Lattice Methods, TQFTs, and Symmetries

Report of Contributions

https://indico.uu.se/e/LTFT26

Contribution ID: **1** Type: **not specified**

Yamazaki - Topology in Lattice Yang–Mills Theory - 1

Monday, 9 March 2026 10:00 (1 hour)

I will explore the role of nontrivial topological sectors in four-dimensional pure Yang–Mills theory. I will highlight lattice formulations and numerical Monte Carlo methods, and discuss new approaches for addressing the sign problem.

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

Kobayashi - ʾt Hooft anomalies of exact/emergent symmetry on lattices - 1

Monday, 9 March 2026 11:00 (1 hour)

I will talk about a way to characterize the ʾt Hooft anomalies of exact/emergent symmetry on the lattices. The anomalies of exact invertible symmetry on lattices is characterized through Else-Nayak approach and its generalization, while those of emergent symmetry can be characterized through so-called generalized statistics. I will explain these two topics in sequential lectures.

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

Hsin - Automorphism is All You Need: Transversal Non-Clifford Gates in 2+1D and Higher Symmetries from Automorphism

Monday, 9 March 2026 12:00 (1 hour)

We study automorphism in twisted gauge theories and discover they can give rise to generalized symmetries such as higher group and/or non-invertible symmetries. Using the automorphism symmetry, we discover transversal non-Clifford logical gates such as T gate in Clifford stabilizer models in 2+1D as well as CCZ gate in 5+1D self correcting non-Abelian quantum memory. The talk is based on arXiv:2511.02900 with Ryohei Kobayashi (Institute for Advanced Study) and Guanyu Zhu (IBM)

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

Moroz - Spontaneously Broken Non-Invertible Symmetries in Transverse-Field Ising Qudit Chains - 1

Monday, 9 March 2026 15:00 (1 hour)

Recent developments have revealed that symmetries need not form a group, but instead can be non-invertible. In these lectures I will use analytical arguments and numerical evidence to illuminate how spontaneous symmetry breaking of a non-invertible symmetry is similar yet distinct from ordinary symmetry breaking. I will consider one-dimensional chains of group-valued qudits, whose local Hilbert space is spanned by elements of a finite group G (reducing to ordinary qubits when G=Z/2Z). I will construct Ising-type transverse-field Hamiltonians with Rep(G) symmetry whose generators multiply according to the tensor product of irreducible representations (irreps) of the group G. For non-Abelian G, the symmetry is non-invertible. In the symmetry broken phase there is one ground state per irrep on a closed chain. The symmetry breaking can be detected by local order parameters but, unlike the invertible case, different ground states have distinct entanglement patterns. I will show that for each irrep of dimension greater than one the corresponding ground state exhibits string order, entanglement spectrum degeneracies, and has gapless edge modes on an open chain – features usually associated with symmetry-protected topological order. Consequently, domain wall excitations behave as one-dimensional non-Abelian anyons with non-trivial internal Hilbert spaces and fusion rules. If time permits, I will discuss how these phenomena can be probed on existing quantum hardware and the new questions they raise for quantum computing.

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

Runkel - From continuum to the lattice in conformal field theory - 1

Monday, 9 March 2026 16:00 (1 hour)

When studying a 2d statistical system, one important question is to identify critical points and the corresponding universality class of critical behaviour, that is, the 2d conformal field theory which describes the statistical model at large length scales. In this talk, I
would like to discuss (but not answer) the converse question: starting from a 2d CFT, is there a way to construct lattice models which recover the given CFT in the continuum limit? A particular focus will be topological symmetries of the CFT, as determined by topological line defects, and how they can be preserved when passing to the lattice model. What is more, the topological symmetry also gives a conjectural condition under which the answer to the above question is "yes". This talk is based on joint work with Enrico Brehm.

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

Yamazaki - Topology in Lattice Yang–Mills Theory - 2

Tuesday, 10 March 2026 10:00 (1 hour)

I will explore the role of nontrivial topological sectors in four-dimensional pure Yang–Mills theory. I will highlight lattice formulations and numerical Monte Carlo methods, and discuss new approaches for addressing the sign problem.

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

Moroz - Spontaneously Broken Non-Invertible Symmetries in Transverse-Field Ising Qudit Chains - 2

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

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

Magdalena De La Fuente - Topological fault tolerance from a path-integral perspective - 1

Tuesday, 10 March 2026 16:00 (1 hour)

Topological quantum error correction encodes quantum information in the ground space of a topologically ordered lattice system. To use such codes for reliable quantum computation, one must design low-overhead circuits that protect and manipulate the encoded information in a fault-tolerant way.

In these lectures, I focus on two-dimensional topological codes and fault-tolerant protocols implemented by circuits composed of 2D local gates. Representing these protocols as tensor networks local in a 3D spacetime lattice leads to a useful viewpoint. We identify a topological QEC circuit with an imaginary-time topological path integral of a topological gauge theory. Within this picture, both physical errors and non-trivial measurement outcomes appear as certain defects in the path integral. Their combinatorial structure defines the associated classical decoding problem.

In the first part, I introduce the necessary foundations from cellular (co)homology and explain how they give rise to a topological path integral that can be compiled into a 2D local circuit together with a (global) classical decoder.

In the second part, I discuss recent work in which we construct a universal logical gate set for 2D topological codes using the path integral of a non-Abelian twisted quantum double. During the computation, information is transported from an Abelian phase, such as the toric code, into the twisted quantum double via topological domain walls, and back.

The path-integral perspective provides a flexible framework to construct QEC circuits that realize the necessary domain walls and other condensation defects that define the logic gate in spacetime and argue about their fault-tolerance properties.

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

Magdalena De La Fuente - Topological fault tolerance from a path-integral perspective - 2

Wednesday, 11 March 2026 10:00 (1 hour)

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

Warman - Clifford-Hierarchy Gates from Group Quantum Doubles

Wednesday, 11 March 2026 11:00 (1 hour)

A critical mission for realizing large-scale quantum computing is the development of simple and resource-efficient implementations of logical non-Clifford gates. This talk discusses how novel protocols for their implementation can be obtained from topological field theory.

In the first part, based on arXiv:2510.20890, we present hybrid lattice surgery between Abelian and non-Abelian codes and show how it enables non-Clifford operations in the Z2 surface code, including magic states and non-Clifford gates.

In the second part, based on arXiv:2512.13777, we construct transversal phase gates at arbitrary levels of the Clifford hierarchy purely in 2D, by encoding a logical qubit in the quantum double of a non-Abelian group on a triangular spatial patch and stacking a symmetry-protected topological (SPT) phase onto the spatial region. This construction remains purely 2D and preserves locality and fault tolerance.

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

Omori - Symmetry Spans and Enforced Gaplessness - 1

Wednesday, 11 March 2026 12:00 (1 hour)

Anomaly matching for continuous symmetries has been the primary tool for establishing symmetry-enforced gaplessness. In this talk, I introduce a new mechanism based on symmetry spans: configurations in which a symmetry E is simultaneously embedded into two larger symmetries C and D. When the sets of gapped phases compatible with each embedding have no overlap, gaplessness is enforced.

In the first introductory part, I explain the classification of symmetric gapped phases as module categories and the restriction of symmetries as pullbacks of module categories. In the second part, I present the span criterion and explicit examples in 1+1d CFTs and lattice spin chains. Notably, this mechanism operates with discrete symmetries and continuous symmetries without anomalies, both of which admit well-understood lattice realizations. Based on joint work with Takamasa Ando [arXiv:2602.11696].

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

Gadde - TBA

Wednesday, 11 March 2026 15:00 (1 hour)

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

Putrov - TBA

Wednesday, 11 March 2026 16:00 (1 hour)

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

Runkel - From continuum to the lattice in conformal field theory - 2

Thursday, 12 March 2026 11:00 (1 hour)

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would like to discuss (but not answer) the converse question: starting from a 2d CFT, is there a way to construct lattice models which recover the given CFT in the continuum limit? A particular focus will be topological symmetries of the CFT, as determined by topological line defects, and how they can be preserved when passing to the lattice model. What is more, the topological symmetry also gives a conjectural condition under which the answer to the above question is "yes". This talk is based on joint work with Enrico Brehm.

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

Honda - TBA - 1

Thursday, 12 March 2026 10:00 (1 hour)

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

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

Delcamp - Dualities in quantum lattice models - 1

Thursday, 12 March 2026 15:00 (1 hour)

I will present a category theoretic framework to systematically study dualities between quantum lattice models. After discussing the interplay between twisted boundary conditions and charge sectors under such dualities, I will show how to construct isometries that relate the spectra of dual models. Along the way I will give practical tricks to apply the framework to your favourite condensed-matter systems.

Contribution ID: **28** Type: **not specified**

Pflaum - C*-algebraic and topological study of quantum spin systems - 1

Thursday, 12 March 2026 16:00 (1 hour)

In the first lecture, the fundamentals of the C*-algebraic approach to quantum many-body systems will be laid out. In particular, the topology and geometry of state spaces describing quantum lattice systems will be studied and a few old and new results on the state space of the quasi-local algebra of a quantum lattice spin system when endowed with either the natural metric topology or the weak* topology will be shown.

In the second lecture some recent results on the homotopy theory of quantum lattice systems will be explained. In particular a homotopy theoretic interpretation of topological phases will be given, and Kitaev's conjecture will be explained. The homotopy groups of the unitary group of a UHF algebra will then be determined and it will be indicated that the pure state space of any UHF algebra in the weak* topology is weakly contractible. In addition, I will show at the example of non-commutative tori that also in the case of a not commutative C*-algebra, the homotopy type of the state space endowed with the weak* topology can be non-trivial and is neither deformation nor Morita invariant. Finally, I indicate how such tools together with methods from higher homotopy theory such as E_∞ spaces may lead to a framework for constructing Kitaev's loop-spectrum of bosonic invertible gapped phases of matter.

The second part is essentially based upon joint work with Agnes Beaudry, Mike Hermele, and Daniel Spiegel.

Contribution ID: **29** Type: **not specified**

Delcamp - Dualities in quantum lattice models - 2

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Contribution ID: **31** Type: **not specified**

Honda - TBA - 2

Friday, 13 March 2026 12:00 (1 hour)

Contribution ID: **32** Type: **not specified**

Michele Fossati - TBA

Tuesday, 10 March 2026 11:00 (1 hour)