Geometry, Quantum Topology and Asymptotics

List of Abstracts

Jørgen Ellegaard Andersen, Aarhus University
The Hitchin connection, degenerations in Teichmüller space and SYZ-mirror symmetry

In this talk we will examine the asymptotics of the Hitchin connection near a part of the Thurston boundary of Teichmüller space. We will find that this will lead us to the specification of a basis for the geometric quantization of the moduli spaces of semi-stable holomorphic bundles on a Riemann surface. We shall end the talk with a discussion on how one might relate this basis to SYZ-mirror symmetry.

Murad Alim, Harvard University
Topological String Lie Algebra

The special geometry of Calabi–Yau threefold moduli spaces allows one to define a set of functions which form a differential ring with finitely many generators. These generators can be thought of as a parameterization of larger moduli space. In this larger space, the composition of certain vector fields with the Gauss–Manin connection defines a Lie Algebra. This Lie Algebra provides a holomorphic and algebraic reformulation of the BCOV anomaly equations. The topological string amplitudes, which yield higher genus generating functions of Gromov–Witten invariants, are polynomials in the generators of the differential ring, which generalizes quasi-modular forms. This is based on joint and ongoing work with H. Movasati, E. Scheidegger and S. T. Yau.

Vladimir Bazhanov, Australian National University
From Fuchsian Differential Equations to Integrable Quantum Field Theory

We establish an intriguing correspondence between an infinite set of special solutions of the (classical) modified sinh-Gordon equation and a set of stationary states in the finite-volume Hilbert space of the integrable 2D QFT invented by V.A. Fateev. The modified sinh-Gordon equation arise in this case as a zero-curvature condition for a class of multivalued connections of the punctured Riemann sphere, similarly to Hitchin's self-duality equations. The proposed correspondence between the classical and quantum integrable systems provides a powerful tool for deriving functional and integral equations which determine the full spectrum of local integrals of motion for massive QFT in a finite volume. Potential applications of our results to the problem of non-perturbative quantization of classically integrable non-linear sigma models are briefly discussed. The talk is based on recent joint work with Sergei Lukyanov.

Gaëtan Borot, Max Planck Institute
SU(N) Chern–Simons in Seifert spaces at large N: a matrix model analysis

The partition function of SU(N) Chern-Simons theory on M = Seifert space can be written as a matrix model, and the colored HOMFLY of basic knots (those going along generators of $\pi_1(M)$) as the correlators of this model. From there follows that the large N expansions satisfy the topological recursion. The task is then to compute the initial data, i.e. the spectral curve. For this purpose, we use a machinery based on pseudoreflection groups and root systems. We obtain many information on the spectral curves, which in turn have consequences for analyticity properties of (the large rank expansion of) quantum knot invariants.

This is a joint work with Bertrand Eynard.

Kwok Wai Chan, The Chinese University of Hong Kong
SYZ and HMS for toric CY manifolds

In this talk, I will explain my joint work in progress with Daniel Pomerleano and Kazushi Ueda on the study of homological mirror symmetry (HMS) for toric Calabi–Yau (CY) manifolds from the viewpoint of the Strominger–Yau–Zaslow (SYZ) conjecture.

Tudor Dimofte, Institute for Advanced Study
A Spectral Perspective on Neumann–Zagier

Thurston's gluing equations for ideal hyperbolic triangulations have certain symplectic properties, initially discovered by Neumann and Zagier, that underlie the formulation of many classical and quantum 3-manifold invariants. It has long been suspected that these symplectic properties have an intrinsic topological interpretation. I will explain such an interpretation based on branched covers of 3-manifolds and their boundaries. (Work with R. van der Veen.)

Bertrand Eynard, Institut de Physique Théorique
Topological recursion and quantum curves

Topological recursion is a universal recursion relation, which was first discovered in the context of random matrix models, then in many enumerative geometry problems. Recently it was proposed that topological recursion computes the asymptotic expansion of a wave function and its annihilator, the "quantum curve". We shall consider examples and discuss recent progress.

Hiroyuki Fuji, Tsinghua University
Colored Superpolynomial and Super-A-polynomial

In this talk, I would like to discuss q-difference structure of the colored superpolynomial for knots. The colored superpolynomial is the Poincare polynomial of the colored HOMFLY homology. In recent years, some developments in the study of colored HOMFLY homology are reported in mathematics and theoretical physics. Using such results, the colored superpolynomial becomes calculable very explicitly for some class of knots, and some novel structures of the knot homology are discovered. One of such structure is the q-difference structure, and the analogue of quantum volume conjecture is found for some knots. This talk is based on works in collaboration with Sergei Gukov, Piotr Sulkowski, and Marko Stosic.

Stavros Garoufalidis, Georgia Institute for Technology
Graph counting and the stable coefficients of the Jones polynomial

We will define the stable coefficients of the Jones polynomial of an alternating knot (using joint work with Thang Le), and show that they are polynomials in induced graph countings (joint with Sergey Norin). These polynomials are elements of a free polynomial algebra of graph countings.

An Huang, Harvard University
Tautological system for period integrals

I will talk about a generalization of the GKZ system, called the tautological system, introduced by Bong Lian, Ruifang Song, and Shing-Tung Yau, that governs period integrals of a complete intersection family in certain ambient variety with a large group action. This is based on joint works with Spencer Bloch, Bong Lian, Vasudevan Srinivas, Shing-Tung Yau, and Xinwen Zhu.

Rinat Kashaev, University of Geneva
A simple model of 4d-TQFT

We show that, associated with any complex root of unity ω, there exists a particularly simple 4d-TQFT model M_ω defined on the cobordism category of triangulations. For an oriented closed 4-manifold X of Euler characteristic $\chi(X)$, calculations make it plausible that the quantity $N^{3\chi(X)/2}M_\omega(X)$, where N is the order of ω, takes only finitely many values as a function of ω.

Louis Hirsch Kauffman, University of Illinois at Chicago
Basics of Khovanov Homology

This talk will show how the algebraic structures (Frobenius algebras) un-

derlying Khovanov homology arise from the geometry/topology of the category of surface cobordisms and how this approach to Khovanov homology illuminates many questions about its topological, geometrical and physical nature. We will use this point of view to discuss relationships of Khovanov homology with quantum statistical mechanics and quantum information theory.

Siu Cheong Lau, Harvard University
SYZ for conifold transitions of toric Calabi–Yau manifolds

I will talk about the SYZ construction of mirrors of conifold transitions of toric Calabi–Yau manifolds. The key points are wall-crossing and computation of open Gromov–Witten invariants. This gives a geometric viewpoint to the classical correspondence between Minkowski decomposition of polytopes and factorization of polynomials.

Thang Le, Georgia Institute of Technology
The Habiro ring and unified quantum invariants of 3-manifolds

Wenxuan Lu, Tsinghua University
Stability Conditions, Attractors and Mirror Symmetry

We study the space of stability conditions on K3 surfaces from the perspective of mirror symmetry in the so called attractor backgrounds which are selected by the attractor mechanism for certain black holes. We find certain non-generic behavior of stability walls (a key notion in the study of wall crossings) which corresponds via mirror symmetry to some non-generic behavior of special Lagrangians in an attractor background. This can be understood as a very simple case of mirror correspondence in a synthesis of homological mirror conjecture and SYZ mirror conjecture.

Feng Luo, Rutgers University
A dilogarithm identity on moduli spaces of curves.

We establish an identity for closed hyperbolic surfaces whose terms depend on the dilogarithms of the lengths of simple closed geodesics in all 3- holed spheres and 1-holed tori in the surface.

Vladimir Mangazeev, Australian National University
A 3D approach to the 6-vertex model

We study geometric consistency relations between angles of 3D circular quadrilateral lattices. We show that these relations generate canonical transformations of an ultra-local Poisson algebra defined on discrete 2D surfaces consisting of circular quadrilaterals. Quantization of this structure allows us to obtain a new solution of the tetrahedron equation (the 3D analog of the Yang–Baxter equation). This solution defines a nontrivial integrable 3D lattice model with positive Boltzmann weights. Further we consider a two-layer projection of this model and obtain a new expression for the higher spin $U_q(sl(2))$ R-matrix with a spectral parameter acting in the tensor product of two representations with arbitrary complex spins. Taking an infinite spin limit we construct the

Baxter's Q-operators for any highest weight representation.

Rahul Pandharipande, ETH Zrich *Counting curves on K3 surfaces: the Katz–Klemm–Vafa formula*

I will explain our recent proof (with R. Thomas) of the KKV formula governing higher genus curve counting in arbitrary classes on K3 surfaces. The subject intertwines Gromov–Witten, Noether–Lefschetz, and Donaldson–Thomas theories. A tour of these ideas will be included in the talk.

Emanuel Scheidegger, University of Freiburg
Topological string on elliptic fibrations

We discuss the relation between topological strings on Calabi–Yau threefolds and modular forms. We show that there is a special differential ring of functions which plays the analogous role of the ring of quasimodular forms in the case of elliptic curves. The existence of this ring is due to special geometry and the topological string amplitudes are polynomials in this ring. We will explain a conjecture that expresses the Gromov–Witten invariants for elliptically fibered Calabi–Yau threefolds in terms of quasimodular forms. In particular, there is a recursion relation which governs these modular forms. Evidence comes from the polynomial formulation of the higher genus topological string amplitudes with insertions.

Bernd Siebert, Universität Hamburg
Geometric quantization of semi-positive varieties inspired by mirror symmetry

The construction of maximal degenerations of Calabi–Yau pairs via wall structures comes with a distinguished basis of sections of the polarizing line bundle. In the case of abelian varieties these are classical theta functions. Following early speculations of Tyurin I will discuss possible interpretations of these generalized theta functions in terms of geometric quantization.

Roland van der Veen, University of Amsterdam
Normal surface theory according to the Jones polynomial

We explore analogies between the classical topology of normal surfaces and quantum knot invariants. An important instance of this analogy is the slope conjecture. It states that the degree of the colored Jones polynomial detects boundary slopes of essential surfaces in the knot complement. In this talk I will explain how these ideas relate to the AJ conjecture and Turaev's theory of shadows.

This is joint work with Stavros Garoufalidis.

Shing-Tung Yau, Harvard University, Chinese University of Hong Kong, Tsinghua University
Non-Kaehler Calabi–Yau Mirror Symmetry and Symplectic Structures

I will describe the extension of mirror symmetry to non-Kaehler Calabi–Yau manifolds. This has led to some recent advances in understanding the structures and cohomologies of differential forms on the symplectic side.

Don Zagier. College de France, France and Max Planck Institute for Mathematics
Kashaev invariants, Nahm sums, and modularity

Yuguang Zhang, Tsinghua University
Triviality of fibered Calabi–Yau manifolds without singular fibers

In this talk, we show that a fibered Calabi–Yau manifold is essentially a product, if there is no singular fiber. The talk is based on the joint work with Valentino Tosatti.