SwissMAP Annual General Meeting

August 30 – September 2, 2026

Les Diablerets
(Maison des Congrès)

Colloquia

Matthias Christandl (University of Copenhagen)

Title: Fault-tolerant quantum input/output

Abstract: *Usual scenarios of fault-tolerant computation are concerned with the fault-tolerant realization of quantum algorithms that compute classical functions, such as Shor's algorithm for factoring. In particular, this means that input and output to the quantum algorithm are classical. In contrast to stand-alone single-core quantum computers, in many distributed scenarios, quantum information might have to be passed on from one quantum information processing system to another one, possibly via noisy quantum communication channels with noise levels above fault-tolerant thresholds. In such situations, quantum information processing devices will have quantum inputs, quantum outputs or even both, which pass qubits among each other.*
Working in the fault-tolerant framework of [Kitaev, 1997], we show that any quantum circuit with quantum input and output can be transformed into a fault-tolerant circuit that produces the ideal circuit with some controlled noise applied at the input and output. The framework allows the direct composition of the statements, enabling versatile future applications. We illustrate this with a concrete application, namely, communication over a noisy channel with faulty encoding and decoding operations [Christandl and Müller-Hermes, 2024]. For communication codes with linear minimum distance, we construct fault-tolerant encoders and decoders for general noise (including coherent errors). For the weaker, but standard, model of local stochastic noise, we obtain fault-tolerant encoders and decoders for any communication code that can correct a constant fraction random errors.

Victor Gorbenko (EPFL)

Title: Quantum Groups and Physics

Abstract: *I will review physical properties of systems that have unusual non-local symmetries called Quantum Groups. I will focus on the case when the symmetry is fully internal, meaning that it commutes with the Hamiltonian, as well as with Lorentz transformations when they are present. We will find that in the continuum Quantum Group generically transforms local fields or operators into non-local ones, and acts naturally on defects present in the theory. We will then discuss non-integrable, chaotic, spin-chain systems and see that*

the symmetry has important consequences for both their low-energy behavior, as well as for high-temperature hydrodynamic regime.

Martin Hairer (EPFL)

Title: TBA

Abstract: *TBA*

Marcos Mariño (UNIGE)

Title: From divergent series to geometry

Abstract: *Most perturbative series in quantum theory are factorially divergent. In the 1970s-1980s, many physicists, starting with the work of Bender and Wu, understood that these divergences are closely related to non-perturbative sectors, and in particular to instantons. In this talk I will first review these results, and then show how they can be applied in a very different context, suggesting new conjectures in algebraic geometry. This is yet another example of physical mathematics, in which physics intuition leads to new conjectures and research directions in pure mathematics.*

João Penedones (EPFL)

Title: Quantum Field Theory as a set of ODEs

Abstract: *Quantum Field Theory (QFT) on hyperbolic space can be characterized by a set of numbers that we call QFT data. For simplicity, we focus on two dimensional QFTs and derive a universal set of first order Ordinary Differential Equations (ODEs) that encode the variation of the QFT data under an infinitesimal change of a bulk relevant coupling. In principle, our ODEs can be used to follow a Renormalization Group (RG) flow starting from a solvable QFT into a strongly coupled phase and to the flat space limit.*

Marcello Porta (SISSA)

Title: Z2 lattice gauge theory coupled to fermionic matter

Abstract: *I will discuss a model for fermions on a two-dimensional square lattice, minimally coupled to a Z2-valued dynamical gauge field, living on the bonds of the lattice. As observed numerically, this system displays a rich phase diagram, depending on the model parameters. In particular, at half-filling, the model at low temperature exhibits a semimetallic phase, in which the low-energy charge excitations are effectively described by 2+1 dimensional massless Dirac fermions.*
I will discuss the rigorous proof of this fact, building on Lieb's seminal work about the solution of the pi-flux phase conjecture. In presence of a staggered mass term, the ground state of the

gauge theory turns out to be four-fold degenerate, and separated by the rest of the spectrum by a gap. In particular, it supports anyonic excitations, equivalent to the ones of the toric code. The proofs are based on reflection positivity, chessboard estimates, fermionic cluster expansion and Hastings' quasi-adiabatic flow. Based on collaborations with Sven Bachmann (UBC Vancouver) and Leonardo Goller (SISSA).

Chiara Saffirio (UniBasel)

Title: Classical approximation of quantum mean-field dynamics

Abstract: *How does collective order emerge from the microscopic laws governing interacting quantum particles? This question lies at the heart of mathematical physics and drives much of its contemporary research. In this talk, I will focus on effective evolution equations emerging in the mean-field approximation and present a functional-analytic method to study their semiclassical regime. Its broad applicability yields quantitative control at the level of observables and explicit error bounds between microscopic and effective dynamics.*

Maryna Viazovska (EPFL)

Title: TBA

Abstract: *TBA*

Yilin Wang (ETH Zurich)

Title: Geodesics and Brownian motion on hyperbolic surfaces

Abstract: *Brownian motion and geodesic dynamics on hyperbolic surfaces are connected in many classical ways. Harmonic measure on the ideal boundary, for instance, can be described either through the asymptotic behavior of Brownian motion or through the endpoint of a geodesic ray with uniformly chosen initial direction. Similarly, recurrence of Brownian motion is intimately tied to the ergodicity of the geodesic flow.*
I will describe further manifestations of this connection. Brownian loop and excursion measures provide probabilistic expressions for the lengths of closed geodesics and orthogeodesics, as well as for the zeta-regularized determinant of the Laplace–Beltrami operator. Combining these formulas with conformal invariance of two dimensional Brownian motion yields a new identity relating the length spectrum of a hyperbolic surface to the length spectra obtained after introducing any countably many additional cusps.

Short talks and posters

Meer Ashwinkumar (UNIBE)

Title: Integrable Deformations of the Breitenlohner-Maison Model from 4d Chern-Simons Theory

Abstract: *We derive integrable deformations of the 2d Breitenlohner-Maison (BM) sigma model that describes the stationary, axisymmetric sector of 4d general relativity, as well as higher-rank generalisations thereof, using the framework of 4d Chern-Simons theory. In particular, we consider deformations of the boundary conditions and action of the 4d Cole-Weck model, which lead to deformations of the BM model associated with solutions to the homogeneous and inhomogeneous classical Yang-Baxter equations respectively. This talk is based on arXiv:2604.26452, to appear in the Journal of High Energy Physics.*

Jahmall Matteo Bersini (ITP Bern)

Title: Dressed Operators, Wilson Lines, and Semiclassical Methods

Abstract: *In this talk, I will present a semiclassical framework for computing correlation functions of nonlocal, gauge-invariant dressed operators in gauge theories. As a case study, I will consider the critical Abelian Higgs model and discuss two key observables: the Dirac-dressed propagator, which provides a nonlocal order parameter for superconductivity, and the cusp anomalous dimension, which captures universal properties of Wilson lines together with the associated defect CFT data.*

August Bohme (EPFL)

Title: The Calabi Conjecture: From Kähler Geometry to the Complex Monge–Ampère Equation

Abstract: *The Calabi problem concerns the existence and uniqueness of Kähler metrics with prescribed Ricci curvature on compact Kähler manifolds. In this poster, we explain the proof of the Calabi conjecture by Shing-Tung Yau published in 1978. We begin by introducing the necessary background in complex geometry and Hodge theory to obtain a complex Monge-Ampère reformulation of the problem. Then, we study this PDE using the method of continuity and explain the difficulty in establishing closedness, which constitutes the crux of the proof. In it, we outline the techniques used to establish a priori estimates on the derivative of the solution, which now form landmarks in Geometric analysis. Finally, we discuss applications of the Calabi-Yau theorem to string theory, particularly the existence of Ricci-flat Kähler metrics on Calabi-Yau manifolds.*

Nikolay Borozenets (UNIGE)

Title: Harmonic effects in compressed two-dimensional crystals

Abstract: *Two-dimensional crystal membranes (most notably graphene) are subject to external strain imposed by the environment in which they are placed. Under external tension, the membranes are expected to be in a harmonic regime, that is, to exhibit logarithmic behavior of fluctuations. The behavior of fluctuations of compressed membranes is considerably more subtle, as their equilibrium states no longer correspond to the flat phase, and perturbative methods are not directly applicable. In this talk, we will present recent progress toward understanding harmonic effects in compressed two-dimensional crystal membranes. The talk is based on joint work with Stanislav Smirnov and Mikhail Katsnelson.*

Kasimir de Lataillade (EPFL)

Title: Computations in Matsushita model structure for graphs

Abstract: *Model structures are a way to generalize homotopy theory of topological spaces onto a broader class of categories. We define model structures, and illustrate how they capture homotopical data on an abstract category. Then, we will explore the Matsushita model structure on graphs, which has the amazing property of being equivalent, as a model structure, to the Quillen model structure on topological spaces, the model structure that captures classical homotopy of topological spaces. Finally, making use of this correspondence, we showcase some algebraic methods that allow us to distinguish homotopy classes of graphs through explicit computations, with some examples.*

Sibylle Driezen (ETH Zurich)

Title: Integrable Sigma-Model Boundaries and D-Branes

Abstract: *Identifying which boundary conditions preserve integrability in two-dimensional sigma-models is a basic structural question, relevant from open string dynamics to impurity problems. I will discuss a simple approach that determines integrable boundary conditions through the divisor structure of the Lax connection, giving a generalisation of previous constructions. As an application, I will treat open strings on AdS3 x S3 with mixed NSNS-RR flux, where the standard approaches cease to work at generic flux, and show how the background supports integrable D-branes that wrap twisted conjugacy classes in SL(2,R)xSU(2). If time permits I will discuss this example and construction from the point of view of 4d Chern-Simons theory.*

Andrea Lanteri (EPFL)

Title: Stabilisation of cat states via single-photon ultrastrong nonlinear coupling.

Abstract: *Cat states are quantum superpositions of coherent states with wide-ranging applications in quantum technologies. In this work, it is shown that they can be generated and stabilised through an effective single-photon nonlinear process, made possible by an auxiliary qubit ultrastrongly coupled to the bosonic modes. The full driven-dissipative setup is simulated and the fundamental properties of the resulting cat states are characterised, with an outlook on the stabilisation properties of the system.*

Robin Löwenberg (UNIGE)

Title: Matrix Holography on an Optical Lattice

Abstract: *Matrix quantum mechanics, most prominently the BFSS and BMN models, provides a powerful framework to study holographic phenomena such as fast scrambling, quantum chaos and emergent gravity. Yet, the strong-coupling regime remains difficult to access. This talk presents a genuinely different approach to extracting holographic information from these models based on quantum simulation. The idea is to realize a quantum optical Hamiltonian that converges to the target model for large matrix sizes, allowing one to study the strong-coupling regime through direct measurement. A bosonic implementation is discussed, as well as ideas and challenges of possible extensions.*

Adrien Martina (EPFL)

Title: Can space emerge from matrices?

Abstract: *Matrix models are candidate microscopic descriptions of quantum gravity, built from nothing but a few large matrices. If space emerges from them, it may be encoded in their eigenvalues. This requires the matrices to commute. We determine when this happens in a class of models.*

Beat Nairz (ETH Zurich)

Title: From integrability to chaos in tensionless AdS3 string theory

Abstract: *We study quantum-gravitational finite N corrections to the planar integrable structure of the symmetric product orbifold that is dual to tensionless string theory on an AdS3 geometry. We consider the deformation that switches on R-R flux in the bulk, and analyse the associated level spacing statistics. The planar spectrum exhibits hallmarks of integrability: there are degeneracies and the level spacings follow a Poisson distribution. The leading non-planar corrections lift the planar degeneracies and produce signs of random-matrix behaviour, indicating the onset of quantum chaos.*

Veronica Sacchi (EPFL)

Title: dS gauge invariant observables: a proposal and computation in perturbative scalar QED

Abstract: *TBA*

Georgii Veprev (UNIGE)

Title: Localization of eigenfunctions in amenable unimodular random graphs

Abstract: *Motivated by Kaplansky's zero divisor conjecture, Elek showed that the existence of an eigenfunction of the adjacency operator on a Cayley graph of an amenable group implies the existence of a finitely supported eigenfunction with the same eigenvalue. Moreover, all eigenfunctions are generated by finitely supported ones. We will discuss a similar question in the context of unimodular random graphs.*

Anders Wallberg (CERN, EPFL)

Title: Time-Dependent Integrability from Gauge Theory

Abstract: *Understanding the dynamics of systems far from equilibrium is one of the central challenges of modern theoretical physics. Questions of thermalization, transport, information spreading, and entanglement growth are notoriously difficult to address analytically, making exactly solvable time-dependent models particularly valuable.*
In this talk, I will present a framework for extending integrability beyond the traditional setting of time-independent field theories to include (space)time-dependent models. I will show that broad classes of such theories can be generated systematically from a higher-dimensional gauge theory, yielding integrable deformations of many familiar solvable models, which have important connections to theories of gravity and string theory. I will also discuss how these ideas can be extended to the quantum regime, providing a novel avenue for non-equilibrium quantum mechanics.