Julia Wolf

Title: The structure of stable sets

Abstract: A long-standing open problem in additive number theory is the following: how large does a set of integers have to be before it is guaranteed to contain a non-trivial arithmetic progression of length 3?

In the first half of this talk we shall survey recent progress on this problem, and the techniques used to solve it and related questions about additive structures in finite abelian groups. In particular, we shall explain the idea behind the so-called "arithmetic regularity lemma" pioneered by Green, which is a group-theoretic analogue of Szemerédi's celebrated regularity lemma for graphs.

In the second half of the talk we shall describe recent joint work with Caroline Terry (University of Chicago), which shows that under the natural model-theoretic assumption of stability the conclusions of the arithmetic regularity lemma can be significantly strengthened, leading to a characterisation of stable subsets of finite abelian groups.

Emmanuel Kowalski

Title: Random / not Random

Abstract: Number theory provides many examples of simple-looking deterministic objects whose individual behavior seems impossible to control, but which turn out to have striking randomness properties. We will survey some of these phenomena, and highlight the fascinating connections with other areas of mathematics that arise when one attempts to understand them, as well as some applications of this randomness of arithmetic objects, especially in de-randomizing various constructions in combinatorics or analysis.

Holly Krieger

Title: Uniform techniques in arithmetic geometry and dynamics

Abstract: I will discuss joint work with Laura DeMarco and Hexi Ye in which we use dynamically-inspired techniques to prove uniform bounds on the number of common torsion points of distinct elliptic curves over the complex numbers. I will explain our strategy, which has general application to proving uniform bounds in unlikely intersections, and deduce a uniform Manin-Mumford result for a family of genus 2 curves.

Leslie Valiant

Title: Holographic Algorithms

Abstract: When are two mathematical functions the same? One might think that this can be generally answered immediately from their definitions. However, functions may have numerous dissimilar alternative definitions. Fortunately, sameness can be often demonstrated systematically by certain linear mappings internal to the function definitions. These mappings, called holographic transformations, offer a powerful tool for showing that a function class is equivalent to one known to be efficiently computable, or, alternatively, that it is equivalent to one known to be in a completeness class suspected of being computationally intractable. We shall survey these ideas and their applications in computational complexity.

Hugo Duminil-Copin

Title: Triviality of the 4D Ising Model

Abstract: (Quantum) Field theory is a powerful tool in modern physics enabling one to perform many computations. For decades, mathematicians asked themselves whether fields involved in these theories can be rigorously defined, for instance in the famous case of Yang-Mills, and for a simpler example of phi4.

Since the work of Wightman in the sixties, mathematicians have launched a program, entitled Constructive (quantum) Field Theory whose goal was to construct the phi4 theory rigorously. After successes by Glimm and Jaffe in dimensions 2 and 3, the program took a bit hit with the works of Aizenman and Frohlich in 1982 proving that constructions of phi4 in dimension 5 (and more) based on the Ising model and the lattice phi4 model were necessary leading to a Gaussian theory, considered by physicists as a trivial theory. This being said, a certain mystery surrounded the case of dimension 4 (which is the most interesting physical dimension corresponding to 3 spatial and one time dimension), leaving open the question of whether the phi4 theory in 4D is Gaussian.

The goal of this talk is to present a recent result obtained with Michael Aizenman proving the equivalent of the famous Aizenman-Frohlich result in 4D. The talk with start with a historical and motivating part (we will in particular define the phi4 model heuristically), before going to the description of the result and the probabilistic interpretation enabling one to understand it. No background is necessary.

Melody Chan

Title: Algebraic and tropical moduli spaces

Abstract: The moduli space of genus g Riemann surfaces, denoted M_g, has been studied for more than a century, yet much of its geometry is still a mystery. For example, in the 1980s Harer and Zagier showed that the Euler characteristic (up to sign) grows super-exponentially with g---yet most of this cohomology is not explicitly known. The first part of my talk will be a prerequisite-free introduction to moduli spaces and M_g. Then, I will discuss some recent results, joint with Galatius and Payne, that we obtained on the cohomology of M_g, using graphs and tropical geometry.

Bianca Viray

Title: Isolated points on families of curves

Abstract: Let C be an algebraic curve over Q, i.e., a 1-dimensional complex manifold defined by polynomial equations with rational coefficients. A celebrated result of Faltings implies that all algebraic points on C come in families of bounded degree, with finitely many exceptions. These exceptions are known as isolated points. We explore how these isolated points behave in families of curves and deduce consequences for the arithmetic of elliptic curves. This talk is on joint work with A. Bourdon, Ö. Ejder, Y. Liu, and F. Odumodu.

Kannan Soundararajan

Title: Integral Factorial Ratios

Abstract: I will describe a new approach to classifying integral factorial ratios, obtaining a direct proof of a result of Bober. These results generalize an observation going back to Chebyshev that (30n)!n!/((15n)! (10n)!(6n)!) is an integer for all natural numbers n. Due to the work of Rodriguez-Villegas and Beukers and Heckman, this problem is closely related to classifying hypergeometric functions with finite monodromy groups, and the result of Bober was originally derived as a consequence of the work of Beukers--Heckman. The new proof is elementary and makes partial progress on other related questions.