VIASM-ICTP SUMMER SCHOOL
ON QUANTUM TOPOLOGY AND HYPERBOLIC GEOMETRY 2025

TIMETABLE

	Monday, June 9th	Tuesday, June 10th	Wednesday, June 11th	Thursday, June 12th	Friday, June 13th
08:00-09:00	Ciprian Manolescu	Ciprian Manolescu	Stavros Garoufalidis	Ciprian Manolescu 08:00 - 08:40	Ciprian Manolescu
09:15- 10:15	Ingrid Irmer	Ingrid Irmer	Ingrid Irmer	Francois Costantino 09:00 - 09:40	Francois Costantino
10:15 - 10:45	*Coffee break*			*Coffee break 09:40 - 10:10*	*Coffee break*
10:45 - 11:45	Stavros Garoufalidis	Stavros Garoufalidis	Francis Bonahon	Francis Bonahon 10:10 - 10:50	Francis Bonahon
11:45 - 13:30	*Lunch*			Ingrid Irmer 11:20-12:00	Lunch
13:30 - 14:30	Francis Bonahon	Francois Costantino	Francois Costantino	*Lunch*	
14:30 - 15:00	*Coffee break*			*Excursion* 13:30 - 17:00	
15:00 - 16:00	Brainstorm session				

ABSTRACT

Quantum topology, hyperbolic geometry, and connections between the two

Lecturer: Francis Bonahon - University of Southern California, USA

Abstract: Quantum topology and hyperbolic geometry are two very distinct approaches to 3-dimensional topology. Quantum topology is very combinatorial and algebraic in nature and provides, for knots in 3-dimensional manifolds, many invariants based on the representation theory of quantum groups. On the geometric side, results of Thurston and Perelman showed that "most" 3-dimensional manifolds admit a unique complete metric that is hyperbolic, in the sense that it has constant sectional curvature -1. In the past two decades, surprising conjectural connections have appeared between these two fields. The minicourse will be an introduction to these developments.

An introduction to TQFTs in dimensions 2, 3 and 4

Lecturer: Francois Costantino - University of Toulouse, France

Abstract: This course has the purpose to provide an overview on the construction of different types of TQFTs in low dimensions.

After providing a general overview we will give the necessary algebraic backup and pass to the construction of TQFTs in 3 dimensions « à la Turaev-Viro ». Our construction will be based on a recent collaboration with Geer,Patureau and Virelizier, which allows to deal also with the case of « non semi-simple » categories. Mimicking this 3d approach we will then pass to the study of some recent 4d TQFT we build with Geer,Haioun and Patureau which generalise the Crane-Yetter one. If time permits we will explain yet another kind of TQFT, based on stated skeins of surfaces and manifolds and valued in the category of algebras and their bimodules.

The Habiro ring of a number field

Lecturer: Stavros Garoufalidis - SUSTech International Center for Mathematics, China

Abstract: We will explain in broad strokes and with examples some recent arithmetic structures on 3-dimensional topological quantum field theory, ultimately related to motivic cohomology. Joint work with Peter Scholze, Campbell Wheeler and Don Zagier.

Equivariant deformation retractions of Teichm\"uller space

Lecturer: Ingrid Irmer - Southern University of Science and Technology, China

Abstract: This minicourse will provide an elementary introduction to the study of moduli space of surfaces via length functions. No prior knowledge of Teichm\"uller space will be assumed, however some knowledge of differential geometry/topology (for example Morse theory) on smooth manifolds will be needed. Following Thurston, it will be explained how to construct mapping class group-equivariant deformation retractions of Teichm\"uller space onto the Thurston spine, as well as some related work of Schmutz Schaller and the speaker.

Khovanov homology and 4-manifolds

Lecturer: Ciprian Manolescu - Stanford University, USA

Abstract: I will start by defining Khovanov homology and the Rasmussen knot invariant. We will then explore a few topological applications of the Rasmussen invariant: bounds on the slice genus of knots (including the Milnor conjecture), and the construction of an exotic R^4. We will then move on to potential constructions of exotic 4-spheres, and to generalizations of the Rasmussen invariant to knots in other 3-manifolds. Finally, we will discuss the skein lasagna module, which is an invariant of knots in the boundary of an arbitrary 4-manifold. By recent work of Ren and Willis, this can detect exotic smooth structures on some compact 4-manifolds with boundary.