MATRIX Research Program:
Harmonic Analytic Connections

Titles and Abstracts

Hong Wang (NYU)

Title: Incidence estimate and oscillatory integrals.
Abstract: We will discuss some recent multi-scale method on incidence estimate for tubes and its application to oscillatory integrals. The multi-scale method was developed by Keleti-Shmerkin, Orponen, Shmerkin, etc.

Camil Muscalu (Cornell)

Title: A new approach to the Fourier Extension Problem for the paraboloid
Abstract: The plan of the talk is to describe a new approach to the so-called Restriction Conjectures, that Itamar Oliveira and I have developed recently. Without entering into details, this new point of view allows one to prove that (essentially) all the relevant conjectures (linear or multi-linear) are true, provided that one of the functions involved has a tensor structure.

Malabika Pramanik (UBC)

Title: Numbers – are they normal?
Abstract: They say the only normal people are the ones you don't know very well. What about numbers? Which ones are normal, and how well do we know them?

The notion of mathematical normality is related to the occurrence of different digits in a number. Roughly speaking, a normal number is one in which every block of digits appears with the same limiting frequency. For example, 0.12345678910111213.. is normal in base 10, but 0.1212121212… is not. Normality of numbers is connected to many areas of mathematics, like iophantine approximation, ergodic theory, geometric measure theory, analysis and computer science.

We will discuss a few open problems about normal numbers that lie at the intersection of harmonic analysis and measure theory and mention some recent progress on them.

Carlos Perez (University of the Basque Country and BCAM)

Title: Connections between Harmonic Analysis and the self-improving property of the oscillation of a function
Abstract: In this lecture, we will show connections between Harmonic Analysis and certain fundamental estimates, such as the Poincar\'e-Sobolev, Trudinger or John-Nirenberg inequalities. The basic theme is the self-improving property of generalized Poncar\'e type inequalities. Through this exploration, we will demonstrate how these connections allow us to avoid the dependence on Potential Operators. This approach is more flexible but also produces more precise estimates, particularly when dealing with singular measures. We will outline some old results which can be improved in modern ways which include fractional type results improving some celebrated results by Bourgain-Brezis-Mironescu.

Zane Li (North Carolina State University)

Title: Comparing and contrasting decoupling and efficient congruencing
Abstract: Vinogradov's Mean Value Theorem (VMVT) was proven by Bourgain-Demeter-Guth in 2015 as a corollary of decoupling for the moment curve. Roughly parallel in time, Wooley was developing the theory of efficient congruencing which culminated in the nested efficient congruencing proof of VMVT in 2017. We compare and contrast both decoupling and efficient congruencing methods and justify how in some sense efficient congruencing is some sort of "p-adic decoupling".

Jongchon Kim (City University of Hong Kong)

Title: Weighted decoupling inequalities and the convergence of Bochner-Riesz means
Abstract: In this expository talk, I will discuss some weighted l^p-decoupling inequalities recently discovered by Gan and Wu and its application to the problem on the almost everywhere convergence of the Bochner-Riesz means for L^p functions for p<2.

Larry Guth (MIT)

Title: A new approach to bounding large values of Dirichlet polynomials.

Abstract: Bounds for Dirichlet polynomials help to bound the number of zeroes of the Riemann zeta function in vertical strips, which is relevant to the distribution of primes in short intervals. A Dirichlet polynomial is a trigonometric polynomial of the form

$$D(t) = \sum_{n = N}^{2N} b_n n^{it}.$$

The main question is about the size of the superlevel sets of D(t). We normalize so that the coefficients have norm at most 1, and then we study the superlevel set $|D(t)| > N^\sigma$ for some exponent sigma between ½ and 1.

For large values of sigma, Montgomery proved very strong bounds for the superlevel sets. But for sigma $\le$ ¾, the best-known bounds follow from a very simple orthogonality argument (and they don't appear to be sharp). We improve the known bounds for sigma slightly less than ¾. Work in progress. Joint with James Maynard.

Ruixiang Zhang (UC Berkeley)

Title: How to produce curved Kakeya sets that are small

Abstract: This talk concerns curved Kakeya sets coming from the study of H\"{o}rmander type operators. When the "position function" is good enough, there is a conceptual way to approach the problem of whether curved Kakeya sets can be small. I will talk about this viewpoint and present some results and questions, explained by examples.
