The Analysis Seminar

Fourier

The seminar meets Wednesdays in WH-100E at 4:00-5:00 p.m. There are refreshments and snacks in WH-102 at 3:15.

The seminar is partly funded as one of Dean's Speaker Series in Harpur College (College of Arts and Sciences) at Binghamton University.

Organizers:Paul Loya, David Renfrew, Minghao Rostami, Emmett Wyman, Xiangjin Xu, Jia Zhao and Gang Zhou

Previous talks

- Fall 2014 to Spring 2023

Spring 2024

* **January 24th, Wednesday** (4-5pm)

Speaker : organizational meeting
Topic: organizational meeting

> ***Abstract***: organizational meeting

* **January 31st, Wednesday** (4-5pm)

Speaker :
Topic:

> ***Abstract***:

* **February 7th, Wednesday** (4-5pm)

Speaker :
Topic:

Abstract:

* **February 14th , Wednesday** (4-5pm)

Speaker:
Topic:

Abstract:

* **February 21st, Wednesday** (4-5pm)

Speaker:

Topic:

Abstract:

* **February 28th, Wednesday** (4-5pm)

Speaker:

Topic:

Abstract:

* **February 29th, Thursday (Special date)** (4-5pm)

Speaker: Alex Iosevich (Rochester)

Topic: Signal recovery, uncertainty principles and Fourier restriction theory

Abstract: We are going to consider functions $f: {\mathbb Z}_N \to {\mathbb C}$ and view them as signals. Suppose that we transmit this signal via its Fourier transform

$$\widehat{f}(m)=\frac{1}{N} \sum_{x=0}^{N-1} e^{-\frac{2 \pi i xm}{N}} f(x),$$

and that the values of $\widehat{f}(m), m \in S$, are lost. Under what circumstances is it possible to recover the original signal? We shall see how this innocent question quickly leads us into the deep dark forest of Fourier analysis.

* **March 6th, Wednesday** (4-5pm) **(Spring Break)**

Speaker:
Topic:

Abstract:

* **March 13th, Wednesday** (4-5pm)

Speaker: Daozhi Han (Buffalo)
Topic: A quasi-incompressible Chan-Hilliard-Darcy model for two-phase flows in porous media

Abstract: Two-phase flows in porous media are known as the Muskat problem. The Muskat problem can be ill-posed. In this talk, we introduce a quasi-incompressible Cahn-Hilliard-Darcy model as a relaxation of the Muskat problem. We show the global existence of weak solutions to the model. We then present a high-order accurate bound-preserving and unconditionally stable numerical method for solving the equations. The talk is based on works joint with Yali Gao and Xiaoming Wang.

* **March 20th, Wednesday** (4-5pm)

Speaker: Zachary Selk (Queen’s University, Canada)
Topic: Stochastic Calculus for the Theta Process

Abstract: The theta process is a stochastic process of number theoretical origin arising as a scaling limit of quadratic Weyl sums. It has several properties in common with Brownian motion such as its H\”older regularity, uncorrelated increments and quadratic variation. However crucially, we show that the theta process is not a semimartingale making It\^o calculus techniques inapplicable. However we show that the celebrated rough paths theory does work by constructing the iterated integrals - the ``rough path” - above the theta process. Rough paths theory takes a signal and its iterated integrals and produces a vast and robust theory of stochastic differential equations. In addition, the rough path we construct can be described in terms of higher rank theta sums.

* **March 27th, Wednesday** (4-5pm)

Speaker:
Topic:

Abstract:

* **April 3rd, Wednesday** (4-5pm)

Speaker:
Topic:

Abstract:

* **April 10th, Wednesday** (4-5pm)

Speaker:
Topic:

Abstract:

* **April 17th, Wednesday** (4-5pm)

Speaker: Christopher Sogge (Johns Hopkins University)
Topic: Curvature and harmonic analysis on compact manifolds

Abstract: We shall explore the role that curvature plays in harmonic analysis on compact manifolds. We shall focus on estimates that measure the concentration of eigenfunctions. Using them we are able to affirm the classical Bohr correspondence principle and obtain a

new classification of compact space forms in terms of the growth rates of various norms of (approximate) eigenfunctions.

This is joint work with Xiaoqi Huang following earlier work with Matthew Blair.

About the Speaker: Christopher Sogge is the J. J. Sylvester Professor of Mathematics at Johns Hopkins University and the editor-in-chief of the American Journal of Mathematics. His research concerns Fourier analysis and partial differential equations. He graduated from the University of Chicago in 1982 and earned a doctorate in mathematics from Princeton University in 1985 under the supervision of Elias M. Stein. He taught at the University of Chicago from 1985 to 1989 and UCLA from 1989 to 1996 before moving to Johns Hopkins University, where he was chair from 2002 to 2005. He gave an invited talk at the International Congress of Mathematicians in Zurich in 1994 and became one of the inaugural fellows of the American Mathematical Society in 2012. He has received numerous awards including a National Science Foundation Postdoctoral Fellowship, Presidential Young Investigator Award, and a Sloan Fellowship. He was named both a Guggenheim and a Simons Fellow. He received the Diversity Recognition Award from JHU in 2007 and earned the distinction of JHU Professor of the Year in 2014.

* **April 24th, Wednesday** (4-5pm) **(Passover Break)**

Speaker:
Topic:

Abstract:

* **May 1st, Wednesday** (4-5pm)

Speaker: Cheng Wang (UMass-Dartmouth)
Topic: Numerical Analysis of a positivity-preserving, energy-stable, and convergent scheme for the Poisson-Nernst-Planck system

Abstract: A finite difference numerical scheme is proposed and analyzed for the Poisson-Nernst-Planck equation (PNP) system. To understand the energy structure of the PNP model, we make use of the Energetic Variational Approach (EnVarA), so that the PNP system could

be reformulated as a non-constant mobility, conserved gradient flow, with singular logarithmic energy potentials involved. To ensure the unique solvability and energy stability, the mobility function is explicitly treated, while both the logarithmic and the electric potential diffusion terms are treated implicitly, due to the convex nature of these two energy functional parts. The positivity-preserving property for both concentrations is established at a theoretical level. This is based on the subtle fact that the singular nature of the logarithmic term around the value of 0 prevents the numerical solution from reaching the singular value so that the numerical scheme is always well-defined. In addition, an optimal rate convergence analysis is provided in this work, in which many highly non-standard estimates have to be involved, due to the nonlinear parabolic coefficients. The higher-order asymptotic expansion (up to third-order temporal accuracy and fourth-order spatial accuracy), the rough error estimate (to establish the discrete maximum norm bound), and the refined error estimate have to be carried out to accomplish such a convergence result. In our knowledge, this work will be the first to combine the following three theoretical properties for a numerical scheme for the PNP system: (i) unique solvability and positivity, (ii) energy stability, and (iii) optimal rate convergence. A few numerical results are also presented in this talk, which demonstrates the robustness of the proposed numerical scheme.

* **May 8th, Wednesday** (4-5pm)

Speaker:
Topic:

Abstract:

Fall 2023

* **August 23rd, Wednesday** (3:30-4:30pm)

Speaker :
Topic: organizational meeting

* **August 30th, Wednesday** (3:30-4:30pm)

Speaker : Emmett Wyman (Binghamton University)
Topic: Can You Hear Where a Drum is Struck?

Abstract: When you hit a drum, the sound it makes is a mix of overtones with frequencies corresponding to the drum's Laplace eigenvalues. A classic paper by Kac [“Can one hear the shape of a drum?” 1966] asks if the frequencies of these overtones uniquely determine the shape of the drum head. This question is still richly studied.

Yakun Xi and I recently posed a related question: Can one hear where a drum is struck? Imagine you know a drum's shape. Could you determine where it is struck, up to symmetry, by listening also to the amplitudes of these overtones?

In this talk, I will state this problem precisely, give additional physical interpretations, work some examples, and share our results so far while trying to not get too deep into the details.

* **September 6th, Wednesday** (3:30-4:30pm)

Speaker :
Topic: No talk this week

Abstract:

* **September 13th, Wednesday** (3:30-4:30pm)

Speaker : Zongyuan Li (Binghamton University)
Topic: Liouville-type theorems for conformally invariant PDEs

Abstract: In this talk, we discuss Liouville-type theorems for several conformally invariant elliptic PDEs. These equations, also commonly known as``nonlinear Yamabe problems'', find their applications in studying conformal metrics on Riemannian manifolds. Based on recently joint works with Baozhi Chu and Yanyan Li (Rutgers).

* **September 20th, Wednesday** (3:30-4:30pm)

Speaker : Xiangjin Xu (Binghamton University)
Topic: Sharp estimates of the heat kernel and Green's function on the manifold with nonnegative Ricci curvature

Abstract: The heat kernel and Green's function are the minimal fundamental solutions of the heat equation and Laplace equation respectively, which play very important roles in many problems in PDEs and geometric analysis. The dependence of the global behavior of the heat kernel and Green's function on the large-scale geometry of M is an interesting and important problem that has been intensively studied during the past few decades by many mathematicians.

In this talk, on a complete Riemannian manifold (M,g) with $Ric(M)\geq 0$, I will discuss my recent work on the sharp estimates of the heat kernel and Green's function, based on the sharp Li-Yau's Harnack inequality, Cheeger-Yau's heat kernel comparison Theorem, and Bishop-Gromov's volume comparison Theorem on such a manifold. We first prove sharp two-side Gaussian bounds for the heat kernel, then we obtain the rigidity of R^n with respect to the asymptotic lower bound of the heat kernel and the sharp gradient estimates on the logarithmic heat kernel. Secondly, on a complete manifold with $Ric(M)\geq 0$ and Euclidean volume growth, we prove the new pointwise lower and upper bounds for the heat kernel by a natural geometric quantity that is characterized by the decay rate of the Bishop–Gromov quantities. As applications of the two side bounds, we obtain the large-scale behavior (asymptotics) of the heat kernel and Green's function on such a manifold.

* **September 27th, Wednesday** (3:30-4:30pm)

Speaker :
Topic:

Abstract:

* **October 4th , Wednesday** (3:30-4:30pm)

Speaker: Jia Zhao (Binghamton University)
Topic: When Differential Equations Meet Computation: A Friendly Introduction to Numerical Analysis for DEs

Abstract: Differential equations are a pillar in the field of mathematical analysis, revealing complex behaviors in nature, science, and engineering. However, providing analytical solutions for them often presents significant challenges, especially in real-world applications. This is where computational mathematics comes into play. In this talk, we'll explore the realm where rigorous analysis intersects with the practicality of numerical methods, offering a friendly introduction to the numerical analysis of (partial) differential equations. This presentation is crafted to be accessible to a general audience, with no prior knowledge of computational methods necessary.

* **October 11th, Wednesday** (3:30-4:30pm)

Speaker:

Topic:

Abstract:

* **October 18th, Wednesday** (3:30-4:30pm)

Speaker:
Topic: fall break

Abstract:

* **October 25th, Wednesday** (3:30-4:30pm)

Speaker:

Topic:

Abstract:

* **November 1st, Wednesday** (3:30-4:30pm)

Speaker:
Topic:

Abstract:

November 8th, Wednesday (3:30-4:30pm)

Speaker:
Topic:

Abstract:

* **November 15th, Wednesday** (3:30-4:30pm)

Speaker:
Topic:

Abstract:

* **November 22nd, Wednesday** (3:30-4:55pm)

Speaker:
Topic: Thanksgiving break

Abstract:

* **November 29th, Wednesday** (3:30-4:30pm)

Speaker:
Topic:

Abstract:

* **December 6th, Wednesday** (3:30-4:30pm)

Speaker:
Topic:

Abstract: