Tuesday, Dec. 3, 2019

Huanchen Bao

Title: The m=2 amplituhedron

Abstract: An amplituhedron (defined in terms of totally nonnegative Grassmannians) is a geometric structure introduced in 2013 by two physicists Nima Arkani-Hamed and Jaroslav Trnka. It enables simplified calculation of particle interactions in some quantum field theory. In this talk. I shall give an introduction of the subject (from a mathematical point of view), and time permitting, explain the triangulation of the m=2 amplituhedron. This is based on joint work with Xuhua He.

Zhen Huan

Title: Level Structures and Morava E-theory.

Abstract: It is a historical problem how elliptic cohomology can classify the geometric structures on the corresponding elliptic curve. Strickland proved that the Morava E-theory of the symmetric group modulo a certain transfer ideal classifies the power subgroups of its formal group. Stapleton proved this result for generalized Morava E-theory via transchromatic character theory. And Huan proved that the subgroups of the Tate curve can be classified in the same way using quasi-elliptic cohomology. In this talk we show Strickland's theorem is also true for the classification of the level structes of generalized Morava E-theory via Hopkins-Kuhn-Ravenel character theory. This result gives further indications that Strickland's result holds for elliptic cohomology theories.

Antoine Song

Title: Morse index, Betti numbers and singular set of bounded area minimal hypersurfaces

Abstract: For minimal hypersurfaces with a uniform area bound and with a codimension at least 7 singular set in a closed manifold, we show quantified bounds for the total Betti number or the size of the singular set in terms of the Morse index. The proofs are based on an essentially combinatorial argument.

Binbin Xu

Title: Ambartzumian-Pleijel identity in hyperbolic geometry

Abstract: Given a convex compact domain with C1 boundary in the Euclidean plane, we can define the length function on the space of straight lines which sends each line to the length of its intersection with this domain. Using this length function, the measure on the space of lines invariant under the isometries of Euclidean plane induces a distribution on the real line. The Ambartzumian-Pleijel identity is about computing the integral of any real valued C1 function on the real line with respect to this distribution. In this talk, we'll introduce its counterpart in hyperbolic geometry. We will show that by well choosing the functions that we integrate, the identity can be used to prove different results, including Croftin formula and the isoperimetric inequality for the hyperbolic plane. We will also discuss its generalizations in other contexts.

Wednesday, Dec. 4, 2019

Wei Qian

Title: On Brownian loop-soup clusters

Abstract: Brownian loop-soups were introduced by Lawler and Werner in 2004. They are closely related to many other important objects in dimension two which arise naturally from statistical physics models and which satisfy the conformal invariance property.

We plan to describe our recent works on the geometric features of the Brownian loop-soup clusters. The first result is based on joint work with Werner. Among other things, we obtain the following decomposition of the clusters with critical intensity: When one conditions a loop-soup cluster by its outer boundary l, then the union of all excursions away from l by all the Brownian loops in the loop-soup that touch l is distributed exactly like the union of all excursions of a Poisson point process of Brownian excursions in the domain enclosed by l.

This then motivates a more recent work on the question of whether there exist double points on the boundaries of clusters. More precisely, we introduce and compute the generalized disconnection exponents. This allows us to obtain the first prediction of the dimension of multiple points on the cluster boundaries in Brownian loop-soups. We plan to rigorously confirm the prediction in a future work. According to our prediction, there exist double points on the cluster boundaries of Brownian loop-soups with any subcritical intensity. Interestingly, for the critical intensity, the dimension of double points on the cluster boundaries becomes zero, leaving an open question of whether such points exist for the critical loop-soup.

Liying Li

Title: Stationary solutions for stochastic Burgers equation and infinite-volume polymer measures

Abstract: Ergodic properties of the stochastic Burgers equation and more general Hamilton—Jacobi equations have been studied in various setting; in 1D, these equations are also believed to sit in the Kardar—Parisi—Zhang universality class. In this talk, the 1D viscous Burgers equation forced by a time-discrete, space-time ergodic random field is considered. We will construct and classify all its stationary solutions, and prove a One—Force—One—Solution principle for the equation. Via the Feynman—Kac formula, this is related to the infinite-volume limit of a directed polymer model. We also study the inviscid limit of the stationary solutions and the zero-temperature limit of the polymer measures. A straightness estimate is established for polymer measures, the analog of which first appeared in the study of the behavior of long geodesics in first-/last-passage percolation. This is joint work with Yuri Bakhtin (NYU).

Xi Chen

Title: Microlocal analysis and inverse problems of wave equations

Abstract: Microlocal analysis studies the structure of differential operators on the cotangent bundle of the underlying space. It has seen a remarkable variety of applications across inverse problems of PDEs since 1980s. We shall look at the use of the microlocal description of the fundamental solutions to wave equations to the recovery of the geometry. Specifically, the following particulars will be discussed.

1. Melrose-Uhlmann's intersecting Lagrangian distributions, developed from Hörmander's Fourier integral operators, describe the fundamental solutions to linear hyperbolic equations.
2. This microlocal description is used to understand the source-to-solution map of semilinear connection wave equations and the Yang-Mills equations in terms of parallel transport associated with the connection.
3. The source-to-solution map determines a broken scattering transform, the injectivity of which solves the geometric inverse problem.

Thursday, Dec. 5, 2019

Zihui Zhao

Title: Boundary regularity of area-minimizing currents: a linear model with analytic interface

Abstract: Given a curve \Gamma, what is the surface T that has smallest area among all surfaces spanning \Gamma? This classical problem and its generalizations are called Plateau's problem. In this talk we consider area minimizers among the class of integral currents, or roughly speaking, orientable manifolds. Since the 1960s a lot of work has been done by De Giorgi, Almgren, et al to study the interior regularity of these minimizers. Much less is known about the boundary regularity, in the case of codimension greater than 1. I will speak about some recent progress in this direction.

Yang Lan

Title: Dynamics of threshold solutions for energy-critical fourth order NLS

Abstract: We consider the energy-critical fourth order non-linear focusing Schr\"odinger equation with radial data. An explicit stationary solution for this equation is known, which is also called the ground state. Its energy has been shown as a threshold for solutions of this equation, where the dynamical behavior of solutions with energy strictly below the ground state is known. In this talk, we will study the long time dynamical behavior of solutions with threshold energy, using the concentration compactness argument and modulation theory. This also provides a comprehensive dynamical characterization of the ground state.

Yifei Zhu

Title: Algebraic topology and arithmetic

Abstract: Power operations are natural transformations on generalized cohomology theories. In a precise way, they lift Frobenius maps on commutative rings. They have powerful applications to questions beyond classical algebraic topology, such as in Voevodsky's proof of the Milnor conjecture. In the context of an "elliptic" cohomology theory, its characteristic classes tie its power operations intimately with the arithmetic of a family of elliptic curves. I'll discuss some of these aspects, including explicit calculations of the power operation algebra and integral models for modular curves.

Zhouli Xu

Title: The geography problem on 4-manifolds: 10/8 + 4

Abstract: A fundamental problem in 4-dimensional topology is the following geography question: "which simply connected topological 4-manifolds admit a smooth structure?" After the celebrated work of Kirby-Siebenmann, Freedman, and Donaldson, the last uncharted territory of this geography question is the "11/8-Conjecture". This conjecture, proposed by Matsumoto, states that for any smooth spin 4-manifold, the ratio of its second-Betti number and signature is least 11/8.

Furuta proved the "10/8+2"-Theorem by studying the existence of certain Pin(2)-equivariant stable maps between representation spheres. In this talk, we will present a complete solution to this problem by analyzing the Pin(2)-equivariant Mahowald invariants. In particular, we improve Furuta's result into a "10/8+4"-Theorem. Furthermore, we show that within the current existing framework, this is the limit. This is joint work with Mike Hopkins, Jianfeng Lin and XiaoLin Danny Shi.