Interactions of Low-dimensional Topology and Quantum Field Theory

Report of Contributions

https://indico.global/e/9602

Contribution ID: **2** Type: **not specified**

The geometric cobordism hypothesis

I will explain my recent work with Daniel Grady on locality of functorial field theories (arXiv:2011.01208) and the geometric cobordism hypothesis (arXiv:2111.01095). The latter generalizes the Baez–Dolan cobordism hypothesis to nontopological field theories, in which bordisms can be equipped with geometric structures, such as smooth maps to a fixed target manifold, Riemannian metrics, conformal structures, principal bundles with connection, or geometric string structures. Applications include a generalization of the Galatius–Madsen–Tillmann–Weiss theorem, a solution to a conjecture of Stolz and Teichner on representability of concordance classes of functorial field theories, a construction of power operations on the level of field theories (extending the recent work of Barthel–Berwick-Evans–Stapleton), and a recent solution by Grady of a conjecture by Freed and Hopkins on deformation classes of reflection positive invertible field theories. If time permits, I will talk about the planned future work on nonperturbative quantization of functorial field theories and generalized Atiyah–Singer-style index theorems.

Author: PAVLOV, Dmitri

Presenter: PAVLOV, Dmitri

Contribution ID: **3** Type: **not specified**

The Geometry of Light

Thursday 25 May 2023 14:00 (45 minutes)

In the first part of the talk, we give some background on the geometry of diamond cuts, and the special optical properties that make them so captivating to look at. In the second part, we discuss how the classical mathematics of the Maxwell-Cremona correspondence can assist in the enumeration of possible diamond cuts.

Author: CONANT, James (Gemological Institute of America)

Presenter: CONANT, James (Gemological Institute of America)

Contribution ID: **4** Type: **not specified**

Machine learning and hard problems in topology

Thursday 25 May 2023 09:30 (45 minutes)

Considering the special occasion and to diversify the list of topics, in this talk, intended for a broad audience, I decided to turn to something that hopefully can be fun and entertaining: While the "state-of-the-art" machine learning algorithms already make an impact at the level of high school or undergraduate curriculum, in this talk I want to explore whether they can help us with some of the most difficult mathematical challenges, at the cutting edge of the mathematical research. No prior familiarity with machine learning is required; rather, one of the goals of this talk is to provide a gentle introduction to some of the modern tools in this subject, in part explaining its rapidly increasing role in everyday life and, hopefully, in pure mathematics as well.

Author: GUKOV, Sergei

Presenter: GUKOV, Sergei

Contribution ID: **5** Type: **not specified**

Surfaces in 4-manifolds

Monday 22 May 2023 10:45 (45 minutes)

We will review the genus function (associating to a second homology class the minimal genus of an embedded surface representing it), and show how to extend it. The function turns out to be useful in obstructing smooth sliceness, while the extension might become handy in contemplating about smooth structures on the four-sphere.

Author: STIPSICZ, Andras

Presenter: STIPSICZ, Andras

Contribution ID: **6** Type: **not specified**

Towards a (3+1)-dimensional TQFT from TMF

Thursday 25 May 2023 11:35 (45 minutes)

I will discuss work in progress, joint with Sergei Gukov, Lennart Meier, and Du Pei. It concerns a construction of a 4-manifold invariant using the theory of topological modular forms, and TQFT properties of this invariant. This is a mathematical construction related to a particular instance of the Gukov-Pei-Putrov-Vafa program associating an invariant of 4-manifolds to certain 6-dimensional superconformal field theories.

Author: KRUSHKAL, Slava

Presenter: KRUSHKAL, Slava

Contribution ID: **7** Type: **not specified**

The 0-1 part of extended 2d QFTs

Wednesday 24 May 2023 11:35 (45 minutes)

I will present a conjecture according to which the 0-1 part of an extended 2d QFTs is, up to isomorphism, independent of the QFT.
This conjecture is analogous to the well known fact that there exists a unique separable Hilbert space up to isomorphism (a Hilbert space is the 0 part of a 1d QFT), and has striking consequences about the existence of various kinds of symmetries.

Author: HENRIQUES, André

Presenter: HENRIQUES, André

Contribution ID: **9** Type: **not specified**

Stable equivalence relations of 4-manifolds

Tuesday 23 May 2023 10:45 (45 minutes)

I will introduce and study relations of 4-manifolds up to connected sum with copies of $S^2 \times S^2$ and their relations. This includes stable diffeomorphism and homotopy equivalence. The talk is based on joint work with Johnny Nicholson and Simona Veselá.

Authors: KASPROWSKI, Daniel (University of Southampton); NICHOLSON, John; VESELÁ, Simona

Presenter: KASPROWSKI, Daniel (University of Southampton)

Contribution ID: **10** Type: **not specified**

Homology manifolds and their Spivak normal fibration

Tuesday 23 May 2023 11:35 (45 minutes)

I propose to present a construction of a Poincare duality space with the two properties: 1) its Spivak normal fibration does not admit a Top-reduction (equivalently, there is no degree one normal map from a topological closed manifold) and 2) its (periodic) total surgery obstruction vanishes. This contradicts the validity of two theorems in the literature, the one stating that PD complexes with trivial periodic tso are homotopy equivalent to homology manifolds, and the other saying that the Spivak normal fibration of a homology manifold admits a Top-reduction. Joint with Hebestreit, Winges, and Weiss.

Author: LAND, Markus

Presenter: LAND, Markus

Contribution ID: **11** Type: **not specified**

Smoothing surfaces in 4-manifolds

In 4-dimensional topology, differences between the smooth and topological categories can be understood as a failure of smoothing topologically embedded disks. Modern smooth techniques, including these from gauge theory, detect a large extent of the failure of disk smoothing, but little was known about when topological disks are smoothable. I will talk about a new smoothing technique for topologically embedded surfaces in smooth 4-manifolds. As applications, we obtain "topological = smooth" results in dimension 4 for isotopy classes of certain disks and spheres. The main results are joint with Byeorhi Kim.

Author: CHA, Jae Choon (POSTECH)

Contribution ID: **12** Type: **not specified**

On non-isotopic Seifert surfaces in the 4-ball

Wednesday 24 May 2023 09:30 (45 minutes)

Pete (in an informal seminar) and before him Livingston wondered, whether there exist non-isotopic oriented surfaces in the 3-sphere with boundary a fixed knot that remain non-isotopic when pushed into the 4-ball. It turns out that such examples exist, as recently observed by Hayden-Kim-Miller-Park-Sundberg, and, surprisingly, they can be distinguished by a classical invariant: the intersection form on the second homology of the double branched cover.

We report on work in progress with M. Akka, A. Miller, and A. Wieser, where we use an algebraic approach to finding pairs of such examples. A sample result is that, for all positive integers D with D=3 (mod 4) and (D+1)/4 not a prime nor the square of a prime, there exists a knot with determinant D that has genus one Seifert surfaces that remain non-isotopic when pushed into the 4-ball. The relevant algebra input is that the class group of Q(\sqrt(-D)) has non-trivial elements of order different than two. In fact, this class group corresponds to Gauss's group of equivalence classes of integral binary quadratic forms with discriminant -D, and our main result essentially characterizes (in terms of Gauss's group) when two such quadratic forms can arise as the intersection forms of the double branched cover of pushed-in Seifert surfaces of the same knot.

Author: FELLER, Peter

Presenter: FELLER, Peter

Contribution ID: **13** Type: **not specified**

Division, group rings, and negative curvature

Friday 26 May 2023 09:30 (45 minutes)

A basic problem in low dimensional topology is to understand the 2-complexes with a given fundamental group G. I will explain how this can be studied using a division algorithm in the group ring of G, and describe some instances in which such an algorithm is available.

Author: AVRAMIDI, Grigori

Presenter: AVRAMIDI, Grigori

Contribution ID: **14** Type: **not specified**

Strings in (low dimensional?) manifolds

Thursday 25 May 2023 10:45 (45 minutes)

String topology can be seen as a form of 2d field theory on the homology of the free loop spaces of manifolds. I'll describe this field theory, and exhibit some of its interesting features.

Author: WAHL, Nathalie

Presenter: WAHL, Nathalie

Contribution ID: **15** Type: **not specified**

TQFT and Surgery

Tuesday 23 May 2023 09:30 (45 minutes)

How much manifold topology can a given topological quantum field theory see? In this talk, I will answer this question for "semisimple" TQFTs in even dimensions, a certain class of field theories which includes all "once-extended" even-dimensional field theories, i.e. those which also assign linear categories to corners of codimension 2.

These results suggest to think of TQFTs as appropriately "dual" to manifolds, and lead to classification schemes for TQFTs "dual" to surgery theoretic classifications of manifolds. If time permits, I will explain such a classification of linear once-extended 4-dimensional TQFT in terms of certain group theoretical data and bordism invariants, and comment on higher-dimensional variants.

The first part of this talk is based on joint work with Christopher Schommer-Pries, the second part on ongoing joint work with Christopher Schommer-Pries and Noah Snyder, and with Theo Johnson-Freyd.

Authors: REUTTER, David; SCHOMMER-PRIES, Christopher; SNYDER, Noah; JOHNSON-FREYD, Theo

Presenter: REUTTER, David

Contribution ID: **16** Type: **not specified**

Chern-Simons invariants, concordance, and homology cobordism

Tuesday 23 May 2023 21:00 (45 minutes)

Chern-Simons invariants of homology spheres, analyzed in conjunction with moduli spaces of solutions to the ASD Yang-Mills equations on 4-manifolds, provide a powerful tool for studying the homology cobordism groups of 3-manifolds and the closely related smooth concordance group of knots. I'll give an overview of this technique and discuss some of its applications.

Author: HEDDEN, Matt

Presenter: HEDDEN, Matt

Contribution ID: **17** Type: **not specified**

The spinor bundle on loop space

We outline a construction of the spinor bundle of the loop space of a string manifold together with its fusion product. This construction was outlined by Stolz and Teichner in a preprint from 2005. In particular, we prove that the loop space of an oriented manifold X admits a spinor bundle with a fusion product if and only if X is string. Our work partially extends and somewhat simplifies a construction previously given by Kristel and Waldorf.

Authors: WALDORF, Konrad; LUDEWIG, Matthias; KRISTEL, Peter

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

Surfaces in 4-manifolds

Monday 22 May 2023 11:35 (45 minutes)

I will describe a general procedure to homotope an immersed positive genus surface in a simply connected 4-manifold to a locally flat embedding. This is a special case of a surface embedding theorem, joint with Daniel Kasprowski, Mark Powell, and Peter Teichner.

Author: RAY, Arunima (Max Planck Institute for Mathematics)

Co-authors: KASPROWSKI, Daniel (University of Southampton); POWELL, Mark; TEICHNER, Peter (Max Planck Institute for Mathematics, Bonn, Germany)

Presenter: RAY, Arunima (Max Planck Institute for Mathematics)

Contribution ID: **19** Type: **not specified**

Entanglement of sections

Wednesday 24 May 2023 21:00 (45 minutes)

TBA

Author: FREEDMAN, Michael

Presenter: FREEDMAN, Michael

Contribution ID: **20** Type: **not specified**

TBA

Monday 22 May 2023 09:30 (45 minutes)

Presenter: FREED, Dan (University of Austin)

Contribution ID: **21** Type: **not specified**

TBA

Monday 22 May 2023 21:00 (45 minutes)

Presenter: NIKOLAUS, Thomas (University of Münster)

Contribution ID: **22** Type: **not specified**

The Stringor Bundle

The stringor bundle has been anticipated by pioneering work of Stephan Stolz and Peter Teichner, as a string-theoretic analog of the spinor bundle of quantum mechanics. In this talk, I will explain a neat construction of the stringor bundle as an associated 2-vector bundle. The main ingeredients are a new model for the string 2-group and a representation of that 2-group on a von Neumann algebra.

Authors: WALDORF, Konrad (Universität Greifswald); LUDEWIG, Matthias; KRISTEL, Peter

Contribution ID: **23** Type: **not specified**

How to get rid of pointings for constructiong TFTs

Wednesday 24 May 2023 10:45 (45 minutes)

Vector spaces having “duals”are automatically finite dimensional, and this is the case for those appearing as values of TFTs. However, if we assume that the vector spaces are pointed, they are automatically one dimensional (lines). When constructing extended n-dimensional TFTs, a natural family of targets (replaceing Vect) naturally has the feature that pointings are built in. This is due to “factoriazation algebras”having this property. I will explain an approach to fixing this, allowing us to prove a conjecture by Lurie on higher dualizability, which in turn gives fully extended TFTs. This joint work with Eilind Karlsson.

Presenter: SCHEIMBAUER, Claudia (University of Munich)

Contribution ID: **24** Type: **not specified**

TBA

Friday 26 May 2023 10:45 (45 minutes)

Presenter: BONATTO, Luciana Basualdo (MPIM)

Contribution ID: **25** Type: **not specified**

Twisted/relative field theories, anomalies, and symmetries

TBA

Author: FREED, Dan

Presenter: FREED, Dan

Contribution ID: **26** Type: **not specified**

Maximal Knotless Graphs

A graph G is maximal knotless if it is edge maximal for the property of having a knotless embedding. That is, there exists an embedding of G into S^3 such that every cycle in G is the unknot, but for any edge e, any embedding of $G' = G + e$ has a cycle that is embedded as a non-trivial knot.

We show that any maximal knotless graph must have at least $|E| \geq \frac{7}{4}|V|$ edges, and we construct an infinite family of maximal knotless graphs with $|E| < \frac{5}{2}|V|$. For any $|E| \geq 20$ (with the exception of $|E| = 22$) we construct a maximal knotless graph with $|E|$ edges. We also construct an infinite family of maximal knotless graphs that are not clique sums.

Authors: EAKINS, Lindsay; FLEMING, Thomas; MATTMAN, Thomas

Contribution ID: **27** Type: **not specified**

Moduli Spaces of Manifolds with Configurations

Understanding moduli spaces of manifolds has been closely related to understanding (invertible) topological field theories, through the classifying space of the cobordism category. Inspired by generalized categories of cobordisms where manifolds can have punctures or singularities, and by factorization homology, we look at a generalized moduli space construction. These can be modelled as moduli of configuration spaces on manifolds. We show that, in many cases, they exhibit homological stability and explicitly compute its stable cohomology.
On the one hand this gives explicit candidates for classifying spaces of generalized cobordism categories, and on the other, this gives Diff-equivariant homological stability for configuration spaces and factorization homology.

Author: BASUALDO BONATTO, Luciana (MPIM Bonn)