak solutions of a diffuse interface model for the two-phase flow of incompressible fluids with different densities with a nonlocal Cahn-Hilliard equation to weak solutions of the corresponding system with a standard “local” Cahn-Hilliard equation. The analysis is done in the case of a sufficiently smooth bounded domain with no-slip boundary condition for the velocity and Neumann boundary conditions for the Cahn-Hilliard equation. The proof is based on the corresponding result in the case of a single Cahn-Hilliard equation and compactness arguments used in the proof of existence of weak solutions for the diffuse interface model. This talk is based on a joint work with Helmut Abels (Regensburg University, Germany).

STRICHARTZ ESTIMATES ON ASYMPTOTICALLY HYPERBOLIC MANIFOLDS

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In this talk, I will discuss our recent works concerning Strichartz type estimates for wave equations on asymptotically hyperbolic manifolds. As a sample application, we prove an analog of the Strauss conjecture on asymptotically hyperbolic manifolds. It is based on my joint works with Yannick Sire, Christopher D. Sogge and Junyong Zhang.

A TWO TERM KUZNECOV SUM FORMULA

Yakun Xi

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A period integral is the average of a Laplace eigenfunction over a compact submanifold. Much like for the Weyl law, one can obtain improved estimates on period integrals given geometric or dynamical assumptions on the geodesic flow. While there are many results improving bounds on period integrals, there have been none which improve the remainder of the corresponding sum formula. In this talk, we discuss a recent joint work with Emmett Wyman. We show that an improvement to the remainder term of this sum formula reveals a lower-order oscillating term whose behavior can be described by the dynamics of the geodesic flow. Moreover, this oscillating second term illuminates bounds on period integrals.

GLOBAL SMALL ANALYTIC SOLUTION OF 3-D ANISOTROPIC NAVIER-STOKES SYSTEM

Ping Zhang

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In this talk, we prove the global existence of analytic solution for 3D anisotropic Navier-Stokes system with initial data which is small and analytic in the vertical variable. We shall also prove that this solution will be analytic in the horizontal variables soon after $t > 0$.

A STATIONARY SET METHOD FOR ESTIMATING OSCILLATORY INTEGRALS

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Given a polynomial P of constant degree in d variables and consider the oscillatory integral

$$I_P = \int_{[0,1]^d} e(P(\xi)) d\xi.$$

Assuming d is also fixed, what is a good upper bound of $|I_P|$? In this talk, I will introduce a “stationary set” method that gives an upper bound with simple geometric meaning. The proof of this bound mainly relies on the theory of o-minimal structures. As an application of our bound, we obtain the sharp convergence exponent in the two dimensional Tarry’s problem for every degree via additional analysis on stationary sets. Consequently, we also prove the sharp $L^\infty \rightarrow L^p$ Fourier extension estimates for every two dimensional Parsell-Vinogradov surface whenever the endpoint of the exponent p is even. This is joint work with Saugata Basu, Shaoming Guo and Pavel Zorin-Kranich.

REMARKS ON LOCAL REGULARITY OF AXISYMMETRIC SOLUTIONS TO THE
3D NAVIER-STOKES EQUATIONS

Ting Zhang

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In this talk, we will present the recent progress on axisymmetric solution to the 3D Navier-Stokes equations. Moreover, we will give a new local regularity criteria. It is slightly supercritical and implies an upper bound for the oscillation of $\Gamma = ru^\theta$: for any $0 < \tau < 1$, there exists a constant $c > 0$,

$$|\Gamma(r, x_3, t)| \leq Ne^{-c|\ln r|^\tau}, \quad 0 < r \leq \frac{1}{4}.$$

This talk is based on work with Hui Chen and Taipeng Tsai.

TRACE ADAMS TYPE INEQUALITIES AND EXISTENCE OF THE EXTREMALS

Maochun Zhu

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In this talk, I will report our recent work on Trace Adams on bounded domains. By using the classic blow-up analysis, we obtain a sharp second order Trace Adams type inequalities on the bounded domains with smooth boundary, and show the existence of the extremals. This talk is based on the joint works with L. Chen, G. Lu.