

Book of abstracts

Gong show of the ASC school 2026

“Generalized Symmetries”

October 5

1. Lattice realisation of T-duality in curved backgrounds

Coraline Bacq (University of Würzburg)

We address the question of whether dualities formulated in continuum field theory can be realised exactly at finite lattice spacing, rather than only emerging in the infrared. In this context, we construct a lattice framework for a genuinely stringy form of T-duality. We extend the exact lattice T-duality of the compact boson to curved backgrounds with non-trivial circle fibrations, where the duality is no longer exhausted by the familiar exchange of momentum and winding, but also involves global topological data. To this end, we define the twisted Villain model, which couples the lattice fibre field to cochains encoding the bundle connection and the fibre-horizontal component of the B-field. Using a half-gauging procedure, we derive the associated lattice defect action and show that it defines a topological defect. This establishes that the distinctive topological features of T-duality on curved manifolds can be captured exactly in a lattice model.

2. Dynamical mean-field theory for spin systems on a Keldysh contour

Przemyslaw Bieniek (TU Dortmund)

Dynamical mean-field theory for spins systems is a newly developed method for computing dynamical spin correlations. It introduces a single-site model with a time-dependent mean field, which is then connected to the full spin system by a self-consistency condition. The mean field is assumed to be Gaussian distributed and the mean-field covariances are related to the spin correlations. The method was first developed for spin systems at infinite temperature. Although it has found use in simulating nuclear magnetic resonance experiments, the infinite-temperature assumption limits its applicability. Therefore, an extension was formulated which can access finite-temperature correlations, but at the cost of working in imaginary instead of real time. In this talk, I show how to further extend the method to compute correlations at finite temperature and in real time using the Keldysh contour. I compare the results to other numerical methods and discuss the possible applications.

3. Quantisation of wild character varieties

Julia Bierent (University of Edinburgh)

We want to quantise wild character varieties, i.e., the moduli space of Stokes local systems. For that, we will use factorisation homology of stratified surfaces, in particular of codimension 2 defects exhibiting central bimodule structure. In this talk, I will explain what category we assign to this defect and its structure in terms of factorisation homology and of representation theory.

4. Local and global structure of moduli spaces of connections in gauge theory

Jurek Bleischwitz (University of Southern Denmark)

Assume we are given a field theory over compact spacetime, in which a field is a connection on a principal bundle and the variation of the action is elliptic on a gauge slice, for example, Yang-Mills or Chern-Simons theory. We have shown the moduli space of solutions to Euler Langrange equations up to gauge transformation can locally be described by generalized Kuranishi charts. Topos theoretic arguments give global gluing gluing to a derived stack. Surprisingly, it matters (mathematically) when we take the gauge quotient. (Joint work with Jonah Epstein)

5. Decay of Metastable Domain Walls under Thermal Fluctuations

Davide Chiego (Max Planck Institute for Physics)

In some theories, topological defects are metastable and can decay via the nucleation of defects of lower dimensionality through quantum or thermal fluctuations. While at low temperatures the decay is dominated by quantum tunnelling, at higher temperatures thermal decay dominates. Using numerical methods, we simulate defects in a thermal bath at various temperatures and study their thermal decay. In particular, our study focuses on a 2+1-dimensional model that supports metastable domain walls and vortices connected by these walls. The decay occurs through the nucleation of vortex–antivortex pairs along the wall. From a large number of samples, the decay rate is found to be compatible with that expected for a process described by a sphaleron configuration. Studying this model serves as a first step towards understanding how thermal decay impacts the stability of defects in relevant 3+1-dimensional scenarios, such as domain walls bounded by strings in axion models and magnetic monopoles confined by cosmic strings in Grand Unified Theories. Given the relevance of topological defects in the early Universe, understanding the thermal breaking of such configurations provides important insights into their evolution.

6. Higher-form symmetries and anyon condensation in lattice models of non-Abelian topological order

Rafael Alvaro Flores Calderon (TUM)

We investigate non-invertible higher-form symmetries in discrete-group non-Abelian topological order, focusing on quantum double models. Moving beyond the exactly solvable fixed point, we construct an exact matterization isometry that enables sign-problem-free path-integral Monte Carlo simulations of the phase diagram. We also introduce generalized Fredenhagen–Marcu order parameters to diagnose non-Abelian anyon condensation, providing practical tools for characterizing transitions out of non-Abelian topological phases.

7. Topological String From The RNS Worldsheet: A Worldline Approach

Jingqian Gou (Heidelberg University)

The relation between the physical RNS worldsheet and topological string theory remains unclear at the level of BV/BRST structures. We study it in a worldline setting based on the $N=2$ spinning particle, viewed here as a model for the relevant RNS zero-mode structure, and its complexified $N=4$ and doubled $N=8$ extensions. Following Costello–Li, we twist their BV differentials by square-zero supercharge backgrounds. The $N=2$ twist gives the de Rham complex. For the B-type choices, the $N=4$ and $N=8$ models yield the linear holomorphic Chern–Simons complex of the open B-model and the BCOV complex of the closed B-model, respectively. An A-type branch of the doubled model returns to de Rham cohomology. We also formulate the $N=4$ parent model on curved Kähler targets. At the reduced level, we couple the $N=4$ and $N=$ charges to target-space backgrounds. Requiring the deformed charges to remain nilpotent gives the nonlinear holomorphic Chern–Simons and extended Kodaira–Spencer equations. Together, these results place the open and closed B-models in a common worldline framework, where their nonlinear target-space equations arise as nilpotency conditions.

8. Euler–Poincaré Reduction: A Geometric Treatment of the Relativistic Spinning Particle

Burak Gül (LMU)

The heavy top is a classic example of Euler–Poincaré reduction on a semidirect product group, demonstrating how an advected quantity—the direction of gravity—couples to rotational motion. While the description of relativistic spinning particles via Lie group configurations is well established in Hamiltonian and symplectic mechanics, we demonstrate that an explicit Lagrangian Euler–Poincaré reduction provides a direct, transparent parallel to the heavy top. Specifically, we show that the free relativistic spinning particle on the Poincaré group is the precise Lorentzian analog of this system, with spacetime position being the advected quantity. This geometric unification not only illuminates the underlying symmetry of both systems but also clarifies why the introduction of external electromagnetic fields leads to a partial reduction. Finally, we establish that the transition to left-trivialized coordinates acts as a geometric selection mechanism, naturally favoring a class of interaction Lagrangians where spin-field coupling manifests as a dynamical redefinition of the particle’s mass.

9. The SymTFT on the lattice: From ribbons to patch operators

David Hofmeier (University of Southern Denmark)

The SymTFT associates to a d -dimensional QFT a $(d+1)$ -dimensional TFT, which encodes the symmetry information of the theory, with all the local dynamics left as a relative theory on the boundary. The original theory is obtained after interval compactification of the bulk. Here, we realize the same idea on the lattice: Taking the 2d quantum double model in the bulk, we propose a compactification circuit, depending only on the symmetry boundary, that layer-by-layer disentangles the bulk, leaving all dynamics constrained to an effective 1d qudit chain on the boundary. We apply this idea to construct patch operators, creating generic excited states of $(1+1)d$ G and $\text{Rep}(G)$ -symmetric quantum phases. This is joined work with S. Moudgalya, A. Prem, A. Tiwari, and L. Zheng.

10. n-Bistellar Data for the Orbifold Construction

Aleksandar Ivanov (University of Vienna)

The orbifold construction is a procedure that constructs new TQFTs from old ones given a particular algebraic input consisting of symmetries. I will present a framework that algorithmically generates the form of the algebraic input called bistellar data. The benefit of the framework is that it immediately works in any dimension, and easily provides a description of iterated bistellar bimodules, which describe the symmetries of the new theory.

11. Telum.jl: A Julia-based non-Abelian tensor library with exact Clebsch–Gordan data

Kiyeon Kim (Seoul National University)

Telum.jl is a non-Abelian tensor network library written entirely in Julia. Its internal Clebsch–Gordan engine, LurCGT.jl, extends the approaches of QSpace and TensorKit.jl to compute symmetry-related quantities for $SU(N)$, $Sp(2N)$, $SO(N)$, and G_2 exactly using integer arithmetic and in a deterministic manner. Telum.jl is designed to handle tensors with arbitrary combination of these symmetries, with ready-to-use support for spinful fermionic spaces involving $U(1)$, $SU(2)$, and $SU(N)$ charge, spin, and channel symmetries. Telum.jl is designed for users to implement high-performance tensor network algorithms with simple and readable syntax. It provides an ITensor-style interface, together with utility methods for explicitly controlling contracted legs. On the performance side, Telum.jl implements an efficient SVD algorithm that avoids explicit leg fusion, as well as lazy evaluation for simple operations such as conjugation. In benchmark calculations performed so far, Telum.jl achieves CPU runtimes comparable to QSpace while reducing memory usage. Further optimizations, including lazy evaluation for tensor contractions and GPU support, are planned for future releases.

12. The Strong-CP Problem and its Gauge Axion solution as Evidence for Fundamental Strings

Lucy Elisabeth Komisel (Max Planck Institute for Physics/LMU Munich)

The topological susceptibility of the QCD vacuum provides an understanding of θ -vacua as vacua of a Chern-Simons gauge theory. In this way, it gives an immediate proof of the physicality of the boundary θ -term. This makes the essence of the strong-CP puzzle very transparent and offers a solution in form of the gauge axion, which has exact quality. This axion represents an intrinsic part of the QCD gauge redundancy without any reference to an anomalous global symmetry. It is a two-form transforming under the QCD gauge symmetry. Due to its pure gauge nature, the gauge axion represents a powerful tool to monitor physics of θ -vacua in various regimes. Unlike the ordinary Peccei-Quinn axion, which is UV-completed into a Goldstone phase of a complex scalar and thereby suffers from the quality problem, the gauge axion is UV-completed directly into a fundamental theory of gravity. We study the domain wall and string structure of the gauge axion and show that the strings sourcing it must be a part of this fundamental theory. We thus observe that the absence of the axion quality problem motivates the presence of fundamental strings. This provides a new argument for a connection between the axion and gravity.

13. 2 broken symmetries: hierarchies between breaking scales

Daniele Licciardello (University of Padua- INFN Padua)

Based on the recent work arXiv:2606.26004, I will present the invertible and non-invertible generalized symmetries of four-dimensional axiverse effective field theories with multiple axions coupled to abelian gauge sectors. I will also discuss the associated symmetry-breaking mechanisms together with the resulting hierarchies of energy scales. Particular attention will be paid to the quantum-gravitational breaking of non-invertible axion shift symmetries predicted by the existence of wormholes and the recently proposed Imaginary Distance Bound.

14. Phase structure and symmetry breaking in $SU(N)$ ferromagnets

Joaquin Lopez Suarez (Stockholm University)

We study the phase structure of ferromagnets whose elementary building blocks (atoms) carry an irreducible representation (irrep) of the group $SU(N)$, and interact in pairs via long-range interactions that are invariant under $SU(N)$ transformations. We develop the formalism to study the thermodynamics of these ferromagnets and apply it to the cases where the atoms carry the fundamental, symmetric, antisymmetric and adjoint representations. We observe that at high temperatures, a non-magnetized phase prevails, whereas at lower temperatures different magnetized phases appear, depending on the irrep carried by the atoms. Phases are characterized by Young Tableaux, and in the low temperature limit they correspond to $SU(N)$ irreps with a fixed number of boxes that maximize the quadratic Casimir. The magnetized phases spontaneously break the $SU(N)$ symmetry of the ferromagnet. In the case of the adjoint representation, a breakdown of the discrete conjugation symmetry is also observed. We observe the coexistence of phases at finite temperature intervals, as well as first order phase transitions. We verify that for $N = 2$, usual ferromagnets are recovered. Possible applications in cold atom systems are examined.

15. BSM phenomenology with RECOLA2

Luis Lourenco (Würzburg University)

RECOLA2 automates the numerical computation of one-loop scattering amplitudes in the Standard Model and beyond. I currently work on extending its reach to new physics models via a new interface for UFO2 model files, and on applying it to BSM phenomenology at NLO.

16. (Non-invertible) symmetry, boundary, and entanglement

Shuma Nakashiba (Institute for Solid State Physics, The University of Tokyo)

Symmetry and boundary conditions are alike in a sense: they both constrain the bulk physical degrees of freedom. The interplay of global symmetry and boundary conditions is of great importance in studying the dynamics of physical systems, since every real material has boundaries. Recent developments of generalized symmetry has enriched the notion of quantum phases of matter: especially remarkable is the non-invertible symmetry in $(1+1)$ -dimensional QFT, where the fusion of topological defects does not necessarily have an inverse. One key notion of quantum phases of matter is entanglement. Understanding the entanglement property from the symmetry point of view is thus a fundamental problem in quantum many-body physics, and this problem becomes richer when we consider the existence of boundaries. Especially, I am interested in characterising the boundary contribution to entanglement entropy in the presence of two different boundary conditions in $(1+1)$ -d. A recent work about the relationship between boundary CFT and entanglement asymmetry in $(1+1)$ -d theory is attracting for me, and I am writing a paper about (non-invertible) symmetry-preserving/breaking boundary and entanglement with my collaborators.

17. Relative form symmetries - Algebraic QFT and differential cohomology

Filippo Nava (University of York)

I will briefly present the algebraic approach to Quantum Field Theory, and how to phrase locality in terms of the additivity property. I'll highlight the tension between gauge theories and locality, and introduce relative differential cohomology in order to solve this issue. Eventually, I'll point out how a relative version of higher form symmetries arises.

18. Finite-Time Scattering with Gaussian Wave Packets

Yuya Nishio (Hokkaido University)

Scattering probabilities are usually described by a transition rate multiplied by the scattering time. In a finite-time formulation, an additional contribution arises from the time boundaries and has properties distinct from the usual bulk contribution. We call the bulk and time-boundary contributions first and second class, respectively. Using normalized Gaussian wave-packet states, we evaluate scattering probabilities including both contributions. I will briefly introduce this framework and illustrate their contrasting dependence on a variable related to the energy difference between the initial and final states: Gaussian suppression for the bulk contribution and a power-law tail for the time-boundary contribution. Our aim is to understand the second-class contribution as a distinct part of the scattering probability, beyond what is captured by the usual transition rate.

19. Low-energy dynamics of tensor chiral gauge theories and breakdown of the color-flavor-locked $\mathbb{Z}_N^{(1)}$ center symmetry

Matteo Orso (University of Pisa & INFN, Sezione di Pisa)

The low-energy dynamics of a class of four dimensional strongly-coupled chiral $SU(N)$ gauge theories namely, “tensor chiral gauge theories”, is studied. We focus on a few models with a single left-handed Weyl fermion in a two-index symmetric tensor representation, and a certain number of Weyl fermions in a two-index anti-symmetric tensor representation of the gauge group, by extending previous works on chiral gauge theories, such as the generalized Bars-Yankielowicz and Georgi-Glashow models. The main tool of our analysis is the anomaly obstructing the gauging of a certain “color-flavor-locked one-form $\mathbb{Z}_N^{(1)}$ center symmetry”, together with a $U(1)$ global symmetry. The presence of such anomaly at high energies is an indication of the spontaneous breaking of the $U(1)$ symmetry. The formation of a bifermion condensate is assumed, causing the spontaneous symmetry breaking and inducing Higgs mechanism as well, meaning that the $\mathbb{Z}_N^{(1)}$ symmetry itself is lost in the infrared. One is led to a solution, if not unique, which fully satisfies the conventional, as well as the new, generalized, ’t Hooft anomaly matching requirements (“natural anomaly matching”). Further generalizations are briefly introduced. Based on a joint work together with Stefano Bolognesi, Kenichi Konishi and Andrea Luzio.

20. Gauge group extensions from magnetic (-1) -form symmetry gauging

Alonso Perez-Lona (Max Planck Institute for Mathematics in the Sciences)

Topologically gauging a magnetic (-1) -form symmetry in pure G gauge theory does not merely restrict the sum over topological sectors: it changes the gauge group. Given a characteristic class $c: BG \rightarrow B^d A$ describing a $\hat{A} = \text{Hom}(A, U(1))$ (-1) -form symmetry in d -dimensions, we show that the resulting theory is pure G' gauge theory, where G' is the higher group extension $1 \rightarrow B^{d-2} A \rightarrow G' \rightarrow G \rightarrow 1$ by a discrete $(d-1)$ -group. The proof reduces to a three-line homotopy fiber sequence. Four familiar phenomena emerge as special cases across different choices of (d, A) : the decompactification $U(1) \rightarrow \mathbb{R}$, the Schur cover $\tilde{G} \rightarrow G$ underlying discrete torsion, instanton restriction in four dimensions, and the modified instanton sum of Tanizaki and Ünsal (recovered here for $A = \mathbb{Z}_p$).

21. Non-Invertible symmetries and dualities in Type IIB supergravity

Luca Quagliarella (University of Padua)

Type IIB supergravity bosonic pseudo-action exhibits a variety of global symmetries. In my thesis work we study them within the formalism of generalized symmetries. Particular attention is dedicated to the 0-form symmetry $SL(2, \mathbb{R})$, broken to $SL(2, \mathbb{Z})$ due to the quantization of the fluxes of the 2-form fields. We find that interestingly a larger symmetry group $SL(2, \mathbb{Q})$ survives as a non-invertible symmetry. The topological defects associated with this symmetry are constructed. The higher-form symmetries of the theory are analyzed as well. We exploit this non-invertible symmetry structure to derive inequalities constraining the hierarchy of energy scales at which the different symmetries of Type IIB supergravity must be broken in any consistent ultraviolet completion, in accordance with the No Global Symmetry Conjecture.

22. $Z(N)$ Lattice Gauge Theory can Emerge a Photon

Emily Richards (Durham University)

Confinement in theories with a $Z(N)$ 1-form symmetry is typically attributed either to centre-vortex proliferation or monopole condensation. EFT arguments suggest that models with this symmetry in $d=4$ generically have three phases: confined, Higgs and photon, with the latter arising when vortices proliferate but monopoles do not. This has been shown previously – analytically for the $Z(N)$ Villain lattice gauge theory and numerically for the Wilson LGT for $N > 2$ – but the $Z(2)$ Wilson LGT remained open. In this talk, I will sketch the importance of vortex orientation for defining monopoles and emerging a photon. I will highlight how odd N and even $N>2$ circumvent this problem, before finally showing one way to emerge a photon in the unoriented $Z(2)$ Wilson LGT.

23. Non-invertible T-dualities: a path integral perspective

Matteo Serafini (University of Padova)

Symmetries have always played a fundamental role in physics. Recently, within the framework of quantum field theory, the traditional notion of symmetry has been significantly broadened. In particular, this generalization allows for the inclusion of so-called non-invertible symmetries, which do not correspond to unitary operators. The thesis focuses on a peculiar manifestation of such non-invertible symmetries in string theory that is not yet completely understood. In 2012, Bachas, Brunner, and Rognenkamp (BBR) showed that, within the two-dimensional world-sheet formulation of toroidal compactifications of both bosonic and superstring theories, one can construct non-invertible topological interfaces connecting physically inequivalent string theory vacua. These vacua may be regarded as related by non-invertible T-dualities. Such interfaces imply the existence of selection rules for string theory amplitudes, which should be interpretable as non-invertible symmetries from the physical spacetime point of view; however, this interpretation remains to be clarified. With this motivation in mind, the thesis aims to investigate an alternative derivation of the BBR world-sheet interfaces and their properties, based on the path-integral formulation and exploiting powerful techniques recently developed within the generalized symmetry community. The results will provide an alternative perspective on non-invertible T-dualities, and on their quantum gravity implications.

24. Domain walls between string theories and twist field correlators

Başar Deniz Sevinç (University of Bologna)

Domain walls interpolating between string theories, joining type IIA and IIB, have recently been constructed. We discuss ongoing work on walls between the two ten-dimensional heterotic theories, and between type II and heterotic theories. Our description utilizes matrix string theory, which captures the perturbative string as a symmetric product orbifold CFT in which interactions are governed by an irrelevant twist field deformation. We compute twist field correlators in this deformation, from which the energy and pressure densities of the walls can be extracted.

25. Monodromy of Isolated Extrema in Elliptic Calogero–Moser Systems

Valdo Tatitscheff (Technische Universität München)

I will discuss how elliptic Calogero-Moser (CM) systems can be used to study the vacua of $N=1^*$ theories in both perturbative and non-perturbative regimes, the spontaneous breaking of non-invertible duality symmetries, as well as the resulting notion of global variants of CM systems introduced recently in arXiv:2504.01502. I will also mention some mysterious monodromy phenomena that arise for isolated extrema of type D elliptic Calogero–Moser systems, which are the subject of ongoing work.

26. Equivariant quantization

Jackson Van Dyke (Technical University of Munich)

One instance of a symTFT is BF theory associated to a compact Lie group. I will explain some mathematical avatars of such theories. The main focus will be on (projective) symmetries of 3-dimensional TFTs, e.g. Chern-Simons and Rozansky-Witten theory.

27. Disordered Phases of Matter with Non-Abelian Symmetries: Instabilities and Enlargements

Ludwig Zweng (Technical University of Munich)

Recent works have developed a unifying framework for classifying ground state phases of matter with a wide range of discrete symmetries—both group-like and non-invertible symmetries—via a holographic correspondence between symmetric operators in d dimensions and topological operators in a $d+1$ dimensional system often known as the SymTO or SymTFT. Its lattice formulation naturally yields fixed-point commuting Hamiltonians that realize these phases in their ground state. In this work, we extend this framework to disordered and non-equilibrium settings by analyzing excited states of the disordered versions of these fixed-point models. Characterizing symmetry breaking patterns in the excited states requires new tools and diagnostic methods, which we develop to find that they can differ dramatically from their ground state counterparts, leading to a rich and sometimes surprising phenomenology. We illustrate these phenomena by constructing lattice models for a variety of invertible and non-invertible symmetries, classifying the distinct excited state phases that arise in each case. Finally, we propose a concrete definition of excited state phases of matter and argue that the SymTFTs that capture ground state phases do not fully capture the intricacies of the excited states.