

# From Subfactors to Quantum Topology - In memory of Vaughan Jones



**SwissMAP**

The Mathematics of Physics  
National Centre of Competence in Research

## Report of Contributions

Contribution ID: 1

Type: **not specified**

## Zeta cycles and the scaling site

*Monday 27 June 2022 10:00 (1 hour)*

**Presenter:** CONNES, Alain

Contribution ID: 2

Type: **not specified**

## Planar algebras, noncommutativity and hyperfinite subfactors

*Monday 27 June 2022 11:30 (1 hour)*

The hyperfinite  $\text{II}_1$  factor contains a wealth of subfactors that give rise to many new and fascinating mathematical structures.

Vaughan Jones discovered that the unitary tensor category generated by the standard representation of a subfactor has a planar structure and can be described as what he called a planar algebra". It is a complete invariant for amenable subfactors by a deep result of Popa. However, generic subfactors are not amenable, and one typically does not know how to distinguish them.

I will discuss a notion of asymptotic noncommutativity that can be used to distinguish subfactors with the same planar algebra invariant.

I will construct very noncommutative" examples from actions of suitable groups on the hyperfinite  $\text{II}_1$  factor. Moreover, planar algebra techniques lead to new subfactors with Temperley-Lieb-Jones planar algebra.

**Presenter:** BISCH, Dietmar

Contribution ID: 3

Type: **not specified**

## The search for the exotic in Subfactors and Conformal Field Theory

*Monday 27 June 2022 14:30 (1 hour)*

Groups can act as symmetries of physical systems and on their mathematical models as in conformal field theory.

Vaughan's subfactor theory provides a framework for quantum symmetries beyond those arising from groups or their deformations as quantum groups or loop groups. The accepted position was that the Haagerup system, associated with the a subfactor at index  $(5 + \sqrt{13})/2$ , was exotic and surely could not be constructed from group like symmetries. I discuss work with Terry Gannon that this should be considered as misconception and the more general issue of constructing conformal field theories from subfactors and their associated modular tensor categories.

**Presenter:** EVANS, David

Contribution ID: 4

Type: **not specified**

## From Jones relation to representations of Mapping Class Groups

*Tuesday 28 June 2022 09:30 (1 hour)*

We will review fundamental contributions of Vaughan Jones in the genesis of Quantum Topology. Then we will focus on representations of Mapping Class Groups highlighting a contribution of Vaughan Jones in genus 2. We will finally discuss homological models producing new representations.

**Presenter:** BLANCHET, Christian

Contribution ID: 5

Type: **not specified**

## Skein algebra of a punctured surface

*Tuesday 28 June 2022 11:00 (1 hour)*

In the case of a closed surface, there is a rich body of work describing how the Kauffman bracket skein algebra can be regarded as a quantization of Teichmüller space. In order to generalize to a surface with punctures, Roger and Yang defined a skein algebra with extra generators and relations that they conjectured to be a quantization of Penner's decorated Teichmüller space. In joint work with Han-Bom Moon, we resolve their conjecture by appealing to another algebra closely related to the decorated Teichmüller space, a cluster algebra for punctured surfaces first defined by Fomin, Shapiro, and Thurston.

**Presenter:** WONG, Helen

Contribution ID: 6

Type: **not specified**

## The ADE link conjecture

*Thursday 30 June 2022 13:30 (1 hour)*

It is well known that the ADE graphs arise in many classification problems in mathematics. In 2019 Michel Boileau, Steve Boyer and I conjectured a modest addition to this list: the fibered links that induce the tight contact structure on  $S^3$  and have a cyclic branched cover whose fundamental group is left-orderable. We will describe the conjecture, its background, and some recent results that establish it in many cases.

This is joint work with Steve Boyer and Ying Hu.

**Presenter:** GORDON, Cameron

Contribution ID: 7

Type: **not specified**

## Skein modules for generic quantum parameters”

*Tuesday 28 June 2022 15:00 (1 hour)*

Skein modules were defined by Przytycki and Turaev as a way to generalize the Jones polynomial and the Kauffman bracket to links in manifolds other than the 3-sphere. In this talk I will review some recent structural results, such as the fact that the skein module of a closed 3-manifold is finite-dimensional for generic quantum parameters. I will also describe a work in progress joint with Gunningham which relates skein modules for generic quantum parameters to the cohomology of a certain perverse sheaf on the character stack of the 3-manifold. This allows one to generalize skein modules to finite 3-dimensional Poincaré complexes and compute them for those with a finite fundamental group.

**Presenter:** SAFRONOV, Pavel



Contribution ID: 8

Type: **not specified**

## Braids, Dualities and more subfactors

*Thursday 30 June 2022 15:00 (1 hour)*

{Abstract:}\textit{The famous Schur-Weyl duality states that the commutant of the action of  $Gl(V)$  on  $V^{\otimes n}$  is generated by the obvious action of the symmetric group  $S_n$  on  $V^{\otimes n}$ . We will first give a survey of quantum groups  $U_q\mathfrak{g}$  and representations  $V$ , where the commutant of the action of  $U_q\mathfrak{g}$  on  $V^{\otimes n}$  is (almost) generated by the braid group  $B_n$ . In the case of spin representations of  $U_q\mathfrak{so}_N$ , these braid representations are best described in the context of another  $q$ -deformation  $U'_q\mathfrak{so}_n$  of  $U\mathfrak{so}_n$ . This  $q$ -deformation can be embedded into  $U_q\mathfrak{sl}_n$  as a coideal subalgebra. It can also be used to construct more examples of subfactors which correspond to the embedding  $SO(n) \subset SU(n)$  in the classical limit  $q \rightarrow 1$ .}

**Presenter:** WENZL, Hans

Contribution ID: 10

Type: **not specified**

## The cell dispensibility problem for spaces and manifolds

*Wednesday 29 June 2022 09:30 (1 hour)*

We consider the following problem: when is a CW-space  $X$  homotopy equivalent to a CW-complex without  $j$ -cells for  $k < j < r$  ?

We show that this is equivalent to some cohomology condition together with the vanishing of an algebraic K-theory “cell-dispensability obstruction”, analogous but not equal to the Wall finiteness obstruction. A similar theory holds for closed manifolds, replacing cells” byhandles”.

**Presenter:** HAUSMANN, Jean-Claude

Contribution ID: 11

Type: **not specified**

## **Knot my problem: looking for rigidity in group theory**

*Wednesday 29 June 2022 11:00 (1 hour)*

**Presenter:** BRIDSON, Martin

Contribution ID: 13

Type: **not specified**

## On skein theory in dimension four

*Thursday 30 June 2022 09:30 (1 hour)*

The Temperley-Lieb algebra describes the local behaviour of the Jones polynomial and gives rise to the Kauffman bracket skein modules of 3-manifolds. Going up by one dimension, Bar-Natan's dotted cobordisms describe the local behaviour of Khovanov homology and, likewise, give rise to skein modules of 4-manifolds. I will describe the construction of these skein modules and methods to compute them via a handle decomposition. Based on joint work with Morrison-Walker, Manolescu-Walker, and Hogancamp-Rose.

**Presenter:** WEDRICH, Paul

Contribution ID: 14

Type: **not specified**

## 4-manifolds with boundary and fundamental group $Z$

*Thursday 30 June 2022 11:00 (1 hour)*

In this talk I will discuss a classification of topological 4-manifolds with boundary and fundamental group  $Z$ , under some mild assumptions on the boundary. I will apply this classification to classify surfaces in simply-connected 4-manifolds with 3-sphere boundary, where the fundamental group on the surface complement is  $Z$ . I will also compare these homeomorphism classifications with the smooth setting, showing for example that every appropriate form can be realized as the equivariant intersection form of a pair of exotic smooth 4-manifolds with boundary and fundamental group  $Z$ , and that every smooth 2-handlebody with 3-sphere boundary contains a pair of exotic surfaces. This is joint work with Anthony Conway and Mark Powell.

**Presenter:** PICCIRILLO, Lisa

Contribution ID: 15

Type: **not specified**

## **Cars, Interchanges, Traffic Counters, and a Pretty Darned Good Knot Invariant**

*Tuesday 28 June 2022 13:30 (1 hour)*

Reporting on joint work with Roland van der Veen, I'll tell you some stories about  $\rho_1$ , an easy to define, strong, fast to compute, homomorphic, and well-connected knot invariant.  $\rho_1$  was first studied by Rozansky and Overbay, it is dominated by the coloured Jones polynomial (but it isn't lesser!), it has far-reaching generalizations, and I wish I understood it.

drorbn.net

**Presenter:** BAR-NATAN , Dror

Contribution ID: 17

Type: **not specified**

## Facets of Temperley-Lieb algebra" 10:30-11:00 Coffee Break

*Friday 1 July 2022 09:30 (1 hour)*

Skein modules were defined by Przytycki and Turaev as a way to generalize the Jones polynomial and the Kauffman bracket to links in manifolds other than the 3-sphere. In this talk I will review some recent structural results, such as the fact that the skein module of a closed 3-manifold is finite-dimensional for generic quantum parameters. I will also describe a work in progress joint with Gunningham which relates skein modules for generic quantum parameters to the cohomology of a certain perverse sheaf on the character stack of the 3-manifold. This allows one to generalize skein modules to finite 3-dimensional Poincaré complexes and compute them for those with a finite fundamental group.

**Presenter:** KHOVANOV, Mikhail

Contribution ID: **18**Type: **not specified**

## Lattice models arising from non-semisimple TQFT

*Friday 1 July 2022 11:00 (1 hour)*

There is a rich interplay between two-dimensional topological phases in quantum mechanical systems and topological quantum field theory. This interaction is further enriched as topological structures inherent in TQFT lead to novel features, such as non-abelian braiding statistics for low energy excitations, when expressed in the corresponding quantum mechanical models. In this talk, we will review the relationship between Turaev-Viro TQFTs and Levin-Wen string net models for topological matter. We will explain new joint work with Geer, Patureau-Mirand, and Sussan extending this relationship to modified Turaev-Viro theories coming from non-semisimple TQFT. These new non-semisimple Levin-Wen models exhibit a novel feature of being pseudo-Hermitian, so that they have real spectrum, evolve via the Schrodinger equation, and have normalizable wavefunction, but are not given by Hermitian Hamiltonians.

**Presenter:** LAUDA, Aaron