
# Corfu2021: Workshop on Quantum Geometry, Field Theory and Gravity

SEPTEMBER 20 - SEPTEMBER 27, 2021

physics.ntua.gr/corfu2021/nc.html

Scientific Programme

**Zoom**: tinyurl.com/yuv4ks8h (Webinar ID 848 3872 2281)

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## 1 Program Summary

All times are in the Eastern European Standard Time (EEST) timezone (click here to see the current EEST time).

**Tuesday, September 21, 2021**

| | | | |
|---|---|---|---|
| 9:00 | 9:30 | Buric, Maja and Grosse, Harald | Opening - Tribute to John Madore |
| 9:30 | 10:00 | Karabali, Dimitra | Entanglement entropy for integer Quantum Hall effect in two and higher dimensions |
| 10:00 | 10:30 | Nair, Parameswaran | Entanglement Entropy and Matter-gravity Couplings for Fuzzy Geometry |
| 10:30 | 11:00 | Hasebe, Kazuki | Quantum geometry in the lowest Landau level and higher Landau levels (remote) |
| 11:00 | 11:30 | **Coffee Break** | |
| 11:30 | 12:00 | Iorio, Alfredo | Towards the M=0 BTZ black hole in a lab |
| 12:00 | 12:30 | Calmet, Xavier | Quantum gravity and the dark side of the universe (remote) |
| 12:30 | 13:00 | Wiseman, Toby | Quantum black holes on the lattice (remote) |
| 13:00 | 13:30 | Floratos, Emmanuel | The Arithmetic geometry of AdS2 and its continuum limit |
| 13:30 | 16:00 | **Lunch** | |
| 16:00 | 16:30 | Tekel, Juraj | Fuzzy field theories in the string modes formalism |
| 16:30 | 17:00 | Vaidya, Sachindeo | New Results in SU(N) Gauge Matrix Models (remote) |
| 17:00 | 17:30 | **Coffee Break** | |
| 17:30 | 18:00 | Weber, Thomas | Noncommutative Levi-Civita connections on covariant spaces |
| 18:00 | 18:30 | Arnlind, Joakim | Levi-Civita connections for a class of noncommutative minimal surfaces (remote) |
| 18:30 | 19:00 | Morsella, Gerardo | UV and IR finiteness on quantum spacetime through perturbative algebraic QFT and cosmology (remote) |
| 19:00 | 19:30 | Oriti, Daniele | Quantum gravity states as tensor networks: entanglement and holography in spin networks |
| 20:00 | 23:00 | **Welcome Reception** | |

**Wednesday, September 22, 2021**

| | | | |
|---|---|---|---|
| 9:00 | 9:30 | Kulaxizi, Manuela | Conformal Correlators and Black Holes (remote) |
| 9:30 | 10:00 | Ramgoolam, Sanjaye | String theory, random tensors and combinatoric constructibility (remote) |
| 10:00 | 10:30 | Percacci, Roberto | Higher-derivative and metric-affine gravity |
| 10:30 | 11:00 | Skvortsov, Evgeny | Integrable models from non-commutative geometry, with applications to 3d dualities (remote) |
| 11:00 | 11:30 | **Coffee Break** | |
| 11:30 | 12:00 | Fukuma, Masafumi | Numerical sign problem and the tempered Lefschetz thimble method (remote) |
| 12:00 | 12:30 | Nishimura, Jun | Signature change of the emergent space-time in the IKKT matrix model (remote) |
| 12:30 | 13:00 | Tsuchiya, Asato | Target space entanglement in the matrix model for bubbling geometry (remote) |
| 13:00 | 13:30 | Asano, Yuhma | Numerical simulation of real-time dynamics of Matrix Theory (remote) |
| 13:30 | 16:00 | **Lunch** | |
| 16:00 | 16:30 | Hoppe, Jens | Recent progress on Membrane Theory (remote) |
| 16:30 | 17:00 | Klinkhamer, Frans | IIB matrix model, bosonic master field, and emergent spacetime (remote) |
| 17:00 | 17:30 | **Coffee Break** | |
| 17:30 | 18:00 | Hanada, Masanori | Large-N limit as a second quantization |
| 18:00 | 18:30 | Penati, Silvia | Lines and defects in ABJM theory (remote) |
| 18:30 | 19:00 | Kupriyanov, Vladislav | Poisson gauge theory (remote) |
| 19:00 | 19:20 | Lovrekovic, Iva | Three dimensional conformal higher spins and holography |
| 20:00 | 0:30 | **Greek Night** | |

**Thursday, September 23, 2021**

| | | | |
|---|---|---|---|
| 9:00 | 9:30 | Sasakura, Naoki | Emergence of classical spacetimes in canonical tensor model (remote) |
| 9:30 | 10:00 | van Suijlekom, Walter | Cyclic cocycles in the spectral action and one-loop corrections. |
| 10:00 | 10:30 | Martinetti, Pierre | Standard model in noncommutative geometry Wick rotation and twisted spectral triples |
| 10:30 | 11:00 | Sitarz, Andrzej | Spectral geometry and modifications of gravity |
| 11:00 | 11:30 | **Coffee Break** | |
| 11:30 | 12:00 | Wulkenhaar, Raimar | From scalar fields on noncommutative geometries to blobbed topological recursion (remote) |
| 12:00 | 12:30 | Schomerus, Volker | Supergroup Chern-Simons Theory and Topological Phases (remote) |
| 12:30 | 13:00 | Castellani, Leonardo | Supergravity with integral forms (remote) |
| 13:00 | 13:30 | Chatzistavrakidis, Athanasios | Twisted R-Poisson Sigma Models |
| 13:30 | 16:00 | **Lunch** | |
| 16:00 | 16:30 | Platania, Alessia | String Tension between de Sitter vacua and Curvature Corrections |
| 16:30 | 17:00 | Hebecker, Arthur | Some recent issues in the quest for stringy de Sitter models (remote) |
| 17:00 | 17:30 | Buric, Maja | Fuzzy de Sitter and anti-de Sitter spaces (remote) |
| 17:30 | 18:00 | **Coffee Break** | |
| 18:00 | 18:30 | Giaccari, Stefano | Moyal Yang Mills theory and higher spin in flat spacetime |
| 18:30 | 19:00 | Iazeolla, Carlo | Unfolding and higher-spins spacetime/fibre duality, resolution of spacetime singularities and observables (remote) |
| 19:00 | 19:30 | Catterall, Simon | Anomalies, symmetric mass generation and staggered fermions (remote) |

**Friday, September 24, 2021**

| | | | |
|---|---|---|---|
| 9:00 | 9:30 | Arzano, Michele | Getting hot without accelerating vacuum thermal effects from conformal quantum mechanics |
| 9:30 | 10:00 | Landi, Giovanni | Hopf algebroids and noncommutative gauge transformations |
| 10:00 | 10:30 | Fioresi, Rita | Quantum Principal bundle and Non Commutative differential calculus |
| 10:30 | 11:00 | Watamura, Satoshi | Metric algebroid in DFT (remote) |
| 11:00 | 11:30 | **Coffee Break** | |
| 11:30 | 12:00 | Jonke, Larisa | On Hopf and Lie-infinity algebras |
| 12:00 | 12:30 | Vysoky, Jan | Introduction to Graded Manifolds |
| 12:30 | 13:00 | Bonechi, Francesco | Diagonalization of the Nijenhuis tensor from invariant polynomials |
| 13:00 | 13:20 | Manolakos, Georgios | A gravity model on a covariant 4-d noncommutative space |
| 13:20 | 15:50 | **Lunch** | |
| 17:30 | 20:30 | **Boat Trip** | |

**Saturday, September 25, 2021**

| | | | |
|---|---|---|---|
| 9:00 | 9:30 | Wallet, Jean-Christophe | Gauge Theories on kappa-Minkowski spaces Results and prospects. (remote) |
| 9:30 | 10:00 | Meusburger, Catherine | 3d State sum models with defects (remote) |
| 10:00 | 10:30 | Sorokin, Dimitri | ModMax electrodynamics, its generalizations and applications |
| 10:30 | 10:50 | Hejda, Filip | Generalised BSW effect and extraction of energy from extremal electrovacuum black holes |
| 10:50 | 11:20 | **Coffee Break** | |
| 11:20 | 11:50 | Lukierski, Jerzy | Spinorial Snyder Type Models from Superalgebras and Noncommutative (Phase)Superspaces (remote) |
| 11:50 | 12:20 | Lechtenfeld, Olaf | The Nicolai map for supersymmetric Yang-Mills theory and application to the supermembrane |
| 12:20 | 12:50 | Cattaneo, Alberto | The BFV formalism for Palatini-Cartan gravity and corner structure |
| 12:50 | 13:20 | Krajewski, Thomas | A short glimpse into the loop vertex expansion (remote) |
| 13:30 | 16:00 | **Lunch** | |
| 16:00 | 16:30 | Kurkcuoglu, Seckin | Chaos in Matrix Gauge Theories with Massive Deformations (remote) |
| 16:30 | 17:00 | Bergner, Georg | Non-perturbative investigations of gauge theories with adjoint and fundamental matter related to supersymmetric gauge theories (remote) |
| 17:00 | 17:30 | **Coffee Break** | |
| 17:30 | 18:00 | Filev, Veselin | Backreacted D0/D4 background (remote) |
| 18:00 | 18:30 | Giesel, Kristina | Reduced phase space quantisation in loop quantum gravity and loop quantum cosmology (remote) |
| 18:30 | 18:50 | Bhattacherjee, Sandipan | Non-equilibrium Quantum Cosmology with a distinct hint of Condensed-Matter Physics |
| 18:50 | 19:20 | Karczmarek, Joanna | Target space entanglement entropy, matrix models and noncommutative geometry (remote) |

**Sunday, September 26, 2021**

| | | | |
|---|---|---|---|
| 9:10 | 9:30 | Kovacik, Samuel | Microscopic black holes |
| 9:30 | 10:00 | Martin, Carmelo Perez | Unimodular supergravity (remote) |
| 10:00 | 10:30 | Ferrari, Frank | On Jackiw-Teitelboim Quantum Gravity At Finite Cut-Off (remote) |
| 10:30 | 11:00 | Dobrev, Vladimir | Heisenberg Parabolic Subgroups and Invariant Differential Operators (remote) |
| 11:00 | 11:30 | **Coffee Break** | |
| 11:30 | 11:50 | Morand, Kevin | Graph complexes and deformation quantization of Lie bialgebroids (remote) |
| 11:50 | 12:20 | Fiore, Gaetano | Twisted submanifolds of R^n |
| 12:20 | 12:50 | Jurco, Branislav | TBA |
| 12:50 | 13:20 | Brzezinski, Tomasz | Heaps of connections (remote) |
| 13:30 | 16:00 | **Lunch** | |
| 16:00 | 16:30 | Toppan, Francesco | Signatures of Z2xZ2-graded physics (remote) |
| 16:30 | 17:00 | Chryssomalakos, Chryssomalis | Entanglement entropy in fuzzy R^3 (remote) |
| 17:00 | 17:30 | **Coffee Break** | |
| 17:30 | 18:00 | Freidel, Laurent | Local Holography a new paradigm for quantum gravity (remote) |
| 18:00 | 18:30 | Minic, Djordje | On quantum gravity and quantum gravity phenomenology in the infrared (remote) |
| 18:30 | 19:00 | Semenoff, Gordon | Entanglement Harvesting or Crop Failure? (remote) |
| 19:00 | 19:30 | Van Raamsdoonk, Mark | Cosmology from confinement (remote) |

# 2 Detailed Program with Abstracts

## 2.1 Tuesday, September 21, 2021

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**Time**: 9:00 – 9:30
**Speaker**: Buric, Maja and Grosse, Harald ()
**Title**: Opening - Tribute to John Madore
**Abstract**: The wife of John, Genevieve Madore will also be present.

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**Time**: 9:30 – 10:00
**Speaker**: Karabali, Dimitra (Lehman College, CUNY)
**Title**: Entanglement entropy for integer Quantum Hall effect in two and higher dimensions
**Abstract**: Quantum Hall effect (QHE) on compact spaces, and in particular the corresponding lowest Landau levels (LLL), have been used as models for noncommutative spaces. Here I will focus on the calculation of the entanglement entropy for integer QHE in arbitrary spatial even dimensions. In the case of the LLL, a semiclassical analysis shows that the entanglement entropy is proportional to the phase-space area with a universal overall constant, same for any dimension and abelian or nonabelian background magnetic fields. This is modified at higher Landau levels.

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**Time**: 10:00 – 10:30
**Speaker**: Nair, Parameswaran (City College of the City University of New York)
**Title**: Entanglement Entropy and Matter-gravity Couplings for Fuzzy Geometry
**Abstract**: Using the Landau-Hall paradigm for fuzzy geometry, I will discuss entanglement entropy showing that its dependence on background fields is given by a generalized Chern-Simons form. This will make a point of connection with the thermodynamic view of gravity. I will also discuss matter-gravity couplings in the same framework, arguing that nonminimal couplings involving powers of the curvature are naturally obtained.

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**Time**: 10:30 – 11:00
**Speaker**: Hasebe, Kazuki (Sendai NCT)
**Title**: Quantum geometry in the lowest Landau level and higher Landau levels
**Abstract**: I will talk about emergent geometry of Landau models in higher dimensions. The higher Landau models are realized on higher dimensional manifolds in non-Abelian monopole magnetic field background. I investigate the quantum geometry of the SO(5) Landau model for its lowest Landau level and higher Landau levels as well. The quantum geometry in the higher Landau levels is shown to be a pure quantum geometry with no classical counterpart. I also discuss the SO(4) Landau model and the associated fuzzy geometry.

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**Time**: 11:30 – 12:00
**Speaker**: Iorio, Alfredo (Charles University)
**Title**: Towards the M=0 BTZ black hole in a lab
**Abstract**: After a brief discussion on analogs in general, along the lines of Feynman's approach, I shall point to their role as probes of high energy scenarios. I focus then on Dirac materials, showing how far they can be used in the hunt for quantum gravity. As a specific (and tantalizing) example I shall outline the case of the M=0 BTZ black hole.

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**Time**: 12:00 – 12:30
**Speaker**: Calmet, Xavier (University of Sussex)
**Title**: Quantum gravity and the dark side of the universe

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**Time**: 12:30 – 13:00
**Speaker**: Wiseman, Toby (Imperial College London)
**Title**: Quantum black holes on the lattice
**Abstract**: Holography apparently relates certain quantum field theories to quantum theories of gravity. The original instance of this is Maldacena's duality between maximally supersymmetric gauge theories and type II string theory in the presence of D-branes. In the â_x0080__x0099_t Hooft limit, and at appropriate temperatures, the dual to the gauge theory is described by certain black holes (or rather black p-branes). This allows the remarkable opportunity to perform calculations of quantum black holes through the equivalent gauge theory, and to check the consistency of holographic duality. I will discuss such calculations, and the progress that has been made over the last decade in showing that the

predicted gravity behaviour does indeed emerge from thermal gauge theory.

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**Time**: 13:00 – 13:30
**Speaker**: Floratos, Emmanuel (NKUoA - NCSR DEMOKRITOS)
**Title**: The Arithmetic geometry of AdS2 and its continuum limit
**Abstract**: According to the 't Hooft-Susskind holography, the black hole entropy,S, is carried by the chaotic microscopic degrees of freedom, which live in the near horizon region and have a Hilbert space of states of finite dimension d=ExpS In a series of previous works, we have proposed the hypothesis that the near horizon geometry, when the microscopic degrees of freedom can be resolved, can be described by the AdS2[Z/NZ] discrete, finite and random geometry, where NS=LogN and this geometry has been constructed by purely arithmetic and group theoretical methods . We studied this geometry as a toy model to describe the dynamics of single particle probes of the near horizon region of 4d extremal black holes. Since the only way to study the structure of the microstates of space time geometries is by scattering of probe particles the probe microstates contain all the necessary information.Our approach can be described also as an information theoretic compression ,(with finite dimensional Hilbert space of microstates of probe particles),of the AdS2 continuous geometry( which has an infinite dimensional Hilbert space of microstates for probe particles). What has been left in our previous study as an open problem ,is how the smooth AdS2 classical geometry can be recovered, in the limit when N ->Infinity .In the present article we solve this problem, by showing that the discrete and finite geometry can be embedded in a family of finite geometries, AdS2[M,Z/NZ] where M is another integer such that M<N and M^2=1modN. This family of finite geometries can be constructed by an appropriate toroidal compactification and discretization of the ambient 2+1 dimensional Minkowski space-time where the continuum geometry AdS2 lives. In this construction N and M can be understood as the infrared (IR)and the ultraviolet(UV) cutoffs respectively. The above construction enables us to obtain the continuum limit of the discrete and finite geometry AdS2[M,Z/NZ], by taking both N and M to infinity in a specific correlated way, following a reverse process Firstly, we show how it is possible to recover the continuous, toroidally compactified, AdS2 geometry by removing the ultraviolet cutoff, secondly, we show how it is possible to remove the infrared cutoff in a specific decompactification limit, while keeping the radius of AdS2 finite. This method can be easily generalized to apply to any algebraically defined spacetime geometry of any dimension.

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**Time**: 16:00 – 16:30
**Speaker**: Tekel, Juraj (Comenius University, Bratislava)
**Title**: Fuzzy field theories in the string modes formalism
**Abstract**: We review the formulation of the scalar field theory on the fuzzy sphere in terms of the string modes - functions optimally localized in position and momentum space. We show how this greatly simplifies the computation of the loop contributions in position space and provides some new insights into the structure of the effective action.

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**Time**: 16:30 – 17:00
**Speaker**: Vaidya, Sachindeo (Indian Institute of Science, Bengaluru, INDIA)
**Title**: New Results in SU(N) Gauge Matrix Models
**Abstract**: SU(N) gauge matrix models coupled to fermions display a variety of interesting phenomena like quantum phases, the axial anomaly, and spontaneous symmetry breaking. Numerical evidence shows that the SU(3) model with quarks makes for a compelling new approximation of low energy QCD. Such features, usually associated with quantum field theories, are therefore a surprise when seen in quantum mechanical matrix models. We will review and explain these new results.

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**Time**: 17:30 – 18:00
**Speaker**: Weber, Thomas (University of Eastern Piedmont)
**Title**: Noncommutative Levi-Civita connections on covariant spaces

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**Time**: 18:00 – 18:30
**Speaker**: Arnlind, Joakim (Linköping Universitet)
**Title**: Levi-Civita connections for a class of noncommutative minimal surfaces
**Abstract**: We study connections on hermitian modules, and show that metric connections exist on regular hermitian modules, i.e finitely generated projective modules together with a non-singular hermitian form. In addition, we develop an index calculus for such modules, and provide a characterization in terms of the existence of a pseudo-inverse of the matrix representing the hermitian form with respect to a set of generators. The framework is applied to a class of noncommutative minimal surfaces, for which there is a natural concept of torsion, and show that there exist metric and torsion-free connections for every minimal surface in this class.

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**Time**: 18:30 – 19:00
**Speaker**: Morsella, Gerardo (Tor Vergata University of Rome)
**Title**: UV and IR finiteness on quantum spacetime through perturbative algebraic QFT and cosmology
**Abstract**: Local QFT on Doplicher-Fredenhagen-Roberts quantum spacetime is equivalent to a non-local QFT on ordinary (commutative) spacetime, which has quite generally a better UV behavior in perturbation theory, but for which the control of the adiabatic limit is problematic. I will show that the adaptation of the methods of perturbative QFT, originally developed for local QFT on ordinary spacetimes, to QFT on quantum spacetime yields a non-local UV-finite theory which enjoys some remnants of causality. This is sufficient to prove the existence of the adiabatic limit of vacuum expectation values of interacting observables to all perturbative orders. The analysis of the dependence of the perturbative expansion thus obtained from the Planck length leads to potentially interesting cosmological applications. (Joint work with S. Doplicher and N. Pinamonti.)

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**Time**: 19:00 – 19:30
**Speaker**: Oriti, Daniele (Arnold Sommerfeld Center for Theoretical Physics)
**Title**: Quantum gravity states as tensor networks: entanglement and holography in spin networks

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## 2.2 Wednesday, September 22, 2021

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**Time**: 9:00 – 9:30
**Speaker**: Kulaxizi, Manuela (Trinity College Dublin)
**Title**: Conformal Correlators and Black Holes
**Abstract**: We will discuss the computation of heavy-heavy-light-light four point functions in CFTs with a large number of degrees of freedom in certain accessible kinematic regimes (here heavy are operators whose conformal dimensions scale with the number of degrees of freedom). We will comment on interesting structures present and compare results with those for thermal two point functions.

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**Time**: 9:30 – 10:00
**Speaker**: Ramgoolam, Sanjaye (Queen Mary Univeristy)
**Title**: String theory, random tensors and combinatoric constructibility
**Abstract**: Random matrix theories and their tensor generalizations, play a central role in gauge-string dualities such as the AdS/CFT correspondence and simpler mathematical models of the correspondence. Belyi maps, of interest in number theory, describe the geometry of string world-sheets in these simple models of gauge-string duality. I will outline links between the combinatorics of Belyi maps (equivalently of bi-partite ribbon graphs) and matrix as well as tensor models. A Fourier transformation of the combinatorics, which is useful in the study of tensor model correlators, involves linear combinations of bipartite ribbon graphs labelled by triples of Young diagrams and Kronecker coefficient multiplicities. This leads to a combinatoric construction of Kronecker coefficients in terms of lattices of bi-partite ribbon graphs. Another example of combinatoric constructibility in string theory gives the dimensions of irreducible representations of a general finite group in terms of group multiplications shaped according to the fundamental groups of two-dimensional surfaces, which arise in partition functions of topological lattice gauge theories. The talk is based on https //arxiv.org/abs/2010.04054 and https //arxiv.org/abs/2106.05598.

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**Time**: 10:00 – 10:30
**Speaker**: Percacci, Roberto (SISSA)
**Title**: Higher-derivative and metric-affine gravity

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**Time**: 10:30 – 11:00
**Speaker**: Skvortsov, Evgeny (UMONS & Lebedev Inst)
**Title**: Integrable models from non-commutative geometry, with applications to 3d dualities
**Abstract**: I will present a new class of integrable models that are defined via certain strong homotopy algebras that can be understood as (non-commutative) deformation quantization. Each such model defines and is defined by a family of associative algebras with particularly rich examples given by the deformation quantization of Poisson orbifolds. The nonlinear classical equations of motion can be solved exactly via an auxiliary Lax pair. The same strong homotopy algebras play a vital role in the recently discovered dualities in 3d conformal field theories, in particular in the 3d bosonization duality.

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**Time**: 11:30 – 12:00
**Speaker**: Fukuma, Masafumi (Department of Physics, Kyoto University)
**Title**: Numerical sign problem and the tempered Lefschetz thimble method
**Abstract**: The numerical sign problem is one of the major obstacles to the first-principles calculations for important physical systems, such as finite-density QCD, strongly-correlated electron systems and frustrated spin systems, as well as for the real-time dynamics of quantum systems. The tempered Lefschetz thimble method (TLTM) [Fukuma and Umeda, 1703.00861] was proposed as a versatile algorithm towards solving the numerical sign problem. There, the integration region is deformed into the complex space according to the antiholomorphic gradient flow equation, and the system is tempered using the flow time as a tempering parameter so as to solve both the sign and ergodicity problems simultaneously. In this talk, I explain the basics of the TLTM, and demonstrate the effectiveness and versatility of the algorithm by showing its successful applications to various models, such as the (0+1)-dimensional massive Thirring model, the Hubbard model away from half filling, and the Stephanov model (a chiral random matrix model). I also would like to explain some of the recent improvements in the algorithm, which is expected to significantly reduce the numerical cost.

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**Time**: 12:00 – 12:30
**Speaker**: Nishimura, Jun (KEK)
**Title**: Signature change of the emergent space-time in the IKKT matrix model
**Abstract**: The IKKT matrix model is known as a promising candidate for a nonperturbative definition of superstring theory in ten dimensions. As a most attractive feature, the model admits the emergence of (3+1)-dimensional space-time associated with the spontaneous breaking of the (9+1)-dimensional Lorentz symmetry. Numerical confirmation of such a phenomenon has been attempted for more than two decades. Recently it has been found that the sign problem, the main obstacle in simulating this model, can be overcome by the complex Langevin method. It has been shown that the Lorenzian version of the model is smoothly connected with the Euclidean version, in which the SO(10) symmetry is known to be spontaneously broken to SO(3). We propose a scenario that this SSB gives rise to the emergence of (3+1)-dimensional expanding space-time in the Lorentzian model after a signature change from Euclidean to Lorentzian. Some preliminary results supporting this scenario are discussed.

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**Time**: 12:30 – 13:00
**Speaker**: Tsuchiya, Asato (Shizuoka University)
**Title**: Target space entanglement in the matrix model for bubbling geometry
**Abstract**: Quantum entanglement has been paid a lot of attention in the context of constructing a quantum theory of gravity. Here we consider quantum entanglement in (bulk) space-time, which corresponds to target space entanglement in the dual field theory. In particular, it can be defined in the case in which the dual field theory is given by a matrix model where space does not exist a priori but emerges from the degrees of freedom of matrices. First, we overview the notion and general properties of target space entanglement. Next, we study it in a complex matrix model that describes the dynamics of the half-BPS sector of N=4 super Yang-Mills theory on RxS^3 and is connected to the bubbling AdS geometry developed by Lin-Lunin-Maldacena. The target space in this case is a two-dimensional plane where complex eigenvalues of the matrix distribute. It is a part of a bubbling space-time, and the eigenvalue distribution corresponds to the boundary condition for a solution of the bubbling geometry. We calculate the entanglement entropy of a region on the plane, and find an area law: we show that it qualitatively agrees with the length of the boundary of the region given by the bubbling geometry. We also discuss a possible connection of our result to the noncommutative geometry through the Chern-Simons matrix model.

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**Time**: 13:00 – 13:30
**Speaker**: Asano, Yuhma (University of Tsukuba)
**Title**: Numerical simulation of real-time dynamics of Matrix Theory
**Abstract**: Birth of the universe is expected to be explained by the matrix models proposed for non-perturbative formulation of superstring theory. One such promising matrix model, the IKKT matrix model, has been intensively studied with the Lorentzian signature, and our understanding of the emergent spacetime in the IKKT matrix model is becoming clear. In particular, there have been provided some numerical results supporting that (3+1)-dimensional spacetime emerges. On the other hand, emergent spacetime of another relating matrix model, the BFSS/BMN matrix model, has not attracted much attention, and we do not know how different it is from that of the IKKT matrix model. In this talk, I will outline numerical simulation of real-time quantum dynamics of the BFSS/BMN matrix model and discuss some important problems that can be potetially addressed by the numerical simulation.

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**Time**: 16:00 – 16:30
**Speaker**: Hoppe, Jens (Technical University Braunschweig)
**Title**: Recent progress on Membrane Theory
**Abstract**: The talk will be based on results reported in my recent arXiv-preprints 2107.03319, 2107.00569, 2103.16540,

2103.08653, 2102.03904, 2101.11510, 2101.04495, 2101.01803

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**Time**: 16:30 – 17:00
**Speaker**: Klinkhamer, Frans (KIT)
**Title**: IIB matrix model, bosonic master field, and emergent spacetime
**Abstract**: It has been argued that the bosonic large-N master field of the IIB matrix model can give rise to an emergent classical spacetime. The outstanding task is to calculate the bosonic master field. This is extremely difficult. In the present talk, we discuss some first results and sketch future steps.

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**Time**: 17:30 – 18:00
**Speaker**: Hanada, Masanori (University of Surrey)
**Title**: Large-N limit as a second quantization
**Abstract**: In the Matrix Model of M-theory proposed by Banks, Fischler, Shenker and Susskind, the large-N limit is interpreted as a second quantization of M-theory. Multi-body states are realized as block-diagonal matrix configurations. We suggest that a similar geometric interpretation is valid for gauge/gravity duality a la Maldacena.

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**Time**: 18:00 – 18:30
**Speaker**: Penati, Silvia (University of Milano-Bicocca)
**Title**: Lines and defects in ABJM theory
**Abstract**: I will discuss the 1D CFT defined on kinematic and dynamical defects in the ABJM theory, that is on a line and on a BPS Wilson line, respectively. In particular, I will focus on the spectrum of local operators and their correlation functions, and their relation with the structure of the localized partition function of the parent 3D theory. Important differences in the construction of the topological sector of the theory will be addressed.

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**Time**: 18:30 – 19:00
**Speaker**: Kupriyanov, Vladislav (UFABC)
**Title**: Poisson gauge theory
**Abstract**: The Poisson gauge algebra is a semi-classical limit of complete non-commutative gauge algebra. In the present work we formulate the Poisson gauge theory which is a dynamical field theoretical model having the Poisson gauge algebra as a corresponding algebra of gauge symmetries. The proposed model is designed to investigate the semi-classical features of the full non-commutative gauge theory with coordinate dependent non-commutativity $\Theta^ab(x)$, especially whose with a non-constant rank. We derive the expression for the covariant derivative of matter field. The commutator relation for the covariant derivatives defines the Poisson field strength which is covariant under the Poisson gauge transformations and reproduces the standard $U(1)$ field strength in the commutative limit. We derive the corresponding Bianchi identities. The field equations for the gauge and the matter fields are obtained from the gauge invariant action. We consider different examples of linear in coordinates Poisson structures $\Theta^ab(x)$, as well as non-linear ones, and obtain explicit expressions for all proposed constructions. Our model is unique up to invertible field redefinitions and coordinate transformations.

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**Time**: 19:00 – 19:20
**Speaker**: Lovrekovic, Iva (TU Wien)
**Title**: Three dimensional conformal higher spins and holography
**Abstract**: In this talk I will review the finite theories of conformal higher spins in three dimensions, their construction and their holography. In holographic analysis we consider the two different boundary conditions. The general boundary conditions and near horizon boundary conditions, both of which can be used on entire infinite number of these conformal higher spin theories. The latter boundary conditions lead to some well known solutions in 3D gravity and their generalizations.

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## 2.3 Thursday, September 23, 2021

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**Time**: 9:00 – 9:30
**Speaker**: Sasakura, Naoki (Yukawa Institute for Theoretical Physics, Kyoto University)
**Title**: Emergence of classical spacetimes in canonical tensor model
**Abstract**: The canonical tensor model is a tensor model in the canonical formalism and the quantum model has an exact expression of its wave function. The wave function has a similarity with the p-spin spherical model of spin glasses, but

also contains some complex-valued terms which do not exist in the latter. In order to clarify its properties, we study the wave function by the Monte Carlo method, and show that there exist phases where fluctuations are strongly suppressed, namely, classical regimes. We observe that classical spaces are formed in the classical regimes.

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**Time**: 9:30 – 10:00
**Speaker**: van Suijlekom, Walter (Radboud University Nijmegen)
**Title**: Cyclic cocycles in the spectral action and one-loop corrections.
**Abstract**: We show that the spectral action, when perturbed by a gauge potential, can be written as a series of Chern-Simons actions and Yang-Mills actions of all orders. In the odd orders, generalized Chern-Simons forms are integrated against an odd $(b,B)$-cocycle, whereas, in the even orders, powers of the curvature are integrated against $(b,B)$-cocycles that are Hochschild cocycles as well. In both cases, the Hochschild cochains are derived from the Taylor series expansion of the spectral action $\tr(f(D+V))$ in powers of $V=\pi_D(A)$, but unlike the Taylor expansion we expand in increasing order of the forms in $A$. We then analyze the perturbative quantization of the spectral action in noncommutative geometry and establish its one-loop renormalizability as a gauge theory. We show that the one-loop counterterms are of the same Chern-Simons-Yang-Mills form so that they can be safely subtracted from the spectral action. A crucial role will be played by the appropriate Ward identities, allowing for a fully spectral formulation of the quantum theory at one loop.

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**Time**: 10:00 – 10:30
**Speaker**: Martinetti, Pierre (Universita di Genova)
**Title**: Standard model in noncommutative geometry Wick rotation and twisted spectral triples
**Abstract**: We shall give an overview on some recent developments on the description of the Standard Model in noncommutative geometry, especially regarding the use of twisted spectral triples, and how they may implement Wick rotation.

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**Time**: 10:30 – 11:00
**Speaker**: Sitarz, Andrzej (Jagiellonian University)
**Title**: Spectral geometry and modifications of gravity
**Abstract**: I'll present the recent results on possible modifications of general relativity that arise from spectral action applied to mildly noncommutative models of spacetime.

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**Time**: 11:30 – 12:00
**Speaker**: Wulkenhaar, Raimar (WWU Munster)
**Title**: From scalar fields on noncommutative geometries to blobbed topological recursion
**Abstract**: Finite-dimensional approximations of noncommutative quantum field theories are matrix models. They often show rich mathematical structures many of them are exactly solvable or even related to integrability, or they generate numbers of interest in enumerative or algebraic geometry. For many matrix models it was possible to prove that they are governed by a universal combinatorial structure called Topological Recursion. The probably most beautiful example is Kontsevich's matrix Airy function which computes intersection numbers on the moduli space of stable complex curves. The Kontsevich model arises from a $\lambda\Phi^3$-model on a noncommutative geometry. The talk addresses the question which structures are produced when replacing $\lambda\Phi^3$ by $\lambda\Phi^4$. The final answer will be that $\lambda \Phi^4$ obeys blobbed topological recursion, a systematic extension of topological recursion due to Borot and Shadrin.

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**Time**: 12:00 – 12:30
**Speaker**: Schomerus, Volker (DESY)
**Title**: Supergroup Chern-Simons Theory and Topological Phases

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**Time**: 12:30 – 13:00
**Speaker**: Castellani, Leonardo (Universita' del Piemonte Orientale and INFN, Torino Section)
**Title**: Supergravity with integral forms
**Abstract**: I will describe how to cast supergravity theories in the language of integral forms, and how this formulation provides a direct bridge between superspace and component actions.

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**Time**: 13:00 – 13:30
**Speaker**: Chatzistavrakidis, Athanasios (Rudjer Boskovic Institute)
**Title**: Twisted R-Poisson Sigma Models

**Time**: 16:00 – 16:30
**Speaker**: Platania, Alessia (Perimeter Institute)
**Title**: String Tension between de Sitter vacua and Curvature Corrections
**Abstract**: Higher-derivative corrections to cosmological effective actions in string theory are largely constrained by T-duality, but have been computed so far only to the first few orders in the string scale alpha'. In this talk I will show that the functional renormalization group (typically employed in the context of asymptotically safe gravity), in conjunction with the strong constraints imposed by T-duality, allows to derive cosmological effective actions to all orders in alpha', while avoiding "truncations" of the theory space. I will discuss two exact solutions for the mini-superspace effective action and I will show that the corresponding alpha'-resummed field equations do not admit de Sitter solutions, in agreement with the implications of the no-de Sitter swampland conjecture.

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**Time**: 16:30 – 17:00
**Speaker**: Hebecker, Arthur (Heidelberg)
**Title**: Some recent issues in the quest for stringy de Sitter models
**Abstract**: The string theory landscape, including metastable de Sitter vacua, arguably remains our simplest path towards understanding our late universe and the fine-tuning problems of the Standard Model. However, the explicit construction of stringy de Sitter vacua is challenging and doubts concerning their existence remain popular. I will discuss two recent issues relevant to this debate The renormalization of a key coupling term between the 7-brane gauginos and bulk fields and the Singular-Bulk Problem potentially threatening the parametric control of the KKLT proposal. I will also comment on why the apparently natural alternative, stringy quintessence, is not obviously preferred from a theoretical perspective.

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**Time**: 17:00 – 17:30
**Speaker**: Buric, Maja (University of Belgrade)
**Title**: Fuzzy de Sitter and anti-de Sitter spaces
**Abstract**: We present a construction of fuzzy de Sitter and anti-de Sitter spaces in 3 and 4 dimensions and discuss their geometric and differential-geometric properties.

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**Time**: 18:00 – 18:30
**Speaker**: Giaccari, Stefano (Holon Institute of Technology (HIT))
**Title**: Moyal Yang Mills theory and higher spin in flat spacetime
**Abstract**: Recently, the long-standing problem of formulating an action principle for higher spin (HS) massless equations of motion has been reformulated in terms of master fields in a non-commutative space including the ordinary spacetime and an auxiliary space of the same dimension. In particular, a Moyal-product structure plays a crucial role at the level of interactions. In this talk, after reviewing the simplest model within this scenario, namely the Moyal-higher-spin Yang Mills (MHSYM) theory, which has such advantages as explicit background independence, the applicability of BRST quantization and a straightforward supersymmetric extension, we will focus on analyzing the perturbative spectrum obtained by expanding master fields in terms of ordinary spacetime ones. The requests of absence of negative norm ghosts and Lorentz covariance will be shown to be naturally satisfied by the use of infinite-dimensional Lorentz representations which are not usually considered in other approaches to the HS problem in Minkowski spacetime. After discussing the coupling to matter, we will also consider some simple tree-level four-particle scattering amplitudes as a first step towards the study of S-matrix and its properties.

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**Time**: 18:30 – 19:00
**Speaker**: Iazeolla, Carlo (G. Marconi University, Rome and INFN Rome Tor Vergata)
**Title**: Unfolding and higher-spins spacetime/fibre duality, resolution of spacetime singularities and observables
**Abstract**: I will recall some of the most relevant features of the unfolded formulation lying at the heart of Vasilieva field equations of higher-spin gravity, in particular stressing the encoding of bulk and boundary degrees of freedom into fibre representatives of spacetime fields and gauge functions, and the mapping of certain spacetime features of solution spaces into algebraic conditions. The latter mapping, in particular, gives indications on how classical singularities of different nature (some curvature singularities as well as degenerate metrics) can be handled and resolved within higher-spin gravity. In parallel, I will compare different kinds of observables available for the Vasiliev systems, in particular asymptotic vs. zero-form charges.

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**Time**: 19:00 – 19:30
**Speaker**: Catterall, Simon (Syracuse University)
**Title**: Anomalies, symmetric mass generation and staggered fermions
**Abstract**: I will show that Kaehler-Dirac fermions exhibit a new gravitational anomaly that ensures that the partition

function transforms under a phase that depends only on the Euler character of the background space. To cancel this anomaly the number of Kaehler-Dirac fermions must be a multiple of four which corresponds to multiples of sixteen Majorana fermions in the flat space limit. This is consistent with results from condensed matter physics for topological insulators. Cancellation of this anomaly is a necessary condition for symmetric mass generation (SMG) which is a mechanism by which fermions can acquire masses without breaking global symmetries. It is conjectured that SMG is a necessary ingredient in obtaining a low energy chiral gauge theory from a U.V vector-like theory. Remarkably this anomaly survives under discretization and, because of the intimate connection between Kaehler-Dirac and staggered fermions, implies constraints on the construction of lattice models that are capable of SMG. I show numerical results that are consistent with these anomaly constraints and speculate on how these models to construct chiral lattice gauge theories.

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## 2.4 Friday, September 24, 2021

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**Time**: 9:00 – 9:30
**Speaker**: Arzano, Michele (University of Naples "Federico II")
**Title**: Getting hot without accelerating vacuum thermal effects from conformal quantum mechanics
**Abstract**: I will discuss how the generators of radial conformal symmetries in Minkowski space-time are related to the generators of time evolution in conformal quantum mechanics. Within this correspondence I will show that in conformal quantum mechanics the state corresponding to the inertial vacuum for a conformally invariant field in Minkowski space-time has the structure of a thermofield double. The latter is built from a bipartite "vacuum state" corresponding to the ground state of the generators of hyperbolic time evolution, which cover only a portion of the time domain. When such generators are the ones of conformal Killing vectors mapping a causal diamond in itself and of dilations, the temperature of the thermofield double reproduces, respectively, the diamond temperature and the Milne temperature perceived by observers whose constant proper time hyper-surfaces define a hyperbolic slicing of the future cone. I will point out how this result indicates that, for conformal invariant fields, the fundamental ingredient for vacuum thermal effects in flat-space time is the non-eternal nature of the lifetime of observers rather than their acceleration.

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**Time**: 9:30 – 10:00
**Speaker**: Landi, Giovanni (Universita di Trieste)
**Title**: Hopf algebroids and noncommutative gauge transformations

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**Time**: 10:00 – 10:30
**Speaker**: Fioresi, Rita (University of Bologna)
**Title**: Quantum Principal bundle and Non Commutative differential calculus

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**Time**: 10:30 – 11:00
**Speaker**: Watamura, Satoshi (Tohoku University)
**Title**: Metric algebroid in DFT
**Abstract**: We discuss a formulation of Double Field Theory (DFT) based on a metric algebroid. We address the covariant completion of the Bianchi identities, the pre-Bianchi identity with torsion, using an improved generalized curvature, and the pre-Bianchi identity including the dilaton contribution. The derived bracket formulation by the Dirac generating operator is applied.

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**Time**: 11:30 – 12:00
**Speaker**: Jonke, Larisa (Rudjer Boskovic Institute)
**Title**: On Hopf and Lie-infinity algebras
**Abstract**: In this talk I will discuss the relation between Lie-infinity and Hopf algebras.

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**Time**: 12:00 – 12:30
**Speaker**: Vysoky, Jan (Czech Technical University)
**Title**: Introduction to Graded Manifolds
**Abstract**: A need for a geometrical theory with integer graded coordinates arose both in geometry (Courant algebroids, Poisson geometry) and physics (AKSZ and BV formalism). Based on the approach of Berezin-Leites and Kostant to supermanifolds, Z-graded manifolds are usually defined as (graded) locally ringed spaces, that is certain sheaves of graded commutative algebras over (second countable Hausdorff) topological spaces, locally isomorphic to a suitable "local model". This approach works with no major issues for non-negatively (or non-positively) graded manifolds, which is

sufficient for most of the applications. However, if one tries to include coordinates of both positive and negative degrees, issues appear on several levels. This was addressed recently by M. Fairon by extending the local model sheaf. Interestingly, this modification creates a new subtle issue on the level of Z-graded linear algebra. This talk intends to point out the aforementioned issues and to offer the modifications required to obtain a consistent theory of Z-graded manifolds with coordinates of an arbitrary degree.

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**Time**: 12:30 – 13:00
**Speaker**: Bonechi, Francesco (INFN, Firenze)
**Title**: Diagonalization of the Nijenhuis tensor from invariant polynomials
**Abstract**: Motivated by the problem of quantization of the symplectic groupoid we study a class of bihamiltonian systems defined on compact hermitian symmetric spaces. Indeed, a Poisson Nijenhuis (PN) structure defines a (singular) real polarization of the symplectic groupoid integrating any of the Poisson structures appearing in the bihamiltonian hierarchy. Despite its singularity, this polarization leads to the quantization of complex projective spaces. We will discuss in some detail a way to discuss this polarization in terms of invariant polynomials of a certain Thimm chain of subalgebras. This approach works for the classical cases, time permitting, I will discuss some partial results about the exceptional cases.

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**Time**: 13:00 – 13:20
**Speaker**: Manolakos, Georgios (Rudjer Boskovic Institute)
**Title**: A gravity model on a covariant 4-d noncommutative space
**Abstract**: Along the lines of the gauge-theoretic description of gravitational theories, we develop a gravity model as a gauge theory on a 4-d covariant noncommutative space, that is a fuzzy version of the 4-d de Sitter space. After the specification of the appropriate gauge group, the corresponding field equations and the field strength tensor are obtained. In turn, the introduction of an auxiliary scalar field induces a spontaneous breaking of the initial symmetry and, last, its implications to the reduced theory, which is produced after considering the commutative limit, are examined.

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## 2.5 Saturday, September 25, 2021

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**Time**: 9:00 – 9:30
**Speaker**: Wallet, Jean-Christophe (Paris)
**Title**: Gauge Theories on kappa-Minkowski spaces Results and prospects.
**Abstract**: kappa-Poincare invariant gauge theories built on kappa-Minkowski spaces exhibit peculiar classical and quantum properties, which are reviewed and discussed. Gauge invariance can be achieved only in 5 dimensions and for a unique family of twisted differential calculi. Physical consequences of the existence of this single extra dimension are discussed and confronted to recent data from collider experiments and of time-delays in the arrival of ultra-energetic photons emitted simultaneously from distant sources. Fixing the gauge needs the use of a BRST symmetry which is rigidly linked to a twisted BRST symmetry obtained from a noncommutative analog of the celebrated horizontality condition of the usual Yang-Mills theories. One-loop computations lead to a non-vanishing 1-point function for the gauge potential. Related consequences are discussed together with a list of open questions.

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**Time**: 9:30 – 10:00
**Speaker**: Meusburger, Catherine (University of Erlangen-NÃ¼rnberg)
**Title**: 3d State sum models with defects
**Abstract**: We show how to construct Turaev-Viro style 3d state sum models with defects that exhibit topological invariance. This is joint work with John W. Barrett.

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**Time**: 10:00 – 10:30
**Speaker**: Sorokin, Dimitri (INFN Padova)
**Title**: ModMax electrodynamics, its generalizations and applications
**Abstract**: Conformal invariance and duality symmetries play an important role in various fields of theoretical physics, ranging from condensed matter to the theory of fundamental interactions. A classical example of duality symmetry is the invariance of free Maxwell electrodynamics under the exchange of the electric and magnetic field. Free Maxwell theory is also conformally invariant. On the other side, non-linear generalizations of Maxwell electrodynamics have attracted a great deal of attention for many decades as possible guides to catch new physics: e.g. for tackling fundamental cosmological problems (such as inflation and dark matter) and for an effective description of properties of certain condensed matter systems and optical media. The choice of non-linear electrodynamics models has mainly been made heuristically without resorting to fundamental principles. In this talk I will show that the requirement of duality and conformal invariance

singles out the unique self-interacting electrodynamics (dubbed ModMax) that reduces to Maxwell's theory in the free field limit. ModMax is interacting but admits exact light-velocity plane-wave solutions and a class of topologically non-trivial configurations with knotted electromagnetic fields. In uniform electromagnetic backgrounds ModMax exhibits the phenomenon of birefringence, i.e. the dependence of the geodesics of the propagation of light on its polarization with respect to the direction of the background electromagnetic field, thus mimicking properties of optically anisotropic materials. ModMax has found applications in the study of its effects on self-gravitating objects in General Relativity, such as charged Reissner-Nordstrom black holes and gravitational waves.

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**Time**: 10:30 – 10:50
**Speaker**: Hejda, Filip (CEICO, Institute of Physics of the Czech Academy of Sciences, Czech republic)
**Title**: Generalised BSW effect and extraction of energy from extremal electrovacuum black holes
**Abstract**: In order to extract energy from a black hole by means of Penrose process, production of particles with high relative velocity is needed. This can be achieved in high-energy collisions. Thus, it sparked a lot of attention when Banados, Silk and West (BSW) described a scenario, in which arbitrarily high centre-of-mass collision energies can be achieved. This BSW effect involves particles with fine-tuned angular momentum orbiting a maximally rotating black hole, but an analogous phenomenon was found for particles with fine-tuned charge moving in the vicinity of a maximally charged black hole. Despite many similarities, the two variants differ profoundly in terms of energy extraction. Whereas in the original, centrifugal version, strict unconditional upper bounds on the extracted energy were found, such bounds are absent in the electrostatic one. This contrast is all the more striking, since we recently demonstrated that the two variants can be seen as special cases of a more general effect [Phys. Rev. D 95, 084055 (2017)]. In the present work, we discuss extraction of energy from an extremal electrovacuum black hole via this generalised BSW effect. Our main conclusion is that there is no unconditional upper bound on the extracted energy whenever both the black hole and the escaping particle are charged. This makes our setup interesting as a simplified model for possible processes happening around astrophysical black holes, which may spin fast, but can have only tiny charge induced via interaction with external magnetic field. Additionally, we show that collisions in the equatorial plane are immune to further caveats that we found in the simpler case of collisions of charged particles moving along the axis of symmetry [Phys. Rev. D 100, 064041 (2019)].

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**Time**: 11:20 – 11:50
**Speaker**: Lukierski, Jerzy (Inst. Theor.Physics, Wroclaw Univ.)
**Title**: Spinorial Snyder Type Models from Superalgebras and Noncommutative (Phase)Superspaces
**Abstract**: In D=4 Snyder model it is shown how to obtain from o(4,1) or o(3,2) algebras the relativistic quantum elementary system: Lorentz covariance group and NC D=4 quantum space- time as its module. In D=4 Yang models from o(5,1) or o(4,2) algebras one deduces the Lorentz-ovariant D=4 generalized Heisenberg algebra. We consider the supersymmetrization of both models what will lead to Lorentz-covariant NC superspaces and phase superspaces. Such model provides the examples of Snyderization procedure applied to Lie (super)algebras, with part of the Lie (super)algebra generators defining the quantum (super)spaces. In such a framework the supercharges after the Snyderization procedure will become fermionic quantum spinors.

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**Time**: 11:50 – 12:20
**Speaker**: Lechtenfeld, Olaf (Leibniz University Hannover)
**Title**: The Nicolai map for supersymmetric Yang-Mills theory and application to the supermembrane
**Abstract**: The nonlocal bosonic theory obtained from integrating out all anticommuting and auxiliary variables in a globally supersymmetric theory is characterized by the Nicolai map. We present a universal formula for the latter in terms of an ordered exponential of the integrated coupling flow operator, which can be canonically constructed. Also for supersymmetric gauge theories, this allows us to perturbatively construct the Nicolai map explicitly in terms of tree diagrams. For off-shell supersymmetry this works in any gauge, in the on-shell case the Landau gauge is required. The dimensional reduction of d=10 super Yang-Mills or of the d=11 supermembrane to the BFSS matrix model allows for a perturbative linearization of the supermembrane in the small-tension regime. Finally we argue about a finite radius of convergence for the Nicolai map, which improves the perturbative computation of correlators in supersymmetric theories.

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**Time**: 12:20 – 12:50
**Speaker**: Cattaneo, Alberto (University of Zurich)
**Title**: The BFV formalism for Palatini-Cartan gravity and corner structure

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**Time**: 12:50 – 13:20
**Speaker**: Krajewski, Thomas (Aix-Marseille University)
**Title**: A short glimpse into the loop vertex expansion
**Abstract**: The large majority of perturbative expansions are in fact divergent power series, even if useful as asymptotic

expansions. This is partly due to the factorial growth of the number of Feynman graphs of a given order which impedes the convergence of the perturbative series. In this talk, we present the Loop Vertex Expansion, which is an alternative to the standard Feynman graph expansion that provides a convergent expansion, and illustrate its use in the case of random matrices.

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**Time**: 16:00 – 16:30
**Speaker**: Kurkcuoglu, Seckin (Middle East Technical University (METU))
**Title**: Chaos in Matrix Gauge Theories with Massive Deformations
**Abstract**: We will focus on the chaotic dynamics emerging from certain matrix gauge theories with massive deformation terms. In particular, we will consider a Yang-Mills matrix model with mass deformation terms and employing the numerical data describing the change in the largest Lyapunov exponent (LLE) with energy and making use of the virial and equipartition theorems, we will model the variation of the LLE with the temperature. From our results, we determine an upper bound, T_c, on the critical temperature over which LLE obeys the MSS bound on quantum chaos, while it eventually violates it at a temperature below T_c. Time permitting, we will also discuss similar results we recently obtained in studying the the mass-deformed ABJM model.

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**Time**: 16:30 – 17:00
**Speaker**: Bergner, Georg (University of Jena)
**Title**: Non-perturbative investigations of gauge theories with adjoint and fundamental matter related to supersymmetric gauge theories
**Abstract**: In this talk I will present the results of the first numerical investigation of a gauge theory with adjoint and fundamental fermion fields. It corresponds to the heavy scalar limit of supersymmetric QCD and has further applications in composite Higgs models and semiclassical investigations of confinement. I will discuss the interplay of the different fermion representations and relations to the numerical investigations of supersymmetric gauge theories.

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**Time**: 17:30 – 18:00
**Speaker**: Filev, Veselin (IMT, Bulgarian Academy of Sciences and IAS, Dublin)
**Title**: Backreacted D0/D4 background
**Abstract**: We construct a type II A supergravity background corresponding to a backreacted D0/D4-brane system. The background is holographically dual to the Berkooz Douglas matrix model, which was recently simulated on a lattice. The localised D0/D4 system is unstable when the D-branes are not separated to circumvent this difficulty we separate the D4-branes from the D0-branes and partially smear them on a four sphere. We construct both numerical and perturbative solutions.

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**Time**: 18:00 – 18:30
**Speaker**: Giesel, Kristina (Friedrich-Alexander-Universität Erlangen-Nürnberg)
**Title**: Reduced phase space quantisation in loop quantum gravity and loop quantum cosmology
**Abstract**: In this talk an overview over recent results that apply a reduced phase space quantisation to formulate the dynamics of loop quantum gravity and loop quantum cosmology will be presented. After a brief introduction it will be discussed how a reduced phase space for GR can be derived by coupling additional reference matter. The reduced phase space for GR is taking as a starting point for a loop quantisation either in full LQG or in the symmetry reduced case of LQC. As will be shown different choices of reference matter yield in general different quantum models and several existing models will be compared. In the framework of LQC it will be analysed how different choices of reference matter can lead to different physical properties of the models and it will be discussed what kind of conditions appropriate reference matter should satisfy.

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**Time**: 18:30 – 18:50
**Speaker**: Bhattacherjee, Sandipan (Birla Institute of Technology Mesra, Ranchi, India)
**Title**: Non-equilibrium Quantum Cosmology with a distinct hint of Condensed-Matter Physics
**Abstract**: The early universe is likely filled with a large number of interacting fields with unknown interactions. How can we quantitatively understand particle production (for example, during inflation and reheating after inflation) when such fields undergo a sufficient number of non-adiabatic, non-perturbative interactions? A recent proposal of a precise mapping between stochastic particle production events during inflation and re-heating in cosmology to conduction phenomena in disordered quasi one-dimensional wires provide a powerful statistical framework to resolve such seemingly intractable calculations. In our work, we use this precise correspondence to present a derivation of the quantum corrected Fokker-Planck equation without dissipation responsible for studying the dynamical features of the stochastic particle creation events during the inflationary and re-heating stage of the universe. We also present a computation for the measure of the stochastic non-linearity arising in the inflationary and reheating epoch of the universe, often described by the

Lyapunov Exponent. Doing so, we quantify this quantum chaos arising in our set-up by a stronger measure, known as the Spectral Form Factor from the principles of Random Matrix Theory. We also discuss hints of emergent universality from Random Matrix Theory in early universe cosmology using this correspondence. Finally, we propose a bound on the Spectral Form Factor arising due to the presence of stochastic non-linear dynamical interactions in the early universe in a model-independent way.

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**Time**: 18:50 – 19:20
**Speaker**: Karczmarek, Joanna (University of British Columbia)
**Title**: Target space entanglement entropy, matrix models and noncommutative geometry
**Abstract**: Emergence of geometry through matrix degrees of freedom is a common feature of many models, from the AdS-CFT correspondence to BFFS and IKKT matrix models. This has prompted several recent attempts to define entropic quantities in matrix models that could correspond to geometric subsystem entanglement entropies. I will discuss what we can learn about this problem through the lens of noncommutative geometry.

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## 2.6 Sunday, September 26, 2021

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**Time**: 9:10 – 9:30
**Speaker**: Kovacik, Samuel (Comenius University Bratislava, MUNI Brno)
**Title**: Microscopic black holes
**Abstract**: One of the expected features of the theory of quantum theory is the Planck-scale structure of space. This structure would affect the behavior of microscopic black holes. In this talk, I'll discuss various approaches to this subject with a focus on the generality of the predictions and possible observational signatures.

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**Time**: 9:30 – 10:00
**Speaker**: Martin, Carmelo Perez (Universidad Complutense de Madrid)
**Title**: Unimodular supergravity
**Abstract**: I shall discuss how to build an off-shell N=1 supersymmetric version of unimodular gravity in d=4. Ads unimodular supergravity will also be discussed. This talk will be based on the papers JHEP 01 (2020) 145 and JCAP 03 (2020) 006

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**Time**: 10:00 – 10:30
**Speaker**: Ferrari, Frank (U Libre Bruxelles & Int Solvay Inst)
**Title**: On Jackiw-Teitelboim Quantum Gravity At Finite Cut-Off

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**Time**: 10:30 – 11:00
**Speaker**: Dobrev, Vladimir (INRNE, BAS)
**Title**: Heisenberg Parabolic Subgroups and Invariant Differential Operators
**Abstract**: We continue the project of systematic construction of invariant differential operators on the example of the non-compact algebra $so^*(8)$. We use the maximal Heisenberg parabolic subalgebra $P = MAN$ with $M = so^*(4)\oplus so(3)$. We give the main multiplets of indecomposable elementary representations. This includes the explicit parametrization of the invariant differential operators between the ERS. Due to the recently established parabolic relations the multiplet classification results are valid also for the two algebras $so(p,q)$ (for $(p,q)=(5,3), (4,4)$) with maximal Heisenberg parabolic subalgebra: $P'=M'A'N'$, $M' = so(p-2,q-2)\oplus sl(2,R)$.

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**Time**: 11:30 – 11:50
**Speaker**: Morand, Kevin (Sogang University)
**Title**: Graph complexes and deformation quantization of Lie bialgebroids

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**Time**: 11:50 – 12:20
**Speaker**: Fiore, Gaetano (Universita di Napoli, and INFN)
**Title**: Twisted submanifolds of R^n
**Abstract**: I will present a general procedure to construct noncommutative deformations of an embedded submanifold M of R^n determined by a set of smooth equations f^a(x)=0. We use the framework of Drinfel'd twist deformation of

differential geometry of ref. [Aschieri et al., Class. Quantum Gravity 23 (2006), 1883], the commutative pointwise product is replaced by a (generally noncommutative) star-product determined by a Drinfel'd twist. I will also show a couple of examples of noncommutative quadrics based on Abelian or Jordanian twists.

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**Time**: 12:20 – 12:50
**Speaker**: Jurco, Branislav (Charles University, Prague)
**Title**: TBA

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**Time**: 12:50 – 13:20
**Speaker**: Brzezinski, Tomasz (Swansea University and University of Bialystok)
**Title**: Heaps of connections
**Abstract**: An algebra is a vector space together with an associative bilinear operation. Replacing the words 'vector' and 'linear' by the word 'affine' we obtain an algebraic structure known as a 'truss'. Such structures (and their representations) originated in the studies of solutions of the Yang-Baxter equation but they occur in a natural way when discussing connections in classical and noncommutative geometry. In this talk I will try to explain elementary properties of trusses and their heaps of modules, and illustrate the latter with connections in noncommutative geometry.

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**Time**: 16:00 – 16:30
**Speaker**: Toppan, Francesco (CBPF)
**Title**: Signatures of Z2xZ2-graded physics
**Abstract**: In 1978 Rittenberg and Wyler introduced the Z2xZ2-graded extension of Lie superalgebras (also known as ..... superalgebras). In recent years a systematic investigation of classical and quantum dynamical systems with Z2xZ2-graded symmetry started. Ordinary bosons and fermions are described by 1 bit of information (0 or 1). In Z2xZ2-graded systems the particles are accommodated in 2 bits ordinary bosons (00), two types of parafermions which mutually commute (10 and 01) and exotic bosonsn(11) which anticommute with the parafermions. Ordinary (boson/fermion) models are recovered if the 01 and 11 sectors are empty. It was proved very recently in a theoretical toy model (see J. Phys. A Math. Theor. 54, 115203 (2021), arXiv 2008.11554[hep-th]) that the colored Z2xZ2-graded world cannot be mimicked by black/white bosons/fermions alone. The construction relies on the braided tensor product, introduced by Majid in 1995, applied to graded Hopf algebras. This result opens the way to search for observable consequences of Z2xZ22-graded parastatistics. In this talk I present the state of the art on this topic model building, testable consequences of Z2xZ2-graded parafermions and parabosons and possible applications.

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**Time**: 16:30 – 17:00
**Speaker**: Chryssomalakos, Chryssomalis (ICN UNAM)
**Title**: Entanglement entropy in fuzzy R^3

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**Time**: 17:30 – 18:00
**Speaker**: Freidel, Laurent (Perimeter Institute For theoretical Physics)
**Title**: Local Holography a new paradigm for quantum gravity

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**Time**: 18:00 – 18:30
**Speaker**: Minic, Djordje (Virginia Tech)
**Title**: On quantum gravity and quantum gravity phenomenology in the infrared
**Abstract**: Quantum gravity effects are traditionally tied to short distances and high energies. In this talk I will argue that, perhaps surprisingly, quantum gravity may have important consequences for the phenomenology of the infrared. I will center my discussion around a conception of quantum gravity involving a notion of quantum spacetime that arises in metastring theory. This theory allows for an evolution of a cosmological Universe in which string-dual degrees of freedom decouple as the Universe ages. Importantly such an implementation of quantum gravity allows for the inclusion of a fundamental length scale without introducing the fundamental breaking of Lorentz symmetry. The mechanism seems to have potential for an entirely novel source for dark matter/energy. The simplest observational consequences of this scenario may very well be residual infrared modifications that emerge through the evolution of the Universe.

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**Time**: 18:30 – 19:00
**Speaker**: Semenoff, Gordon (University of British Columbia, Vancouver)
**Title**: Entanglement Harvesting or Crop Failure?

**Abstract**: It is known that the vacuum state of a field theory is a highly correlated quantum state. The phenomenon called "entanglement harvesting" proposes a process by which, in principle, one can extract quantum entanglement from the vacuum and transfer it to mobile objects such as a pair of Unruh-DeWitt particle detectors. I will present a study of this phenomenon via the analysis of a few simple models where the growth of quantum correlations between Unruh-de Witt detectors can be analyzed analytically. The goal is to find some definitive statements about when entanglement harvesting is or is not possible.

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**Time**: 19:00 – 19:30
**Speaker**: Van Raamsdoonk, Mark (U British Columbia)
**Title**: Cosmology from confinement
**Abstract**: In this talk I will describe a framework for describing microscopic models of big-bang / big-crunch cosmology within the context of the AdS/CFT correspondence in string theory.

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