

Bridging analytical and numerical methods for quantum field theory

Report of Contributions

Contribution ID: 2

Type: **not specified**

Effective string theory on a torus: the 3d Ising interface

We use effective string theory (EST) to describe a toroidal 2d interface embedded in a 3d torus. In particular, we compute the free energy of the interface in an expansion in inverse powers of the area, up to the first non-universal order that involves the Wilson coefficient γ_3 .

In order to test our predictions, we simulate the 3d Ising model with an anti-periodic boundary condition with a two-step multicanonical algorithm that delivers high-precision free-energy data.

Authors: MATOS, José (EPFL); Prof. PENEDONES, João (EPFL); Prof. VIANA, João (Universidade do Porto); Mr LIMA, David

Presenter: MATOS, José (EPFL)

Contribution ID: 3

Type: **not specified**

Flux Tubes and Confinement in Lattice QCD

We present lattice QCD measurements of the field strength tensor and current distributions generated by a static quark–antiquark pair. We perform measurements on smeared Monte Carlo QCD configurations with (2+1) HISQ dynamical flavors with pion mass 140 MeV. Results are discussed both at zero temperature and at finite temperature below and above the chiral transition.

Authors: BAKER, Marshall (Department of Physics, University of Washington, Seattle, USA); CEA, Paolo (INFN Bari, Italy); CHELNOKOV, Volodymyr (Institut für Theoretische Physik, Goethe Universität, Frankfurt am Main, Germany); COSMAI, Leonardo (INFN); PAPA, Alessandro (Università della Calabria & INFN-Cosenza)

Presenter: COSMAI, Leonardo (INFN)

Contribution ID: 4

Type: **not specified**

Stochastic Normalizing Flows for lattice gauge theory and defects

In recent years, flow-based samplers have emerged as a promising alternative to traditional sampling methods in lattice field theory. In this talk, I will introduce a class of flow-based samplers known as Stochastic Normalizing Flows (SNFs), which combine neural networks with non-equilibrium Monte Carlo algorithms. I will then show that SNFs exhibit excellent scaling with volume in lattice $SU(3)$ gauge theory. Afterward, I will focus on gauge theories with defects and outline a general strategy for applying flow-based samplers to these systems. In particular, I will present an application to $SU(3)$ gauge theory with open boundary conditions, broadening the scope of modern sampling techniques.

Author: CELLINI, Elia (University of Turin/ INFN Turin)

Presenter: CELLINI, Elia (University of Turin/ INFN Turin)

Contribution ID: 5

Type: **not specified**

Casimir effect in critical $O(N)$ models with non-equilibrium methods

Lattice systems, when tuned to criticality, exhibit long-range fluctuations that are sensitive to the geometry in which they are confined. The critical Casimir amplitude encodes universal information on this behavior, and it is part of the CFT data at finite temperature. Predicting this quantity in models with $O(N)$ symmetry would have a broad range of applications, from high-energy physics to condensed matter, but so far different calculations have yielded conflicting results. Using a new numerical technique, we push the theoretical predictions to a range of parameters never studied before, revealing a non-trivial dependence on the number of spin components, N , and comparing our results to bootstrap calculations.

Authors: NADA, Alessandro; BULGARELLI, Andrea (University of Turin and INFN Turin); PANERO, Marco; CASELLE, Michele

Presenter: BULGARELLI, Andrea (University of Turin and INFN Turin)

Contribution ID: 6

Type: **not specified**

The Mass of the Baryon Junction: a lattice computation in $2 + 1$ dimensions

We present a systematic study of baryonic flux tubes in $SU(3)$ Yang–Mills theory in $(2 + 1)$ dimensions. A recent next-to-leading-order derivation within the Effective String Theory framework has, for the first time, made explicit the corrections proportional to the baryon–junction mass M , up to order $1/R^2$ (where R is the length of the confining strings), opening the possibility of its non-perturbative determination. Through high-precision simulations of the three-point Polyakov-loop correlator, we measure the baryon–junction mass. By isolating the predicted $1/R^2$ term in the open-string channel, we obtain the value $\frac{M}{\sqrt{\sigma}} = 0.1355(36)$, similar to the phenomenological value which is used to describe hadrons. In addition, studying the high temperature behaviour of the baryon, we present a new test of the Svetitsky–Yaffe conjecture for the $SU(3)$ theory in three dimensions. Focusing on the high-temperature regime just below the deconfinement transition, we compare our lattice results for Polyakov-loop correlators with the quantitative predictions obtained by applying conformal perturbation theory to the three-state Potts model in two dimensions, and find excellent agreement.

Authors: PANFALONE, Dario (Università di Torino); VERZICHELLI, Lorenzo (Università di Torino, INFN sezione di Torino); CASELLE, Michele (Università di Torino); Prof. MAGNOLI, Nicodemo (Università di Genova)

Presenter: PANFALONE, Dario (Università di Torino)

Contribution ID: 7

Type: **not specified**

The spectrum of open confining strings in the large- N_c limit

We present a comprehensive study of the spectrum of the open confining string (open flux tube) in 3+1 dimensions for several $SU(N_c)$ gauge groups, with a focus on the large- N_c limit and the possible emergence of world-sheet axion states. Specifically, we analyze the excitation spectra of flux tubes formed between static quark-antiquark pairs for $N_c = 3, 4, 5$, and 6. Our study includes a detailed analysis of a wide range of radial excitations and eight irreducible representations, classified by the angular momentum quantum number Λ , charge conjugation and parity η_{CP} , and the reflection symmetry ϵ for $\Lambda = 0$. To extract the spectrum, we employ an anisotropic lattice action, smearing techniques, a diverse basis of operators, and solve the generalized eigenvalue problem. We compare our results to the predictions of the Nambu-Goto string model to identify potential discrepancies that may signal new physical phenomena. Notably, we observe clear evidence for a massive axion-like excitation on the world-sheet, with a mass matching that of the axion previously identified in the closed flux-tube spectrum. This strongly supports the conjecture that the axion is an intrinsic world-sheet excitation of the QCD string.

Author: SHARIFIAN, Alireza

Co-authors: Dr ATHENODOROU, Andreas; Prof. BICUDO, Pedro

Presenter: SHARIFIAN, Alireza

Contribution ID: 8

Type: **not specified**

Intrinsic width of the flux tube in 2+1 dimensional Yang-Mills theories

We study the profile of the flux tube in non-Abelian gauge theories in the confined phase in 2+1 dimensions, by means of precise lattice numerical simulations. We observe a non-Gaussian profile with prominent exponentially decaying tails. From the characteristic decay length, we extract the intrinsic width of the flux tube. We compute this scale at different values of the temperature in the confined phase.

At low temperature, the profile of the flux tube is well described by the Clem formula, which has been originally proposed in the context of dual superconductivity models. We compare the value of the intrinsic width extracted from fits assuming the Clem formula with the mass gap of the gauge theory and with the critical distance of the Effective String Theory.

At high temperature, on the other hand, it is possible to predict the profile of the flux tube assuming the Svetitsky-Yaffe mapping. We test this prediction against the numerical data, finding a very good agreement, also in the numerical value of the intrinsic width.

Authors: Dr PANFALONE, Dario (Università di Torino, INFN sezione di Torino); VERZICHELLI, Lorenzo (Università di Torino, INFN sezione di Torino); Prof. CASELLE, Michele (Università di Torino, INFN sezione di Torino)

Presenter: VERZICHELLI, Lorenzo (Università di Torino, INFN sezione di Torino)

Contribution ID: 9

Type: **not specified**

Peculiar phase transitions in three dimensional gauge systems

We summarize the results obtained from lattice simulations for some peculiar continuous phase transitions of three dimensional gauge systems with scalar matter. In several cases these models display continuous phase transitions whose critical behavior can not be described by a gauge invariant ϕ^4 effective field theory. The case in which gauge degrees of freedom develop long range correlations is probably the simplest one in which this happens, but theories with discrete gauge groups offers further possibilities. While introducing the topic we will comment on its possible relevance for the nonperturbative definition of three dimensional gauge QFTs and for finite temperature transitions of 4d gauge theories (e.g. the chiral transition).

Author: BONATI, Claudio (Pisa University)

Presenter: BONATI, Claudio (Pisa University)

Contribution ID: 10

Type: **not specified**

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

Recent developments have revealed that symmetries need not form a group, but instead can be non-invertible. Here we 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. We 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 $G = Z_2$). We construct Ising-type transverse-field Hamiltonians with $\text{Rep}(G)$ 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. We 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. Our work identifies properties of non-invertible symmetry breaking that existing quantum hardware can probe.

Author: MOROZ, Sergej (Karlstad University)

Presenter: MOROZ, Sergej (Karlstad University)

Contribution ID: 11

Type: **not specified**

A new method for measuring high spin glueball states on the lattice

To test the hypothesis that glueballs lie on the pomeron trajectory, accurate theoretical calculations for the masses of high spin glueball states are required. Current methods have been used to determine glueball masses in $D = 2 + 1$ up to $J = 8$ (arXiv:1909.07430), but these calculations quickly become cumbersome for very high spins. We present a new method, which builds operators by calculating staggered fermion lattice propagators. We look at some preliminary results for masses of low spin glueball states in $2 + 1D$ $U(1)$ and $SU(2)$ theories using the new method, and present the progress made so far in applying this method to high spin states.

Author: TWAITES, Kieran (University of Oxford)

Co-author: Dr TEPPER, Mike (University of Oxford)

Presenter: TWAITES, Kieran (University of Oxford)

Contribution ID: 12

Type: **not specified**

Center-vortex semiclassics on $\mathbb{R}^2 \times T^2$ and large- N adiabatic continuity

When the 4d $SU(N)$ Yang-Mills theory is put on $\mathbb{R}^2 \times T^2$ with a nontrivial 't Hooft flux, qualitative features of confinement can be semiclassically described as the gas of center-vortex fractional instantons. We study the condition for the large- N adiabatic continuity via a suitable choice of the N -dependent 't Hooft flux from the viewpoint of both 0-form and 1-form center symmetry.

Author: TANIZAKI, Yuya (Yukawa Institute for Theoretical Physics, Kyoto University)

Presenter: TANIZAKI, Yuya (Yukawa Institute for Theoretical Physics, Kyoto University)

Contribution ID: 13

Type: **not specified**

Effective strings in QED₃

In this blackboard talk I will review the formalism of effective string theory and its generic predictions, and why it breaks down in theories like QED₃ (in UV completions that lead to confinement), for which the mass gap is well below the scale of the confining string tension. A similar breakdown appears for solitonic strings. I will then describe an alternative method to perform computations in such theories, and the results for some properties of strings in QED₃ that differ from standard effective string theory. Based on 2412.01313 written in collaboration with Barel and Sheaffer.

Author: AHARONY, Ofer (Weizmann Institute of Science)

Co-authors: BAREL, Netanel; SHEAFFER, Tal

Presenter: AHARONY, Ofer (Weizmann Institute of Science)

Contribution ID: 14

Type: **not specified**

D-branes in large N gauge theories

I will describe the potential role of D-branes in the characterization of the String Theories dual to a given gauge theory. I will discuss examples in 2d CFTs, Chern-Simons theory and vector models, as well as potential targets for numerical simulation.

Author: GAIOTTO, Davide (Perimeter Institute)

Presenter: GAIOTTO, Davide (Perimeter Institute)

Contribution ID: 15

Type: **not specified**

The Nielsen-Ninomiya theorem versus bosonization

I'll discuss how the Nielsen-Ninomiya no-go theorem fits with recent bosonization-inspired lattice discretizations that preserve exact continuous chiral and vector symmetry.

Authors: CHERMAN, Aleksey (University of Minnesota); Ms NEUZIL, Maria (University of Minnesota); Dr CHEN, Shi (University of Minnesota)

Presenter: CHERMAN, Aleksey (University of Minnesota)

Contribution ID: 16

Type: **not specified**

Emergent thermalisation in the Schwinger model

The Schwinger model is a confining theory in one plus one dimensions theory that has a chiral condensate and a chiral anomaly. I will present tensor network simulations of its real-time dynamics. In particular, I will discuss how the system appears to thermalise when subjected to an inhomogeneous quench reminiscent of the production of hard particles in a QCD jet. I will characterise this approach to equilibrium through the lens of local observables and the rearrangement of entanglement in the system.

Author: FLORIO, Adrien (Bielefeld)

Presenter: FLORIO, Adrien (Bielefeld)

Contribution ID: 17

Type: **not specified**

Registration

Monday 25 August 2025 08:30 (30 minutes)

Contribution ID: **18**

Type: **not specified**

Welcome remarks

Monday 25 August 2025 13:45 (15 minutes)

Contribution ID: **19**

Type: **not specified**

The spectrum of open confining strings in the large-limit

Monday 25 August 2025 14:00 (30 minutes)

Presenter: SHARIFIAN, Alireza

Contribution ID: 20

Type: **not specified**

Intrinsic width of the flux tube in 2+1 dimensional Yang-Mills theories

Monday 25 August 2025 14:30 (30 minutes)

Presenter: VERZICHELLI, Lorenzo

Contribution ID: 21

Type: **not specified**

Using space-time geometry as a tool

Monday 25 August 2025 15:30 (45 minutes)

Presenter: GONZALEZ-ARROYO, Antonio

Contribution ID: 22

Type: **not specified**

Non-perturbative physics of (1+1)d gauge theories using symmetric matrix product states

Tuesday 26 August 2025 09:00 (45 minutes)

We introduce a novel matrix product operator construction for Hamiltonian lattice gauge theories in $(1 + 1)$ dimensions. This framework enables the study of strongly coupled phenomena such as bound states, string tension, and vacuum structure. We demonstrate the effectiveness of our method by applying it to the massive Schwinger model and adjoint QCD₂

Presenter: SOGAARD, Benjamin

Contribution ID: 23

Type: **not specified**

The simplicity of confinement

Tuesday 26 August 2025 09:45 (45 minutes)

Motivated by recent literature on the possible existence of a second higher-temperature phase transition in Quantum Chromodynamics (QCD), I revisit the proposal that colour confinement is related to the dynamics of magnetic monopoles using methods derived from Topological Data Analysis, which provide a mathematically rigorous characterisation of topological properties of quantities defined on a lattice. After introducing homology, I shall discuss how this concept can be used to quantitatively analyse the behaviour of monopoles across the deconfinement phase transition. The proposed approach is first demonstrated for Compact $U(1)$ Lattice Gauge Theory, which is known to have a zero-temperature deconfinement phase transition driven by the restoration of the symmetry associated with the conservation of the magnetic charge. For this system, I perform a finite-size scaling analysis of observables capturing the homology of magnetic current loops, showing that the approach reproduces the expected value of the deconfinement critical coupling. Then, I extend this method to $SU(3)$ gauge theory, in which Abelian magnetic monopoles are identified after projection in the Maximal Abelian Gauge. Specifically, I define an observable called “simplicity”, which measures the number of topologically non-trivial loops per connected component in a current network. A finite-size scaling of the ensemble-averaged simplicity of Abelian magnetic currents provides the expected value of the critical coupling with an accuracy that is generally higher than that obtained with conventional thermodynamic approaches at comparable statistics, suggesting the relevance of the topological properties of monopole currents for confinement. Finally, preliminary results from a study of simplicity in QCD will be briefly discussed.

Presenter: LUCINI, Biagio

Contribution ID: 24

Type: **not specified**

Casimir effect in critical $O(N)$ models with non-equilibrium methods

Tuesday 26 August 2025 11:00 (30 minutes)

Presenter: BULGARELLI, Andrea

Contribution ID: 25

Type: **not specified**

Three-dimensional $U(1)$ strings beyond effective string theory

Tuesday 26 August 2025 11:30 (30 minutes)

Effective string theory provides a successful description of the confining string in non-Abelian gauge theories. On the other hand, $U(1)$ gauge theory in three spacetime dimensions, while confining, displays some peculiar properties (such as the impossibility of holding both the mass and string tension fixed in the continuum limit) which question the applicability of effective string theory to its confining string. In this talk, we report the results of numerical calculations of the ground state energy of the confining string in 3D $U(1)$ gauge theory, and to what extent our results can be described by either effective string theory or alternatives, such as a recent proposal by Aharony, Barel and Sheaffer.

Presenter: MARIANI, Alessandro

Contribution ID: 26

Type: **not specified**

Aspects of Superconducting Strings

Tuesday 26 August 2025 13:30 (45 minutes)

I will examine Abrikosov–Nielsen–Olesen (ANO) vortex strings in variants of Abelian Higgs models. In the large flux limit, the equations governing them simplify, and the resulting giant strings realize two sharply distinct phases. I will explore qualitative features of these strings and identify patterns in their physical properties. I'll also discuss the spectrum of small fluctuations and the associated low energy effective action. I will end by comparing these results to features of confining strings in Yang Mills theory.

Presenter: GAIKWAD, Amey

Contribution ID: 27

Type: **not specified**

Flux Tubes and Confinement in Lattice QCD

Tuesday 26 August 2025 14:15 (45 minutes)

Presenter: COSMAI, Leonardo

Contribution ID: **28**

Type: **not specified**

Training Neural Networks

Tuesday 26 August 2025 15:30 (45 minutes)

Author: DEL DEBBIO, Luigi

Presenter: DEL DEBBIO, Luigi

Contribution ID: 29

Type: **not specified**

D-branes in large N gauge theories

Wednesday 27 August 2025 09:00 (45 minutes)

Presenter: GAIOTTO, Davide

Contribution ID: **30**

Type: **not specified**

Chiral anomaly and Ginsparg-Wilson Hamiltonians

Wednesday 27 August 2025 09:45 (45 minutes)

Presenter: SINGH, Hersch

Contribution ID: 31

Type: **not specified**

Stochastic Normalizing Flows for lattice gauge theory and defects

Wednesday 27 August 2025 11:00 (30 minutes)

Presenter: CELLINI, Elia

Contribution ID: 32

Type: **not specified**

Effective string theory on a torus: the 3d Ising interface

Wednesday 27 August 2025 11:30 (30 minutes)

Presenter: MATOS, José

Contribution ID: 33

Type: **not specified**

The LLR method in Lattice Gauge Theories

Wednesday 27 August 2025 13:30 (45 minutes)

Presenter: VADACCHINO, Davide

Contribution ID: **34**

Type: **not specified**

The Nielsen-Ninomiya theorem versus bosonization

Wednesday 27 August 2025 14:15 (45 minutes)

Presenter: CHERMAN, Aleksey

Contribution ID: 35

Type: **not specified**

Effective strings in QED_3

Wednesday 27 August 2025 15:30 (45 minutes)

Presenter: AHARONY, Ofer

Contribution ID: 36

Type: **not specified**

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

Thursday 28 August 2025 09:00 (45 minutes)

Presenter: MOROZ, Sergej

Contribution ID: 37

Type: **not specified**

Peculiar phase transitions in three dimensional gauge systems

Thursday 28 August 2025 09:45 (45 minutes)

Presenter: BONATI, Claudio

Contribution ID: **38**

Type: **not specified**

The Mass of the Baryon Junction: a lattice computation in dimensions

Thursday 28 August 2025 11:00 (30 minutes)

Presenter: PANFALONE, Dario

Contribution ID: 39

Type: **not specified**

A new method for measuring high spin glueball states on the lattice

Thursday 28 August 2025 11:30 (30 minutes)

Presenter: TWAITES, Kieran

Contribution ID: 40

Type: **not specified**

Floquet Insulators and Lattice Fermions

Thursday 28 August 2025 13:30 (45 minutes)

Presenter: SEN, Srimoyee

Contribution ID: 41

Type: **not specified**

Regulated chiral gauge theory and the strong CP problem

Thursday 28 August 2025 14:15 (45 minutes)

Four-dimensional chiral gauge theory can be formulated as the boundary theory on a five-dimensional manifold in a manner that may be realized on a finite lattice. There are interesting features of these theories which defy a purely four-dimensional conception of universality. We find that QCD as embedded in a chiral gauge theory (the Standard Model) when regulated this way appears to suffer neither from a $U(1)_A$ problem nor a strong CP problem, with a central role played by fermion zero-modes localized far away in the fifth dimension. In this way it differs from conventional lattice QCD formulated as a stand-alone theory.

Presenter: KAPLAN, David

Contribution ID: **42**

Type: **not specified**

Talk

Thursday 28 August 2025 15:30 (45 minutes)

Presenter: MARINKOVIC, Marina

Contribution ID: 43

Type: **not specified**

Quantum Group symmetry, from the Lattice to the Continuum

Friday 29 August 2025 09:00 (45 minutes)

Presenter: ZAN, Bernardo

Contribution ID: 44

Type: **not specified**

Proving chiral symmetry breaking in QCD with 't Hooft anomaly matching

Friday 29 August 2025 09:45 (45 minutes)

Presenter: XU, Ling-Xiao (ICTP, Trieste)

Contribution ID: 45

Type: **not specified**

Yang-Lee Criticality in Various Dimension

Friday 29 August 2025 11:00 (45 minutes)

Yang-Lee criticality is the simplest non-Hermitian conformal field theory. The model was first reported as a phase transition of Ising model in imaginary longitudinal magnetic field more than half a century ago. Since then, many qualitative and quantitative properties of YL criticality have been studied, remarkably, including the fact that the model can be described in Landau-Ginzburg scheme with a scalar $i\phi^3$ theory in $D < 6$ and the fact that the 2D version is an exactly solvable minimal model. In higher dimensions, the model lacks the same level of understanding as the Ising criticality due to its non-Hermitian nature. We report a new study of 3D YL criticality as a phase transition of Fuzzy Sphere model, which facilitates a direct survey of many quantities such as the spectrum and OPE coefficient to high precision. These quantitative results show a beautiful agreement with conformal symmetry and previous estimates from $(6 - \epsilon)$ expansion, high temperature expansion and conformal bootstrap. We also discuss possible approaches in dimensions higher than 3.

Presenter: XIN, Yuan

Contribution ID: 46

Type: **not specified**

Center-vortex semiclassics on $\mathbb{R}^2 \times T^2$ and large- N adiabatic continuity

Friday 29 August 2025 11:45 (45 minutes)

When the 4d $SU(N)$ Yang-Mills theory is put on $\mathbb{R}^2 \times T^2$ with a nontrivial 't Hooft flux, qualitative features of confinement can be semiclassically described as the gas of center-vortex fractional instantons. We study the condition for the large- N adiabatic continuity via a suitable choice of the N -dependent 't Hooft flux from the viewpoint of both 0-form and 1-form center symmetry.

Presenter: TANIZAKI, Yuya

Contribution ID: 47

Type: **not specified**

Fracton topological phases and Foliated field theories

Friday 29 August 2025 14:00 (45 minutes)

Presenter: HONDA, Masazumi

Contribution ID: 48

Type: **not specified**

Emergent thermalisation in the Schwinger model

Friday 29 August 2025 14:45 (45 minutes)

Presenter: FLORIO, Adrien

Contribution ID: 49

Type: **not specified**

Non-perturbative physics of (1+1)d gauge theories using symmetric matrix product states

We introduce a novel matrix product operator construction for Hamiltonian lattice gauge theories in $(1 + 1)$ dimensions. This framework enables the study of strongly coupled phenomena such as bound states, string tension, and vacuum structure. We demonstrate the effectiveness of our method by applying it to the massive Schwinger model and adjoint QCD₂

Authors: GLÜCK, Anna-Maria; SØGAARD, Benjamin (Princeton); DEMPSEY, Ross; PUFU, Silviu

Presenter: SØGAARD, Benjamin (Princeton)

Contribution ID: 50

Type: **not specified**

The simplicity of confinement

Motivated by recent literature on the possible existence of a second higher-temperature phase transition in Quantum Chromodynamics (QCD), I revisit the proposal that colour confinement is related to the dynamics of magnetic monopoles using methods derived from Topological Data Analysis, which provide a mathematically rigorous characterisation of topological properties of quantities defined on a lattice. After introducing homology, I shall discuss how this concept can be used to quantitatively analyse the behaviour of monopoles across the deconfinement phase transition. The proposed approach is first demonstrated for Compact $U(1)$ Lattice Gauge Theory, which is known to have a zero-temperature deconfinement phase transition driven by the restoration of the symmetry associated with the conservation of the magnetic charge. For this system, I perform a finite-size scaling analysis of observables capturing the homology of magnetic current loops, showing that the approach reproduces the expected value of the deconfinement critical coupling. Then, I extend this method to $SU(3)$ gauge theory, in which Abelian magnetic monopoles are identified after projection in the Maximal Abelian Gauge. Specifically, I define an observable called “simplicity”, which measures the number of topologically non-trivial loops per connected component in a current network. A finite-size scaling of the ensemble-averaged simplicity of Abelian magnetic currents provides the expected value of the critical coupling with an accuracy that is generally higher than that obtained with conventional thermodynamic approaches at comparable statistics, suggesting the relevance of the topological properties of monopole currents for confinement. Finally, preliminary results from a study of simplicity in QCD will be briefly discussed.

Authors: Mr CREAN, Xavier (Swansea University); Prof. GIAN SIRACUSA, Jeffrey (University of Durham); LUCINI, Biagio (Queen Mary University of London (UK))

Presenter: LUCINI, Biagio (Queen Mary University of London (UK))

Contribution ID: 51

Type: **not specified**

Aspects of Superconducting Strings

I will examine Abrikosov–Nielsen–Olesen (ANO) vortex strings in variants of Abelian Higgs models. In the large flux limit, the equations governing them simplify, and the resulting giant strings realize two sharply distinct phases. I will explore qualitative features of these strings and identify patterns in their physical properties. I'll also discuss the spectrum of small fluctuations and the associated low energy effective action. I will end by comparing these results to features of confining strings in Yang Mills theory.

Authors: GAIKWAD, Amey (University of California Los Angeles (UCLA)); Dr DUMITRESCU, Thomas (University of California Los Angeles (UCLA))

Presenter: GAIKWAD, Amey (University of California Los Angeles (UCLA))

Contribution ID: 52

Type: **not specified**

Regulated chiral gauge theory and the strong CP problem

Four-dimensional chiral gauge theory can be formulated as the boundary theory on a five-dimensional manifold in a manner that may be realized on a finite lattice. There are interesting features of these theories which defy a purely four-dimensional conception of universality. We find that QCD as embedded in a chiral gauge theory (the Standard Model) when regulated this way appears to suffer neither from a $U(1)_A$ problem nor a strong CP problem, with a central role played by fermion zero-modes localized far away in the fifth dimension. In this way it differs from conventional lattice QCD formulated as a stand-alone theory.

Authors: KAPLAN, David (University of Washington); Prof. SEN, Srimoyee (Iowa State University)

Presenter: KAPLAN, David (University of Washington)

Contribution ID: 53

Type: **not specified**

Yang-Lee Criticality in Various Dimension

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Author: XIN, Yuan (Carnegie Mellon University)

Presenter: XIN, Yuan (Carnegie Mellon University)

Contribution ID: 54

Type: **not specified**

Three-dimensional U(1) strings beyond effective string theory

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Author: MARIANI, Alessandro

Presenter: MARIANI, Alessandro

Contribution ID: 55

Type: **not specified**

Using space-time geometry as a tool

I will review a collection of results obtained over the years using the space-time topology and size to probe the dynamics of Yang-Mills fields. In particular our goal is to connect the region well described by perturbative and semiclassical methods to the confinement regime and its string-like behaviour. We will start by looking at the simpler 2+1 dimensional case and then move on to 3+1 dimensions, including the latest results with a $T_{2 \times R^2}$ geometry.

Author: GONZALEZ-ARROYO, Antonio

Presenter: GONZALEZ-ARROYO, Antonio

Contribution ID: 56

Type: **not specified**

Proving chiral symmetry breaking in QCD with 't Hooft anomaly matching

Chiral symmetry breaking in QCD is a well-established phenomenon, yet it has been a challenge to derive this phenomenon from the theoretical viewpoint. In the seminal 1979 Cargese lectures, 't Hooft showed how to use anomaly matching to prove chiral symmetry breaking, he showed some examples but didn't give the general proof. In this talk, I will present a new strategy which can lead to a general proof.

Authors: CIAMBRIELLO, Luca; CONTINO, Roberto; LUZIO, Andrea; ROMANO, Marcello; XU, Ling-Xiao (ICTP, Trieste)

Presenter: XU, Ling-Xiao (ICTP, Trieste)

Contribution ID: 57

Type: **not specified**

Fracton topological phases and Foliated field theories

I will talk about fracton topological phases (and fracton-like phases) which have quasi-particle excitation like anyons with mobility constraints. It has recently attracted interests in the context of condensed matter physics, quantum information and high energy physics. From condensed matter viewpoint, it describes exotic properties of matter which may be realized in future. From quantum information viewpoint, related lattice models may be useful to make new quantum error correcting codes and quantum hard disks because the models typically have large degeneracy of ground states and can be regarded as generalization of the toric code. From high energy physics viewpoint, fracton topological phases seem to be related to a new type of symmetries called modulated symmetries and a new class of field theories which are partially topological. I will start with explaining relevant concepts and motivations of the topic using some simple examples. Then I will talk about relations to modulated symmetries and foliated field theories.

Author: HONDA, Masazumi (RIKEN iTHEMS / Saitama University)

Presenter: HONDA, Masazumi (RIKEN iTHEMS / Saitama University)

Contribution ID: 58

Type: **not specified**

The LLR method to compute the density of states in Lattice Gauge Theory

In Statistical Mechanics and Quantum Field Theory, the knowledge of the density of states enables the calculation of quantities that are difficult to obtain otherwise, such as interface free energies and latent heats. The LLR method provides a way to obtain a controlled approximation to the density of states. After an introduction to the LLR method, we will demonstrate its application to the computation of observables of cosmological relevance in $SU(3)$ and $Sp(4)$ Lattice gauge Theories.

Author: VADACCHINO, Davide (University of Plymouth)

Presenter: VADACCHINO, Davide (University of Plymouth)

Contribution ID: 59

Type: **not specified**

Training Neural Networks

Machine learning methods are ubiquitous by now. The NNPDF collaboraton has used Neural Networks for many years to extract Parton Distribution Functions (PDFs) from experimental data. A quantitative understanding of the trainig process is now mandatory for precision results for the LHC. We discuss recent progress in modelling the training process and present some potential applications.

Author: DEL DEBBIO, Luigi (The University of Edinburgh)

Presenter: DEL DEBBIO, Luigi (The University of Edinburgh)

Contribution ID: 60

Type: **not specified**

Quantum Group symmetry, from the Lattice to the Continuum

I will discuss some aspects of QFTs with the quantum group $U_q(\mathfrak{sl}_2)$ as a global symmetry. I will show that necessarily this symmetry implies that operators are mutually non-local. To understand these properties in detail, I will study the lattice models underlying these CFTs; using numerical methods I will identify what these non-local scaling operators are. I will end with some open questions related to understanding these properties in terms of twisted sectors of the theory.

Author: ZAN, Bernardo

Presenter: ZAN, Bernardo

Contribution ID: 61

Type: **not specified**

Floquet Insulators and Lattice Fermions

I discuss a recently discovered mathematical correspondence between the spectra of a naively discretized lattice fermion and that of a periodically driven (i.e., Floquet) quantum system and how it can be turned into an infrared equivalence between the two systems. The equivalence can be framed as a duality relation, allowing one to simulate a two-flavor discrete-time fermion theory on the lattice side, where the two flavors arise from time discretization, using a single-flavor fermion theory on the Floquet side. The demonstration establishes an equivalence between (i) the fermion content, (ii) the correlation functions, and consequently (iii) observables of the two theories in the infrared. I also show how interactions may be incorporated into this equivalence.

Authors: BRICENO, Raul; SEN, Srimoyee (Iowa State University); IADECOLA, Thomas; GYORY, William

Presenter: SEN, Srimoyee (Iowa State University)

Contribution ID: **62**

Type: **not specified**

Chiral anomaly and Ginsparg-Wilson Hamiltonians

We discuss various avatars of GW relations in the Hamiltonian approach.

Author: SINGH, Hersh (University of Washington)

Presenter: SINGH, Hersh (University of Washington)