Geometry, Quantum Topology and Asymptotics 2018

Semaine du : **juillet 2**

	02/07 LUNDI	03/07 MARDI	04/07 MERCREDI	05/07 JEUDI	06/07 VENDREDI	07/07 SAMEDI	08/07 DIMANCHE
08:00							
08:30							
09:00	Welcome						
09:30	9:30-10:30 Du Pei: Verlinde formula for complex Chern-Simons theory	9:30-10:30 Du Pei: Verlinde formula for complex Chern-Simons theory	09:30-10:30 Yang-Hui He : The Calabi--Yau Landscape	09:30-10:30 Yang-Hui He: The Calabi--Yau Landscape	09:30-10:30 Tian Yang: Quantum invariants and volume conjectures		
10:00							
10:30			Break				
11:00	11:00-12:00 Tian Yang: Quantum invariants and volume conjectures	11:00-12:00 Du Pei: Verlinde formula for complex Chern-Simons theory	11:00-12:00 Yang-Hui He: The Calabi--Yau Landscape	11:00-12:00 Yang-Hui He: The Calabi--Yau Landscape	11:00-12:00 Gaëtan Borot: Topological and geometric recursion		
11:30							
12:00							
12:30			Lunch @ Confucius Institute				
13:00							
13:30	13:30-14:30 Gaëtan Borot: Topological and geometric recursion	13:30-14:30 Babak Haghighat: Elliptic Calabi-Yau manifolds in string theory	13:30-14:30 Babak Haghighat: Elliptic Calabi-Yau manifolds in string theory	13:30-14:30 Babak Haghighat: Elliptic Calabi-Yau manifolds in string theory			
14:00							
14:30		14:45-15:45 Gaëtan Borot: Topological and geometric recursion	14:45-15:45 Du Pei: Verlinde formula for complex Chern-Simons theory	14:45-15:45 Gaëtan Borot: Topological and geometric recursion			
15:00							
16:00		16:00-17:00 Tian Yang: Quantum invariants and volume conjectures	Cultural activity : Chinese calligraphy live performance	16:00-17:00 Tian Yang: Quantum invariants and volume conjectures			
16:30							
17:00							
17:30				Dinner at Zagara Restaurant (Quai du Seujet 18, 1201 Genève)			
18:00							
18:30							

CONTENTS

Prof. Yang-Hui HE
TITLE: The Calabi--Yau Landscape.
ABS: Motivated by physics, especially string theory and quantum field theory, we take a promenade in the landscape of Calabi-Yau geometries. We will take a computational algebro-geometric and data science driven perspective and focus on the explicit constructions and the various databases which have emerged over the decades. Finally, we discuss some recent developments in using neural networks and machine-learning to study such geometries. This subject of Calabi-Yau varieties has been a fruitful cross-fertilization between mathematics, physics and computer science.

Prof. Gaëtan Borot
TITLE: Topological and geometric recursion.
ABS: We will present the basic theory of the topological recursion (TR) invented by Eynard and Orantin, its recent lift to a geometric setting (GR) in a joint work with Andersen and Orantin, and some of its application to cohomological field theories and Gromov-Witten theory.
In a first part, we will take the perspective recently proposed by Kontsevich-Soibelman of quantization of (quadratic) Lagrangians in symplectic vector spaces. This quantization is a D-module called "quantum Airy structure" and considered as the initial data for TR. Its space of solutions has a distinguished solution which the TR computes. As a particular case, one can handle in this way 2d TQFT partition functions, Virasoro constraints for Gromov-Witten theory of a point, and W_r-constraints for its r-spin version. By studying the symmetries of quantum Airy structure, one can also reach Virasoro constraints attached to spectral curves and Virasoro constraints attached to semi-simple cohomological field theories.
In a second part, I will expose the GR construction, which leverage ideas underlying TR and Mirzakhani-McShane identities, and allows the construction of functorial assignments from a category of surfaces with morphisms given by isotopy classes of diffeomorphisms. In particular, from a small amount of initial data, GR builds mapping class group invariants, which we call GR amplitudes. We will see how this setting works to produce mapping class group invariant functions on Teichmuller space, and explain that integration of GR amplitudes over a fundamental domain of Teichmuller space satisfies TR. Conversely, we can lift any initial data for TR coming from a spectral curve, to an initial data for GR, such that the TR amplitudes are integrals of GR amplitudes over a fundamental domain of the Teichmuller space.

Prof. Babak HAGHIGHAT
TITLE: Elliptic Calabi-Yau manifolds in string theory
ABS: After giving a short overview about string theory, we proceed to the definition and construction of F-theory which is a version of string theory where the coupling constant is promoted to the complex structure of an elliptic curve. By compactifying on elliptic Calabi-Yau 3-manifolds this then leads to non-perturbative backgrounds for string theory. In the course of the lectures we show how six-dimensional quantum field theories with various gauge groups can be obtained from these Calabi-Yau threefolds and give a classification of all minimal base geometries. At the end, we outline how these constructions give rise to new 6d theories with conformal symmetry which are at the center of many current developments in the field.

TÂCHES À EFFECTUER

Prof. Tian Yang
TITLE: Quantum invariants and volume conjectures.
ABS: In this series of lectures, I will introduce two of the most important quantum invariants, the colored Jones polynomials of knots and the Turaev-Viro invariants of 3- manifolds, and talk about the volume conjectures relating them to the (hyperbolic) ge- ometry of the knots and manifolds. Roughly speaking, the volume conjectures predict that the asymptotic behavior of the quantum invariants mentioned above determines some classical invariants of the knot/3-manifold, such as the hyperbolic volume. My goal is to convince you that these conjectures are promising, interesting, and maybe ap- proachable. A working knowledge of hyperbolic geometry and knot/3-manifold theory is very helpful, but not required.

Prof. DU Pei
TITLE: Verlinde formula for complex Chern-Simons theory
ABS: Abstract: Chern-Simons theory with compact gauge group defines a 3D topological quantum field theory. The dimension of its Hilbert space on a surface is given by the renowned Verlinde formula, which has deep connections with conformal field theories, geometric quantization and quantum topology. In this mini-course, I will first construct a 1-parameter deformation of the original Verlinde formula, and then demonstrate that the new formula now gives the graded dimension of the Hilbert space of complex Chern-Simons theory.