Fachverband Theoretische und Mathematische Grundlagen der Physik (MP)

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Die Mehrzahl der Vorträge handeln von der QFT, Quantensystemen, Gravitation und AdS/CFT-Korrespondenz mit Bezug zu oder Anwendungen auf Quanteninformation, Tensor-Netzwerke, Quantengravitation, Entropie und Komplexität, QFT im gekrümmten Raum oder Physik in starken Feldern. Der Plenarvortrag unseres Fachverbandes hält Robert Myers (Waterloo) über „Scanning new horizons: information, holography & gravity".

Gemeinsam mit anderen Fachverbänden organisieren wir am Dienstag um 14 Uhr ein Symposium über „Gravitation – neueste Ergebnisse und Trends- neueste Ergebenisse und Trends". Als Sprecher/in eingeladen sind Lavinia Heisenberg, Luciano Rezzolla, Christian Weinheimer und Kasia Rejzner.

Hauptvorträge halten (in dieser Reihenfolge) Rene Meyer, Christian Gerard, Markus Müller, Dorothea Bahns, Michael Heller und Norbert Bodenhofer.

Übersicht der Hauptvorträge und Fachsitzungen

(Hörsaal Z6 - SR 1.012)

Hauptvorträge

MP 1.1	Mo	16:00–16:45	Z6 - SR 1.012	**Quantum Information and Topological Complexity in AdS/CFT** — •René Meyer, Raimond Abt, Johanna Erdmenger, Haye Hinrichsen, Charles M. Melby-Thompson, Christian Northe, Ignacio A. Reyes
MP 2.1	Di	11:00–11:45	Z6 - SR 1.012	**Analytic Hadamard states and Wick rotation on curved spacetimes** — •Christian Gérard
MP 3.1	Di	16:30–17:15	Z6 - SR 1.012	**Operational meaning of entropy and free energy without the thermodynamic limit** — •Markus P. Müller
MP 5.1	Mi	11:00–11:45	Z6 - SR 1.012	**The Quantum sine-Gordon model in pAQFT** — •Dorothea Bahns
MP 7.1	Mi	16:30–17:15	Z6 - SR 1.012	**Complexity of states in quantum field theory** — •Michal P. Heller
MP 9.1	Do	11:00–11:45	Z6 - SR 1.012	**Holographic aspects of loop quantum gravity** — •Norbert Bodendorfer

Hauptvorträge des fachübergreifenden Symposiums SYMD

Das vollständige Programm dieses Symposiums ist unter SYMD aufgeführt.

SYMD 1.1	Mo	14:00–14:30	Z6 - HS 0.004	**The Data Mining Guide to the Galaxy and Beyond** — •Sabrina Einecke
SYMD 1.2	Mo	14:30–15:00	Z6 - HS 0.004	**A novel method for the energy determination of ultra-high energy cosmic rays through radio emission of particle showers** — •Christian Glaser
SYMD 1.3	Mo	15:00–15:30	Z6 - HS 0.004	**Measuring the neutrino mass hierarchy with the future KM3NeT/ORCA detector in the deep sea** — •Jannik Hofestädt
SYMD 1.4	Mo	15:30–16:00	Z6 - HS 0.004	**Milestone toward a nuclear clock: On the direct detection of ^{229m}Th** — •Lars von der Wense, Benedict Seiferle, Peter G. Thirolf

Hauptvorträge des fachübergreifenden Symposiums SYGR

Das vollständige Programm dieses Symposiums ist unter SYGR aufgeführt.

SYGR 1.1	Di	14:00–14:30	Z6 - HS 0.004	**New horizons in gravity** — •Lavinia Heisenberg
SYGR 1.2	Di	14:30–15:00	Z6 - HS 0.004	**Binary neutron stars: Einstein's richest laboratory** — •Luciano Rezzolla
SYGR 1.3	Di	15:00–15:30	Z6 - HS 0.004	**Search for Dark Matter** — •Christian Weinheimer
SYGR 1.4	Di	15:30–16:00	Z6 - HS 0.004	**From QFT on curved spacetimes to effective quantum gravity** — •Kasia Rejzner

Fachsitzungen

MP 1.1–1.6	Mo	16:00–18:35	Z6 - SR 1.012	**Quantum Information and Complexity**
MP 2.1–2.2	Di	11:00–12:05	Z6 - SR 1.012	**QFT in Curved Spacetimes**
MP 3.1–3.4	Di	16:30–18:25	Z6 - SR 1.012	**Thermodynamics and Field Theory**
MP 4	Di	18:30–19:30	Z6 - SR 1.012	**Mitgliederversammlung FV MP**
MP 5.1–5.2	Mi	11:00–12:05	Z6 - SR 1.012	**Quantum Field Theory I**
MP 6.1–6.5	Mi	14:00–15:50	Z6 - SR 1.012	**Nonperturbative QFT and Strong Fields**
MP 7.1–7.3	Mi	16:30–17:55	Z6 - SR 1.012	**Quantum Field Theory II**
MP 8.1–8.3	Mi	18:10–19:10	Z6 - SR 1.012	**Field Theory**
MP 9.1–9.2	Do	11:00–12:05	Z6 - SR 1.012	**Holography and Quantum Gravity**
MP 10.1–10.5	Do	14:00–15:40	Z6 - SR 1.012	**Quantum Systems, Symmetries and Scattering**
MP 11.1–11.6	Do	16:30–18:40	Z6 - SR 1.012	**Relativity and Unification**
MP 12.1–12.3	Mo	12:00–12:00	Z6 - SR 1.012	**Posters (Montag - Donnerstag)**

Mitgliederversammlung Fachverband Theoretische und Mathematische Grundlagen der Physik

Di 18:30–19:30 Z6 - SR 1.012

MP 1: Quantum Information and Complexity

Zeit: Montag 16:00–18:35 Raum: Z6 - SR 1.012

Hauptvortrag MP 1.1 Mo 16:00 Z6 - SR 1.012

Quantum Information and Topological Complexity in AdS/CFT — •René Meyer[1], Raimond Abt[1], Johanna Erdmenger[1], Haye Hinrichsen[1], Charles M. Melby-Thompson[1], Christian Northe[1], and Ignacio A. Reyes[1,2] — [1]Institut für Theoretische Physik und Astrophysik, Julius-Maximilians-Universität Würzburg, Am Hubland, 97074 Würzburg — [2]Instituto de Fisica, Pontificia Universidad Catolica de Chile, Casilla 306, Santiago, Chile

Recently, using the AdS/CFT correspondence exciting new relations are being established between aspects of quantum information theory and of the geometry of black holes in Anti de Sitter space-times. After a concise review of the roles of entanglement measures such as e.g. the entanglement entropy as well as of the computational complexity within the AdS/CFT correspondence, I discuss the notion of subregion complexity of a 2D critical state from three different viewpoints: the AdS3/CFT2 correspondence, random tensor networks, and kinematic space. From the AdS3/CFT2 point of view I explain how in the discontinuity of subregion complexity as given by the volume within the Ryu-Takayanagi surface is related to the Euler characteristic of the respective bulk regions via the Gauss-Bonnet theorem. I then discuss how the volume of these sub regions can be calculated in kinematic space, which is the space of geodesics on the time-slice of AdS3, and present a new CFT expression of subregion complexity. Finally, I present results that qualitatively reproduce the discontinuity in complexity in a tensor network approach. Based on arXiv:1710.01327 [hep-th].

MP 1.2 Mo 16:45 Z6 - SR 1.012

Bulk Volumes in AdS/CFT from Kinematic Space — •Raimond Abt — TP III, Universität Würzburg, Deutschland

Some important new insights into the AdS/CFT correspondence and its relation to quantum information theory are provided by the concept of kinematic space. In AdS3/CFT2, kinematic space is the space of all geodesics in a constant time slice of AdS3 with endpoints at the boundary of the time slice. Kinematic space allows to find explicit expressions for geometric quantities, such as lengths of curves in the time slice of AdS3, in terms of entanglement entropies on the CFT side. Kinematic space is therefore a powerful tool to determine how quantum information aspects of the CFT are encoded in the geometry of AdS. In addition to curves, also volumes in AdS are an interesting quantity to study in context of quantum information. In particular, volumes may be used to define a concept of complexity. This is an information theoretic quantity measuring how involved a particular quantum operation is. In my talk I present an expression for volumes in terms of entanglement entropies that can be motivated and proven by using kinematic space, and discuss its relation to complexity.

15 mitn. break

MP 1.3 Mo 17:15 Z6 - SR 1.012

Discrete scale invariance in holography revisited — •Mario Flory — Institute of Physics, Jagiellonian University, Łojasiewicza 11, 30-348 Kraków, Poland

In 2013, K. Balasubramanian presented a 5+1 dimensional holographic toy model that allows for an exact solution to Einstein's equations in the bulk in which the isometries of AdS_5 appear to be broken to an isometry group describing a discretely scale invariant and Poincaré invariant setup. We investigate this solution in more detail. By analytically solving the Killing equations, we prove that the full AdS_5 isometry group is still present, although in a somewhat hidden way. We will also comment on the prospects of finding other holographic models which allow for solutions with discrete scale invariance or scale invariance without conformal invariance in the future.

MP 1.4 Mo 17:35 Z6 - SR 1.012

Non-local observables in AdS/CFT: finite temperature results — •Nina Miekley[1,2] and Johanna Erdmenger[1,2] — [1]Julius-Maximilians-Universitaet Wuerzburg, Germany — [2]Max-Planck-Institut für Physik, Munich, Germany

The AdS/CFT correspondence relates strongly coupled field theories to theories containing gravity. One interesting aspect are non-local observables, for instance the two-point function, the Wilson loop and the entanglement entropy. Their dual descriptions are associated to minimal surfaces. We derive a closed, analytic form of the aforementioned observables for d-dimensional finite temperature CFTs dual to Schwarzschild-AdS. Of particular interest is the high-temperature limit, where our results allow insights into new physical behaviour, e.g. a violation of the area theorem for entanglement entropy and a renormalisation of the quark mass.

MP 1.5 Mo 17:55 Z6 - SR 1.012

Subregion Complexities from Kinematic Space — •Christian Northe — TP3 Universitaet, Wuerzburg, Deutschland

We consider subregion complexity within the AdS3/CFT2 correspondence. Using the Gauss-Bonnet theorem we evaluate this quantity for specific examples. In particular, we find a discontinuity when there is a change in the RT surface, given by a topological contribution. There is no further temperature dependence of the subregion complexity. We further propose a CFT expression for this complexity based on kinematic space, and use it to reproduce some of our explicit gravity results. We thus obtain and discuss a concrete matching of results for subregion complexity between gravity and CFT expressions.

MP 1.6 Mo 18:15 Z6 - SR 1.012

Computational complexity in tensor networks and holography — •Ignacio Reyes — Institut fuer Theoretische Physik und Astronomie, Universitaet Wuerzburg, Am Hubland, 97074

We consider the proposal of subregion complexity in holography, which associates the volume enclosed by minimal surfaces in AdS-spaces (Ryu-Takayanagi surfaces) with computational complexity.

We argue that this measures the complexity of data-compression algorithm, and describe recent progress on how to match the calculations coming from AdS/CFT to explicit tensor network constructions, using MERA and random tensor networks. We consider black hole geometries.

MP 2: QFT in Curved Spacetimes

Zeit: Dienstag 11:00–12:05 Raum: Z6 - SR 1.012

Hauptvortrag MP 2.1 Di 11:00 Z6 - SR 1.012

Analytic Hadamard states and Wick rotation on curved spacetimes — •Christian Gérard — Laboratoire de Mathématiques Université Paris-Sud France

Hadamard states are substitutes for vacuum states when one considers for example a free Klein-Gordon field on a globally hyperbolic spacetime. Nowadays Hadamard states are caracterized microlocally by the wavefront set of their two-point function.

If the spacetime is analytic, one can define analytic Hadamard states, obtained using the analytic version of wavefront set, instead of the C^∞ version.

Analytic Hadamard states have the important *Reeh-Schlieder property*, which means that vectors obtained by acting on the ground state with fields localized in any fixed region of spacetime are dense in the physical Hilbert space.

So far the existence of analytic Hadamard states is known only in the very simple situation of static spacetimes. In this talk I will explain a construction of analytic Hadamard states on any analytic spacetime having an analytic Cauchy surface.

The proof uses the Wick rotation in Gaussian normal coordinates and a well-known tool from elliptic boundary value problems, called the *Calderon projectors*.

MP 2.2 Di 11:45 Z6 - SR 1.012

The holographic Hadamard condition on asymptotically AdS spacetimes — •Michał Wrochna — Université Grenoble Alpes, Institut Fourier, 38058 Grenoble, France

Presently, one of the key difficulties in the formulation of QFT on spacetimes that are not globally hyperbolic is the lack of a good substitute of the celebrated Hadamard condition. In settings with a timelike boundary, while it is possible to consider a direct analogue of the Hadamard condition away from the boundary, this does not suffice in applications in holography. A further problem with this idea is that singularities can propagate to the bulk from the boundary, where no control on the regularity is assumed. In this talk, I will focus on asymptotically Anti-de Sitter spacetimes and show that by considering a "holographic Hadamard condition" instead, one can overcome those difficulties and set up a consistent framework for non-interacting scalar quantum fields in the bulk and for the induced conformal fields on the boundary.

MP 3: Thermodynamics and Field Theory

Zeit: Dienstag 16:30–18:25 Raum: Z6 - SR 1.012

Hauptvortrag MP 3.1 Di 16:30 Z6 - SR 1.012

Operational meaning of entropy and free energy without the thermodynamic limit — •Markus P. Müller — Institut für Quantenoptik und Quanteninformation, Boltzmanngasse 3, 1090 Wien, Österreich

Thermodynamics at the nanoscale is known to behave very differently from the familiar regime of the thermodynamic limit. It has been shown that quantum fluctuations lead to severe restrictions on work extraction and state transformations: e.g. the constraint of Helmholtz free energy decrease is replaced by an infinite sequence of "second laws" (cf. Brandao et al., PNAS 112, 2015). In contrast, here we show a surprising positive feature of small-scale thermodynamics which is absent in the standard regime: microscopic thermal machines can tame fluctuations by building up correlations with the particles on which they act. That is, these machines can increase their efficiency via clever "correlation engineering". We prove that they can thus extract or invest the Helmholtz free energy difference exactly and basically without any fluctuations, which restores the original form of the second law in the nano regime.

This result rests on new theorems on majorization of probability distributions which can also be applied in quantum information theory beyond thermodynamics: they allow us to give operational 'single-shot' interpretations of the von Neumannn entropy and the mutual information, without considering a large number of copies of a quantum state.

Based partially on arXiv:1707.03451.

10 min. break

MP 3.2 Di 17:25 Z6 - SR 1.012

Bilinear Ensembles in Quantum Control — •Gunther Dirr — Universität Würzburg, Emil-Fischer-Str. 40

First, we recall necessary and sufficient conditions for controlling finitely many parallel connected bilinear systems. From this we derive controllability conditions for finite "quantum ensembles" and, as a by-product, we extend a well-known controllability result for interconnected spin-systems. Finally, we generalize the previous ideas to infinitely many parallel connected bilinear systems. This leads to infinite dimensional bilinear control systems of particular structure. We will present first results for countably many "quantum ensembles".

MP 3.3 Di 17:45 Z6 - SR 1.012

Path algebras and the controllability of atom-cavity systems — •Michael Keyl — FU Berlin

In this talk we study controllability of a d-level atom interacting with the electromagnetic field in a cavity. The system is modelled by an ordered graph Γ. The vertices of Γ describe the energy levels and the edges allowed transitions. To each edge of Γ we associate a harmonic oscillator representing one mode of the electromagnetic field. The dynamics of the system (drift) is given by a natural generalization of the Jaynes-Cummings Hamiltonian. If we add in addition sufficient control over the atom, the overall system (atom and em-field) becomes strongly controllable, i.e. each unitary on the system Hilbert space can be approximated with arbitrary precision in the strong topology by control unitaries. A key role in the proof is played by a topological *-algebra which is (roughly speaking) a representation of the path algebra of Γ. It contains crucial structural information about the control problem, and is therefore an important tool for the implementation of control tasks like preparing a particular state from the ground state.

MP 3.4 Di 18:05 Z6 - SR 1.012

Quantum energy inequalities inside an uniaxial crystal — Christopher J. Fewster[1], •Christian Pfeifer[2], and Daniel Siemssen[3] — [1]Department of Mathematics, University of York, York, United Kingdom — [2]Laboratory for Theortical Physics, University of Tartu, Tartu, Estonia — [3]Department of Mathematics and Informatics, University of Wuppertal, Wuppertal, Germany

The behaviour of the electromagnetic field inside an uniaxial crystal can be described in the framework of premetric electrodynamics. The electromagentic excitation is related to the electromagnetic field strength by a constitutive relation which depends not only on a metric but in addition on two vector fields describing the crystal's optical axis and rest frame. In this talk we apply the quantization of premetric electrodynamics to the uniaxial crystal and show that averages of the quantized energy density of the electromagnetic field along the worldlines of suitable observers obey a Quantum Energy Inequality (QEI). Compared to the Minkowski spacetime case the QEI bound inside the crystal takes a value which depends on the parameters of the crystal, the observer wordline in consideration and its proper time normalization. The latter may be modified compared to the one employed for observer worldlines in vacuum due to the more complicated birefringent causal structure inside the crystal. I will discuss the derivation of the uniaxial crystal QEI and its dependence on worldlines classified according to the crystal's causal structure.

MP 4: Mitgliederversammlung FV MP

Zeit: Dienstag 18:30–19:30 Raum: Z6 - SR 1.012

Dauer 60 min.

MP 5: Quantum Field Theory I

Zeit: Mittwoch 11:00–12:05 Raum: Z6 - SR 1.012

Hauptvortrag MP 5.1 Mi 11:00 Z6 - SR 1.012

The Quantum sine-Gordon model in pAQFT — •Dorothea Bahns — Mathematisches Institut, Georg August Universität Göttingen, Germany

The sine-Gordon model in the ultraviolet finite regime is quantized in the framework of perturbative Algebraic Quantum Field Theory. It is shown that the resulting S-matrix, at first given as a formal power series, converges. The Haag-Kastler net of local von Neumann algebras is constructed, and its equivalence with the massive Thirring model is proved. In contrast to other authors, we do not add an auxiliary mass

term, and we work completely in Lorentzian signature.

This is joint work with Klaus Fredenhagen (Hamburg) und Kasia Rejzner (York).

MP 5.2 Mi 11:45 Z6 - SR 1.012

Closing cumulant hierarchies: Quantal methods for classical dynamics — •Cora Uhlemann — DAMTP, University of Cambridge

Nonlinear problems in manifold areas of physics (such as cosmology, plasma physics and hydrodynamics including turbulence) are described by an infinite hierarchy of coupled differential equations for cumulants. Typically, truncations are based on fluid-like approximations that cannot capture the phenomenology of the system featuring multiple streams. I suggest to take a closer look at closure schemes that rely on the correspondence principle connecting quantal and classical dynamics. I will illustrate this idea for the gravitational clustering of dark matter, described by a phase-space distribution solving the Vlasov-Poisson equation. I will show that an approximate phase-space distribution can be constructed from a wave function solving the Schrödinger-Poisson equation. Hence, 6-dimensional phase-space information can be encoded in two functions on 3-dimensional position space that consistently generate cumulants at all orders. This provides a starting point for constructing approximate closure schemes that are consistent with the nonlinear dynamics.

MP 6: Nonperturbative QFT and Strong Fields

Zeit: Mittwoch 14:00–15:50 Raum: Z6 - SR 1.012

MP 6.1 Mi 14:00 Z6 - SR 1.012

Hamiltonian lattice gauge theory and Weyl quantization — •Alexander Stottmeister — Dipartimento di Matematica, Università degli Studi di Roma "Tor Vergata", Via della Ricerca Scientifica 1, 00133 Roma, Italia

Weyl quantization and an adapted pseudo-differential calculus may serve as powerful tool to discuss the semi-classical limit of quantum systems. We will present results regarding the construction of a Weyl quantization for Hamiltonian gauge theories defined on directed systems of (finite) graphs. Moreover, we will approach the problem of defining associated symbol spaces and their pseudo-differential calculus. Finally, we dicuss the construction of states and methods to control the type of the resulting observable algebras.

MP 6.2 Mi 14:20 Z6 - SR 1.012

Dualization of Four-Fermion Theories — •Julian Lenz, Björn Wellegehausen, and Andreas Wipf — Theoretisch-physikalisches Institut, FSU Jena, Germany

Four-fermion theories arise as effective theories in solid state physics (e.g. graphene, superconductors) and serve as a toy model for chiral symmetry breaking. They are perturbatively non-renormalizable and strongly coupled, such that non-pertubative methods are required to investigate their properties. Our method of choice are lattice simulations, which for these theories suffer from a fermion sign problem, making standard Monte-Carlo methods inefficient. In the talk we present a dualization of Gross-Neveu- and Thirring-like theories to tackle the sign problem and develop efficient algorithms for lattice simulations.

MP 6.3 Mi 14:40 Z6 - SR 1.012

A curvature bound from gravitational catalysis — •Riccardo Martini and Holger Gies — TPI, FSU Jena

Gravitational catalysis expresses an interplay between the curvature of the spacetime and fluctuation-induced mass generation of quantum matter. I will show how a scale-dependent analysis of this phenomenon on local AdS backgrounds allow us to identify bounds on the curvature of local patches of spacetime, based on the requirement of long-range chiral symmetry. The bound will be expressed in terms of the ratio between the local scalar curvature and the gauge-invariant coarse-graining scale, pointing out a dependence of the result on the relevant modes of the observed physics. I will also show some extensions of this result to higher-dimensional spacetimes.

10 min. break

MP 6.4 Mi 15:10 Z6 - SR 1.012

Nonperturbative QFT and the unstable quantum vacuum — •Ibrahim Akal[1] and Gudrid Moortgat-Pick[2] — [1]DESY, Hamburg, Germany — [2]University of Hamburg, Hamburg, Germany

In this talk, we will discuss vacuum instability in the presence of strong background gauge fields. More precisely, we will focus on certain nonperturbative techniques in QFT which are particularly advantageous in dealing with highly inhomogeneous backgrounds. Some explicit examples will be presented.

MP 6.5 Mi 15:30 Z6 - SR 1.012

Solving the Semiclassical Einstein Equation and a Moment Problem — •Daniel Siemssen — Universität Wuppertal, Wuppertal, Deutschland

I will present a novel approach towards solving the semiclassical Einstein equation in cosmological spacetimes. Different from previous approaches, this approach allows for arbitrary curvature coupling and full renormalization freedom. The method consists of two parts: 1) an infinite dimensional dynamical system, and 2) a moment problem.

MP 7: Quantum Field Theory II

Zeit: Mittwoch 16:30–17:55 Raum: Z6 - SR 1.012

Hauptvortrag MP 7.1 Mi 16:30 Z6 - SR 1.012

Complexity of states in quantum field theory — •Michal P. Heller — MPI for Gravitational Physics (Albert Einstein Institute), Potsdam, Germany

One of the most interesting developments in holography is an apparent link between the notion of complexity of states, the measure of how hard it is to obtain a given state from a chosen reference state using a restricted set of allowed operations, and emergent spacetime geometry. In this talk I will present recent attempts to define complexity of states in quantum field theory and discuss their connection with holographic results, as well as with the field of tensor networks.

MP 7.2 Mi 17:15 Z6 - SR 1.012

Fermionic tensor networks: A functorial approach — •Pascal Fries — Fakultät für Physik und Astronomie, Julius-Maximilians-Universität Würzburg, Am Hubland, 97074 Würzburg, Germany

I give an overview on how fermionic tensor networks can be understood in terms of symmetric monoidal categories. In this setting, the meaning of second quantization as a *functor of diagrams* is made precise.

The results can be used to derive quantum circuits from arbitrary spectral decompositions and thus provide a systematic Ansatz for obtaining new analytic classes of tensor networks.

MP 7.3 Mi 17:35 Z6 - SR 1.012

Holography and criticality in matchgate tensor networks — •Alexander Jahn, Marek Gluza, Fernando Pastawski, and Jens Eisert — Dahlem Center for Complex Quantum Systems, Freie Universität Berlin, 14195 Berlin, Germany

The AdS/CFT correspondence conjectures a holographic duality between gravity in a bulk space and a critical quantum field theory on its boundary. Tensor networks have come to provide toy models to understand such bulk-boundary correspondences, shedding light on connections between geometry and entanglement. We introduce a versatile and efficient framework for studying tensor networks, extending previous tools for Gaussian matchgate tensors in 1+1 dimensions. Using

regular bulk tilings, we show that the critical Ising theory can be realized on the boundary of both flat and hyperbolic bulk lattices. Within our framework, we also produce translation-invariant critical states by an efficiently contractible network dual to the multi-scale entanglement renormalization ansatz. Furthermore, we explore the correlation structure of states emerging in holographic quantum error correction. We hope that our work will stimulate a comprehensive study of tensor-network models capturing bulk-boundary correspondences.

MP 8: Field Theory

Zeit: Mittwoch 18:10–19:10 Raum: Z6 - SR 1.012

MP 8.1 Mi 18:10 Z6 - SR 1.012

Multi-soliton theory of matter in 1+1+2 dimensions — •Ingo Steinbach and Julia Kundin — Ruhr-Universiy Bochum, ICAMS

Soliton solutions of non-linear wave equations have been intensively studied as candidates to formulate elementary particles in a monistic, field-theoretical framework. The presentation reviews shortly the main theoretical background of soliton solutions. An explicit solution of a chain of elementary particles in 1+1 dimensions is constructed [I. Steinbach, arXiv:1703.05583v2, 2017]. Along the concept of 'interface fields' [I. Steinbach, F. Pezzolla, Physica D, 385-393, 1999], these solutions will be generalized to a 'multi-soliton network' in 1+1+2 dimensions. Based on similarities between the energy functionals in the soliton theory and the theory of superconductivity an extension to charged particles in electro-magnetic fields will be discussed.

MP 8.2 Mi 18:30 Z6 - SR 1.012

Conditions for Regular Black Holes — Piero Nicolini[1,2] and •Michael Florian Wondrak[1,2] — [1]Frankfurt Institute for Advanced Studies (FIAS), Frankfurt am Main, Germany — [2]Institut für Theoretische Physik, Johann Wolfgang Goethe-Universität Frankfurt am Main, Frankfurt am Main, Germany

Black hole spacetimes typically exhibit a curvature singularity in the central region. The corresponding divergence in the energy density indicates that general relativity provides no appropriate description in such regions.

Several black hole models inspired by quantum gravity introduce a minimal length. They turn out to avoid singularities and to be regular instead. In this talk we study conditions to be imposed on the energy-momentum tensor in order to ensure regular black hole spacetimes.

MP 8.3 Mi 18:50 Z6 - SR 1.012

From spacetime symmetries to "good tetrads" in teleparallel gravity — •Manuel Hohmann — Universität Tartu, Tartu, Estland

General teleparallel theories of gravity, which have originally been formulated in terms of a tetrad only, can be formulated covariantly with respect to local Lorentz transformations by introducing a flat spin connection as an additional gauge degree of freedom. The corresponding field equations are similar for a wide range of theories and can be solved either by a suitable spin connection, or in the Weitzenböck gauge of vanishing spin connection by a suitable ("good") tetrad. We discuss the geometric meaning of this condition, and show how spacetime symmetries can aid in solving the connection field equations. A number of example solutions will be provided.

MP 9: Holography and Quantum Gravity

Zeit: Donnerstag 11:00–12:05 Raum: Z6 - SR 1.012

Hauptvortrag MP 9.1 Do 11:00 Z6 - SR 1.012

Holographic aspects of loop quantum gravity — •Norbert Bodendorfer — Universität Regensburg

We outline current research programs which aim to connect loop quantum gravity with holographic ideas.

MP 9.2 Do 11:45 Z6 - SR 1.012

Constraints on Non-Commutative Spacetime using CMB Data in Coherent State approach — •Dipanshu Gupta[1,2] and Piero Nicolini[1,2] — [1]Frankfurt Institute for Advanced Studies (FIAS) Ruth-Moufang-Str. 1, D-60438 Frankfurt am Main, Germany — [2]Institut für Theoretische Physik, Goethe-Universität Frankfurt am Main Max-von-Laue-Str. 1, D-60438 Frankfurt am Main, Germany

From the seminal work of Witten and Seiberg, it has been shown that non commutativity is inherent in String Theory and a good low energy approximation in the form of non commutative fields. We try to constrain the length scale of non commutativity of spacetime using a new power spectrum of CMB Anisotropy derived using the Coherent State approach to noncommutativity instead of Star-Product approach in widespread literature. This formalism has many advantages, one of which is the preservation of Lorentz Invariance. We compute this new power spectrum and compare it with available data from CMB Experiments to put a new bound on the noncommutative parameter.

MP 10: Quantum Systems, Symmetries and Scattering

Zeit: Donnerstag 14:00–15:40 Raum: Z6 - SR 1.012

MP 10.1 Do 14:00 Z6 - SR 1.012

Derivation of Quantum Hamilton Equations of Motion — •Jeanette Köppe[1], Markus Patzold[1], Michael Beyer[1], Wilfried Grecksch[2], and Wolfgang Paul[1] — [1]Institut für Physik, MLU Halle-Wittenberg, Germany — [2]Institut für Mathematik, MLU Halle-Wittenberg, Germany

Non-relativistic quantum systems are analyzed theoretically or by numerical approaches using the Schrödinger equation. Compared to the options available to treat classical mechanical systems this is limited, both in methods and in scope. However, based on Nelson's stochastic mechanics, the mathematical structure of quantum mechanics has in some aspects been developed into a form analogous to classical analytical mechanics.

We show that finding the Nash equilibrium for a stochastic optimal control problem, which is the quantum equivalent to Hamilton's principle of least action, allows to derive two aspects: i) the Schrödinger equation as the Hamilton-Jacobi-Bellman equation of this optimal control problem and ii) a set of quantum dynamical equations which are the generalization of Hamilton's equations of motion to the quantum world. We derive their general form for the n-dimensional, non-stationary and the stationary case. The resulting quantum Hamilton equations of motion can be solved (numerically) without knowledge on the wave function and are analyzed for many different systems, e.g. one-dimensional double-well potential or hydrogen atom.

MP 10.2 Do 14:20 Z6 - SR 1.012

Analytic approximation for eigenvalues of a class of $\mathcal{PT}$-symmetric Hamiltonians — •Oleg D Skoromnik[1] and Ilya D Feranchuk[2,3,4] — [1]Max Planck Institute for Nuclear Physics, Saupfercheckweg 1, D-69117 Heidelberg, Germany — [2]Atomic Molecular and Optical Physics Research Group, Ton Duc Thang University, 19 Nguyen Huu Tho Street, Tan Phong Ward, District 7, Ho Chi Minh City, Vietnam — [3]Faculty of Applied Sciences, Ton Duc Thang University, 19 Nguyen Huu Tho Street, Tan Phong Ward, District 7, Ho

Chi Minh City, Vietnam — [4]Belarusian State University, 4 Nezavisimosty Avenue, 220030, Minsk, Belarus

An analytical approximation for the eigenvalues of $\mathcal{PT}$ -symmetric Hamiltonian $\mathsf{H} = -d^2/dx^2 - (\mathrm{i}x)^{\epsilon+2}$, $\epsilon > -1$ is developed via simple basis sets of harmonic-oscillator wave functions with variable frequencies and equilibrium positions. We demonstrate that our approximation provides high accuracy for any given energy level for all values of the parameter $\epsilon > -1$. [1] Phys. Rev. A 96, 052102 (2017)

MP 10.3 Do 14:40 Z6 - SR 1.012

Quantum Systems Theory Viewed from Lie Semigroups — •Thomas Schulte-Herbrüggen[1], Robert Zeier[1], and Gunther Dirr[2] — [1]TU-München, Lichtenbergstraße 4, 85747 Garching — [2]Uni-Würzburg, Math. Inst., Emil-Fischer-Straße 40, 97074 Würzburg

The solutions to the celebrated Kossakowski-Lindblad equation extended by coherent controls yield Markovian quantum maps. More precisely, the set of all its solutions forms a semigroup of CPTP maps taking the specific form of a *Lie semigroup* [1].

Non-trivial symmetries of these semigroups are shown to preclude accessibility in Markovian dissipative systems. This is the open-system analogue to closed systems, where triviality of (quadratic) symmetries of the Hamiltonian part suffices to decide that the system is fully controllable [2-3].

These findings are placed into a unifying Lie frame of quantum systems and control theory alongside with illustrating examples [4].

[1] *Rep. Math. Phys.* **64** (2009), 93.
[2] *J. Math. Phys.* **52** (2011), 113510 and **56** (2015), 081702.
[3] *Phys. Rev. A* **92** (2015), 042309.
[4] *Open Sys. Inf. Dynamics* **24** (2017), 1750001 [in press].

MP 10.4 Do 15:00 Z6 - SR 1.012

Unitary Dilations of Discrete Quantum-Dynamical Semigroups — •Frederik vom Ende[1] and Gunther Dirr[2] — [1]TU München, Lichtenbergstr. 4 — [2]Universität Würzburg, Emil-Fischer-Str. 40

Quantum channels acting on trace-class operators have a well-known Stinespring dilation originally described in the Schrödinger picture.

Here, we extend this concept to the whole dynamical semigroup induced by a quantum channel yielding a unitary dilation of the semigroup. Via duality of trace-class and bounded operators one immediatly gets a similar result for quantum channels in the Heisenberg picture. Following a similar line of thought, we mathematically structure (a) the solution of discrete quantum dynamical systems and (b) several types of discrete quantum dynamical control systems.

MP 10.5 Do 15:20 Z6 - SR 1.012

Hadronic contributions to μe scattering at NLO — •Matteo Fael — Theoretische Physik 1, Naturwiss. techn. Fakultät, Universität Siegen, D-57068 Siegen, Germany

Recently, a new experiment, MUonE, has been proposed at CERN to measure the differential cross section of the elastic scattering of high-energy muons on atomic electrons as a function of the spacelike (negative) squared momentum transfer. This measurement will provide the running of the effective electromagnetic coupling in the spacelike region and, as a result, a new and independent determination of the leading hadronic contribution to the muon g-2.

In order for this new determination to be competitive with the present dispersive one, which is obtained via timelike data, the μe differential cross section must be measured with statistical and systematic uncertainties of the order of 10ppm. This high experimental precision demands an analogous accuracy in the theoretical prediction.

In this work we take a step towards the calculation of the full NNLO corrections to μe scattering. In particular, we consider the hadronic contribution arising from virtual hadrons in the loops. Generally speaking, these corrections can be calculated via dispersion relation employing the R-ratio and timelike data for the photon vacuum polarization. However, the experiment MuonE will measure the vacuum polarization in the spacelike region. In this talk I will show how it is possible to evaluate such hadronic corrections employing only spacelike data by means of the Gegenbauer polynomials, without making use of the dispersion relation and timelike data.

MP 11: Relativity and Unification

Zeit: Donnerstag 16:30–18:40 Raum: Z6 - SR 1.012

MP 11.1 Do 16:30 Z6 - SR 1.012

Woher kommt die Trägheit ? — •Christian Ythier[1] und Daniel Cvikevic[2] — [1]Universite de Nice, 06108 Nice cedex 2, France — [2]Bismarckstr. 73, Stuttgart 70197, Deutschland

Newtons Versuch mit dem Eimer zeigt wie sehr er sich nach einer Erklärung der Zentrifugalkraft gesehnt hat. Der Gegenstand in Rotation war Wasser; jeder Teil dieses Milieus, selbst der kleinste, hat die Eigenschaft der Zentripetalkraft zu widerstehen; so, die Ursache der Trägheit kann in den Elementarteilchen liegen. Elektronen und Quarks haben eine Ruhemasse; aber kann diese durch Einsteins Beziehung, die eine Frequenz enthält, dargestellt werden? denn, wie kann ein Elektron, in Ruhe, trotzdem schwingen oder rotieren ? Nach Zisman, oder Feynman, dürften Elektronen sich längs der Zeitachse bewegen. Aber warum dürften sie nicht in der Zeit, senkrecht zum 3D-Raum,rotieren, und dadurch ständig einer Zentripetalkraft unterliegen ? Es könnte die Ursache ihrer Trägheit sein ! Dasselbe dürfte für jedes der drei Quarks eines Protons oder Neutrons gelten, da sie auch eine Rotationsfrequenz ω besitzen können. Wir schlagen also vor, dass jede Materie, weil sie aus Elektronen und Quarks besteht, Zentripetalkräften unterliegt, und so Trägheit und Masse erhält. Und wir zeigen einige Anwendungen von dieser Idee.

MP 11.2 Do 16:50 Z6 - SR 1.012

Ist die Lichtgeschwindigkeit eine nicht-klassische Konstante? — •Helmut Hansen — Obere Scharr 5, 23896 Panten

Die Lichtgeschwindigkeit gilt als fundamentale Konstante. Obwohl sie ihren Ursprung der Wellentheorie des Lichts verdankt, ist ein möglicher Bezug zum Welle-Teilchen-Dualismus nie eingehender in Betracht gezogen worden.

Mittlerweile wissen wir, dass zum Verständnis der Natur des Lichtes weder Wellen- noch Teilchenbild, für sich genommen, ausreichen, um seinem Wesen gerecht zu werden. Diese duale Charakteristik des Lichtes wird daher - entsprechend der Quantentheorie - als eine ihrer fundamentalen Eigenschaften aufgefasst.

Angesichts dieser Auffassung erscheint es als eine natürliche Annahme, dass nicht nur das Licht selbst, sondern auch die Lichtgeschwindigkeit dualer Natur sein sollte. Das bedeutet, die Lichtgeschwindigkeit c sollte nicht nur in einer wellenartigen Form vorkommen, sondern auch in einer teilchenartigen. Eben diese Annahme bezeichne ich als das *Prinzip der Dualen Konstanz der Lichtgeschwindigkeit*.

Um dieses Prinzip physikalisch fruchtbar machen können, sieht man sich indessen mit einem –logischen– Widerspruch konfrontiert: Es zeigt sich nämlich, dass die Lichtgeschwindigkeit im Falle ihrer dualen Konstanz sowohl von der Geschwindigkeit der Lichtquelle abhängig (k = 1) als auch nicht-abhängig (k = 0) ist.

In dem Vortrag soll geschildert werden, wie dieser logische Widerspruch, mit Hilfe einer multivalenten Logik lösbar ist.

MP 11.3 Do 17:10 Z6 - SR 1.012

From strand model unification to the fine structure constant — •Christoph Schiller — München

The strand model of black holes, vacuum and particles predicts black hole entropy, the field equations of general relativity and the Dirac equation. Modelling particles as rational (unknotted) tangles of strands leads to the observed elementary particle spectrum. Modelling interactions as tangle deformations, and using the three Reidemeister moves of knot theory, yields the electromagnetic, the weak and the strong interaction, with all features. Strands suggest the lack of physics beyond the standard model. Strands also suggest how to calculate the fundamental constants of elementary particle physics, and in particular, the fine structure constant. An approximation is presented.

The page www.motionmountain.net/research.html provides details.

10 min. break

MP 11.4 Do 17:40 Z6 - SR 1.012

The Exceptional E-8 Symmetry Group and their applications. — •Norbert Sadler — Sadler Norbert ; Wasserburger Str. 25a, 85540 Haar

The Exceptional E-8 Symmetry Group is the real, dimensions-less representation of all possible symmetry operations in the universee.

Through the application of the E-8 Group on complex physical and biological systems totally new approaches and new findings in the cosmology, the statistical physics, the gravitation as well in the biological physics can be achieved.

Further informatios: www.cosmology-harmonices-mundi.com

MP 11.5 Do 18:00 Z6 - SR 1.012

Materie und Kosmos - Vorschläge zur Einheit der Physik — •Helmut Hille — Fritz-Haber-Straße 34, 74081 Heilbronn

Der Name der 2018 in Würzburg tagenden Sektion Materie und Kosmos weist bereits auf das Problem heutiger Physik hin. Teilchentheorie, Relativitätstheorie und Quantenphysik stehen zumeist unverbunden nebeneinander. Das muss nicht sein. Sobald man einsieht, dass die Gravitation ein durch den Big Bang verursachtes Verschränkungsphänomen ist, gibt es nicht nur kein Problem zwischen der Gravitation, den Teilchen und dem Kosmos, ganz im Gegenteil: erst die Quantenphysik macht uns die Gravitation und den Kosmos verständlich. So kann die Einheit der Physik wieder hergestellt werden. Freilich, ohne den Mut, den Denkhorizont zu erweitern, kann dies nicht gelingen. Auch Intentionen Einsteins werden dadurch besser verständlich. Den Weg zu dieser Einheit aufzuzeigen ist mein zentrales Anliegen auf dieser Tagung.

MP 11.6 Do 18:20 Z6 - SR 1.012

Emission & Regeneration UFT. — •Osvaldo Domann — Stephanstr. 42, D- 85077 Manching

The SM defines for each force a different field resulting the electric, magnetic, weak, strong and gravitation fields. A theory is presented based on a space-like representation of Subatomic Particles (SPs) as Focal Points of rays of Fundamental Particles (FPs) that extend over the whole space. The FPs store the energy of the SPs as rotations defining angular momenta, allowing the description of the interactions between SPs as the interactions between the angular momenta of their FPs. All SPs interact permanently so that the local physical laws are determined by the large-scale structure of the universe according to Ernst March's principle. The main finding of the approach is that many concepts introduced by the SM like gluons, gravitons, dark mater, dark energy, expansion of the universe, equivalence principle, etc. are the product of the incorrect representation of SPs. The approach derives all four known forces as electromagnetic interactions validating QED and disproving QCD and Gauge/Gravitation Duality. Another important finding is the interaction of light with the measuring instruments, which together with the emission of light with speed 'c' relative to its source and absolute time and space, leads to Galilean relativity multiplied with the gamma factor. No unphysical concepts like time dilation and length contraction are required. More at www.odomann.com

MP 12: Posters (Montag - Donnerstag)

Zeit: Montag 12:00–12:00 Raum: Z6 - SR 1.012

MP 12.1 Mo 12:00 Z6 - SR 1.012

- Tri-Graphs - The fundament to compute the physical constants — •Takizaki Zen — Synspike Lab GmbH Schmickstraße 18, 60314 Frankfurt

Tri-Graphs describe by binary Graphs with the in mum nodes equal three and the logical operations Boolean and, no and xor a way to calculate the physical constants in unitary units. What is the definition of it?

MP 12.2 Mo 12:00 Z6 - SR 1.012

Emission & Regeneration UFT. — •Osvaldo Domann — Stephanstr. 42, D- 85077 Manching

The SM defines for each force a different field resulting the electric, magnetic, weak, strong and gravitation fields. A theory is presented based on a space-like representation of Subatomic Particles (SPs) as Focal Points of rays of Fundamental Particles (FPs) that extend over the whole space. The FPs store the energy of the SPs as rotations defining angular momenta, allowing the description of the interactions between SPs as the interactions between the angular momenta of their FPs. All SPs interact permanently so that the local physical laws are determined by the large-scale structure of the universe according to Ernst March's principle. The main finding of the approach is that many concepts introduced by the SM like gluons, gravitons, dark mater, dark energy, expansion of the universe, equivalence principle, etc. are the product of the incorrect representation of SPs. The approach derives all four known forces as electromagnetic interactions validating QED and disproving QCD and Gauge/Gravitation Duality. Another important finding is the interaction of light with the measuring instruments, which together with the emission of light with speed 'c' relative to its source and absolute time and space, leads to Galilean relativity multiplied with the gamma factor. No unphysical concepts like time dilation and length contraction are required. More at www.odomann.com

MP 12.3 Mo 12:00 Z6 - SR 1.012

Rotating Isospectral Drums - on the intricate relationship of constitutive equations and boundary conditions — •Anton Lebedev — Institut für Theoretische Physik, Tübingen, Deutschland

The majority of laws in physics is formally expressed in the form of (partial) differential equations (PDEs). Each differential equation remains incomplete without initial or boundary conditions.

Using Maxwell's equations and rotating planar domains I endeavour to highlight the intimate relationship between PDEs and boundary conditions. The necessity of the general covariant formulation of the laws of electrodynamics when dealing with accelerated motion will be highlighted. This will be used to derive of a Coriolis-Zeeman addendum to the wave equation for rotating ring resonators. All of the above will be done using the examples of isospectral domains and planar ring resonator models. Furthermore the use of the Coriolis-Zeeman term for a geometric classification of planar domains will be discussed.