WINTERBRAIDS XV

Marseille
March 9–12, 2026

	Monday	Tuesday	Wednesday	Thursday
09:00-10:00	Chu 1	Rechtman 2	Masbaum 2	Masbaum 3
10:00-10:30	Coffee	Coffee	Coffee	Coffee
10:30-11:30	Masbaum 1	Chu 2	Rechtman 3	Brown / Kitaeff
11:30-14:00	Lunch	Lunch	Lunch	Cigna
14:00-15:00	Rechtman 1	Audoux	Chu 3	12:00 Lunch
15:00-15:30	Monika	Kohli	Manouras	
15:30-16:00	Coffee break	Coffee break	Coffee break	
16:00-17:00	Graff / Makri	Flash talks+posters	Merz / Yakupov	

Mini-courses and special lecture

Michelle Chu: Arithmetic hyperbolic manifolds

In this mini-course I will introduce the study of arithmetic hyperbolic manifolds. These manifolds are constructed using quaternion algebras and quadratic forms, and their geometric and topological structures reflect their arithmetic and number theoretical properties. I will introduce the construction of such manifolds and discuss several geometric properties of arithmetic hyperbolic manifolds. I will also discuss the geometric and algebraic dichotomy between arithmetic and non-arithmetic manifolds.

Gregor Masbaum: Integral structures in TQFT and applications

Following Atiyah and Segal, a (2+1)-dimensional TQFT consists of (1) numerical invariants of closed 3-manifolds, (2) vector-valued invariants of 3-manifolds with boundary, and (3) finite-dimensional representations of mapping class groups of surfaces, whith all three sets of invariants interrelated through various axioms. In this mini-course, we will focus on Witten-Reshetikhin-Turaev SO(3)-TQFT at roots of unity of prime order. We will describe this TQFT from scratch, using the skein theory of knots and links in 3-manifolds. We will then see that this TQFT has an integral structure, meaning that in the appropriate normalization, the 3-manifold invariants are algebraic integers, and so are the coefficients of the mapping class group representations. This leads in particular to mapping class group representations into arithmetic groups with interesting properties. The aim of this mini-course is to explain how this works and to discuss some applications of this integral structure both in low-dimensional topology and to mapping class groups.

Ana Rechtman: On the existence of periodic orbits

This minicourse will focus on the following (old) question: given a flow without fixed points on a closed manifold, does it have periodic orbits? For the question to make sense, the Euler characteristic of the manifold has to be equal to zero. The question can then be specified in many ways: type of manifold, differentiability class of the flow and manifold, properties preserved by the flow. The quest of periodic orbits began with the work of Poincaré. In view of the Poincaré-Lefschetz theorem one could expect that the topology of manifold forces the existence of periodic orbits. We now know that this is only true in dimension 2, it follows from work of Wilson and Kuperberg that in dimension bigger or equal to three every manifold admits a flow without periodic orbits. On the other hand, there are some classes of flows that always admit periodic orbits. We will review some of the results on the existence and non-existence of periodic orbits for flows, and discuss open questions in particular for volume preserving flows.

Benjamin Audoux: Quantum codes and topology

Error correction is the art of encoding data in such a way that small errors (that might occur during transmission or storage) can be detected and corrected. Important in the classical setting, it is even more essential in quantum setting because of natural quantum decoherence. In my talk, I will explain how error correction can be done for quantum information and how topology can help. I will indeed focus on the case of CSS codes which are very closely related to chain complexes.

Short talks

Jennifer Brown: Quantum Abelianisation

Any square matrix can be conjugated into Jordan canonical form, but it's often impossible to do this simultaneously to multiple non-commuting matrices. This is a shame because Jordan blocks contain a lot of useful information, visible even at a glance.

We'll talk about how this basic problem arises when studying quantised moduli spaces of G-local systems on a surface or 3-manifold, and a work around which uses defect skein theory. This is based on joint work in progress with Matthias Vancraeynest and Juan Ramòn Gòmez Garcìa.

Alessandro Cigna: A dual graph approach to minimal-genus surfaces and the Thurston norm

Consider a surface S in the exterior of a knot K. When is S a minimal-genus Seifert surface for K? More generally, if S is properly embedded in a link exterior M, when is S Thurston norm-minimising in its homology class? Gabai's classical work on sutured manifolds gives a characterisation: S is norm-minimising if and only if we can carry out a taut sutured manifold hierarchy of M starting from S. The main idea of this talk is that taut sutured manifold hierarchies not only determine the Thurston norm of a class in homology - they actually give global information about the Thurston norm.

More precisely, we show how to use the data of a sutured manifold hierarchy to construct a dual graph G such that for every surface S' in M, the algebraic intersection between G and S' gives a lower bound for the genus of any surface homologous to S'. In fact, G represents the Poincaré dual of the Euler class of any foliation carried by the hierarchy. We apply this construction to exhibit a general approach to computing the Thurston norm of a manifold.

Emmanuel Graff: Classification of links up to link-homotopy

Link-homotopy is an equivalence relation on links in which distinct components remain disjoint during deformations, while self-intersections within a component are allowed. Milnor initiated the study of link-homotopy in 1954 and classified links with two and three components. In 1988, Levine extended this classification to four-component links, and in 1990, Habegger and Lin provided a complete classification using string links, though in a less explicit form. In this talk, we revisit their approach through the framework of Habiro's clasper calculus and present a new geometric proof of Levine's classification of four-component links up to link-homotopy.

Edwin Kitaeff: A new criterion for computing the Kauffman bracket skein module

Skein modules can be seen as generalizations of combinatorial invariants such as the Jones polynomial to arbitrary oriented 3-manifolds, and they play a central role in quantum topology. The Kauffman bracket skein module (KBSM) is among the simplest skein modules to define, yet it remains notoriously difficult to compute. In this talk, we present a new criterion for computing the KBSM, extending previous work by Detcherry, Kalfagianni, and Sikora. In particular, our criterion applies to Dehn surgeries on 2-bridge knots. Based on its connexion with the $SL_2(\mathbb{C})$-character variety, we describes the contribution to the dimension of the KBSM of a non-central character. For now, the contribution of central characters remains more difficult to compute.

Ben-Michael Kohli: Alexander and Jones-type properties of the Links-Gould invariant of links

The Links-Gould polynomial is a two-variable link invariant derived from the quantum supergroup $U_q(\mathfrak{sl}(2|1))$. As such, LG has a "hybrid" flavor between the Jones and Alexander polynomials. Thus one can wonder what properties of the Jones polynomial and what properties of the Alexander polynomial are inherited by LG. Several recent results have shown that the Links-Gould invariant shares some of the Alexander polynomial's most geometric features – a surprising fact for a quantum invariant. In this talk, we will review these properties, then focus on proving that the Links-Gould polynomial and its colored counterparts provide lower bounds for the 3-genus of a knot that are quite precise. In particular, the 2-colored Links-Gould polynomial provides a genus bound that is sharp for all 58 million prime knots with up to 18 crossings.

Stavroula Makri: Generalised Lefschetz number and loop braids

The study of braid types in surface dynamics was started in the early 1980's and has developed into an extensive area in the theory of low-dimensional dynamical systems. One application is the use of matrix representations of braid groups on surfaces, which are closely related to the theory of the generalized Lefschetz number established by Fadell, Husseini, and Fried.

Let M be a compact surface. For a homeomorphism $f : M \to M$ isotopic to the identity that leaves invariant a finite set S, that is, a union of finitely many periodic orbits of f , we can associate a braid on M . In fact, the trace of the matrix associated to this braid coincides with the abelianization of the generalized Lefschetz number of the restriction of f to $M \setminus S$. The generalized Lefschetz number describes how periodic orbits not belonging to S link with S. Hence, by computing the matrix, one can obtain information on the existence and linking behavior of periodic orbits.

The goal of this talk is to present an extension of this result to a 3-dimensional setting.

Manousos Manouras: Twisted Alexander polynomials of plane algebraic curves

The topology of plane algebraic curves, initiated by the work of Enriques and Zariski. The fundamental group of their complement is a natural invariant, strong enough to show that the combinatorial description of the curve may not determine its embedding. The twisted Alexander polynomials provide an accessible invariant of the group, still very sensitive to these phenomena. We study twisted Alexander polynomials, focusing on the reducible non-abelian $\mathrm{SL}_2(\mathbb{C})$ representations. We describe a geometric parametrization of all such reducible families as projective varieties whose dimensions are governed by characteristic varieties. Within this framework, we obtain new divisibility relations for the corresponding twisted Alexander polynomials and explain geometrically they vary across reducible strata. In the case of plane algebraic curves, we show that these invariants can be computed explicitly and that their variation is controlled by a finite linear stratification of the reducible representation space, on which the Reidemeister torsion remains locally constant.

Alice Merz: Equivariant sliceness and the extension of involutions on lens spaces to rational homology balls

A knot in the three-sphere is called slice if it bounds a smoothly embedded disk in the four-ball. Deciding which knots are slice is a central question in low-dimensional topology, closely tied to fundamental conjectures such as the smooth 4-dimensional Poincaré conjecture and the Slice-Ribbon conjecture, and more in general to the study of 4-manifold topology.

One obstruction to sliceness arises from analyzing the double branched cover of the knot and determining whether the branching involution extends to a rational homology 4-ball.

In this talk, I will discuss the problem of extending involutions to rational homology balls and explain its relation to the question of whether a knot is equivariantly slice. I will then focus on the case of involutions on lens spaces and revisit the equivariant sliceness of two-bridge knots, giving a new proof of a theorem of Di Prisa and Framba. This is a joint work with Antony Fung and Lisa Lokteva.

Monika: Contact Surgery Numbers of Projective Spaces

A celebrated theorem of Ding and Geiges states that every connected, oriented, closed 3-manifold with a cooriented contact structure can be obtained via contact surgery along a Legendrian link in the standard tight contact 3-sphere. This leads to a complexity measure for contact 3-manifolds: the contact surgery number (csn), which is defined as the minimal number of components required in such a link presentation. The contact surgery numbers for the 3-sphere, certain lens spaces, and Brieskorn spheres have been studied extensively in the works of John Etnyre, Rima Chatterjee, Marc Kegel, and Sinem Onaran.

In this joint talk I will talk about the joint work with Marc Kegel which extends the study of csn to projective spaces by classifying all contact structures on 3-dimensional projective spaces that have contact surgery number one. We also see that there exists infinitely many contact structures on 3-dimensional projective spaces with csn 2.

Sardor Yakupov: Moduli space of curves and achiral Lefschetz fibrations

Lefschetz fibrations provide a powerful tool for studying symplectic 4-manifolds and contact 3-manifolds. Achiral Lefschetz fibrations extend this framework beyond the symplectic case, allowing us to address more general questions about 4-manifolds. On the other hand, the moduli space of complex curves is one of central objects in complex and Riemannian geometry of surfaces. The goal of this talk is to introduce these two concepts separately and explore their connection through the notion of the classifying map.