Theoretical and Mathematical Physics Division
Fachverband Theoretische und Mathematische Grundlagen der Physik (MP)

Karl-Henning Rehren
Institut für Theoretische Physik
Friedrich-Hund-Platz 1, 37077 Göttingen
rehren@theorie.physik.uni-goettingen.de

Overview of Invited Talks and Sessions

(Lecture room: HFT-FT 101 and H 2013; Posters in the foyer of HFT, 1st floor)

Invited Talks

MP 3.1	Tue	12:00–12:40	HFT-FT 101	**Quantum information measures for quantum fields** — •Tobias Osborne
MP 8.1	Wed	11:00–11:40	HFT-FT 101	**Semigroup of gauge fields from noncommutative geometry** — •Walter van Suijlekom
MP 10.1	Wed	15:00–15:40	HFT-FT 101	**Functional renormalization group for the scale-dependent effective action** — •Andreas Wipf
MP 15.1	Thu	10:35–11:15	HFT-FT 101	**Applications of local gauge covariance: Anomalies and QED in external potentials** — •Jochen Zahn

Invited talks of the joint symposium "Geometric Paradigms in Modern Physics" (SYGP)

Location: AudiMax H0105, see SYGP for the full program of the symposium.

SYGP 1.1	Thu	15:00–15:30	H 0105	**General relativity: a theory born in creative confusion** — •Harvey Brown
SYGP 1.2	Thu	15:30–16:00	H 0105	**Gravitating Non-Abelian Fields: Solitons and Black Holes** — •Jutta Kunz
SYGP 1.3	Thu	16:00–16:30	H 0105	**Geometric principles in the physics of topological matter** — •Alexander Altland
SYGP 1.4	Thu	16:30–17:00	H 0105	**General Covariance in Quantum Field Theory on Curved Spacetimes** — •Thomas-Paul Hack
SYGP 1.5	Thu	17:00–17:30	H 0105	**The (noncommutative) Geometry of the Standard Model of Particle Physics** — •Christoph Stephan

Sessions

MP 1.1–1.4	Tue	9:30–10:50	HFT-FT 101	**Statistische Mechanik**
MP 2.1–2.3	Tue	10:55–11:55	HFT-FT 101	**Quanteninformation**
MP 3.1–3.1	Tue	12:00–12:40	HFT-FT 101	**HV Osborne**
MP 4.1–4.3	Tue	9:30–11:30	H 2013	**HV Gravitation (gemeinsam mit GR)**
MP 5.1–5.2	Tue	15:00–15:30	HFT-FT 101	**Alternative Theorien**
MP 6.1–6.3	Wed	9:30–10:30	HFT-FT 101	**Quantenfeldtheorie I**
MP 7.1–7.1	Wed	10:35–10:55	HFT-FT 101	**Integrable Strukturen**
MP 8.1–8.1	Wed	11:00–11:40	HFT-FT 101	**HV van Suijlekom**
MP 9.1–9.3	Wed	11:45–12:45	HFT-FT 101	**Quantenmechanik I**
MP 10.1–10.1	Wed	15:00–15:40	HFT-FT 101	**HV Wipf**
MP 11.1–11.3	Wed	15:45–16:45	HFT-FT 101	**Quantenfeldtheorie II**
MP 12.1–12.2	Wed	16:50–17:30	HFT-FT 101	**Quantenmechanik II**
MP 13.1–13.1	Wed	17:35–17:55	HFT-FT 101	**Klassische Feldtheorie**
MP 14.1–14.2	Thu	9:30–10:30	HFT-FT 101	**Mathematische und Philosophische Grundlagen (gemeinsam mit AG Phil)**
MP 15.1–15.1	Thu	10:35–11:15	HFT-FT 101	**HV Zahn**
MP 16.1–16.3	Thu	11:20–12:20	HFT-FT 101	**Gravitation**

MP 17.1–17.6 Tue 9:30–18:00 HFT-FT 101 **Poster (permanent Di-Do)**

Mitgliederversammlung des FV Theoretische und Mathematische Grundlagen der Physik

Mittwoch 18.3.2015 18:00–19:00 HFT-FT 101

- Bericht
- Wahl des Leiters und des Beirats
- Dissertationspreis
- Tagungen
- Verschiedenes

MP 1: Statistische Mechanik

Time: Tuesday 9:30–10:50 Location: HFT-FT 101

MP 1.1 Tue 9:30 HFT-FT 101

Condensate-induced transitions and critical spin chains: Exactly solvable spin-1/2 chains with $so(N)_1$ critical points — •Ville Lahtinen[1,2], Teresia Månsson[3], and Eddy Ardonne[4] — [1]FU Berlin, Arnimallee 14, 14195 Berlin, Germany — [2]Institute for Theoretical Physics, University of Amsterdam, Science Park 904, 1090 GL Amsterdam, The Netherlands — [3]Department of Theoretical Physics, School of Engineering Sciences, Royal Institute of Technology (KTH), Roslagstullsbacken 21, SE-106 91 Stockholm, Sweden — [4]Department of Physics, Stockholm University, AlbaNova University Center, SE-106 91 Stockholm, Sweden

We construct a hierarchy of exactly solvable spin-1/2 chains with $so(N)_1$ critical points. Our construction is motivated by the framework of condensate-induced transitions between topological phases. We employ this framework to construct a Hamiltonian term that couples N transverse field Ising chains such that the resulting theory is critical and described by the $so(N)_1$ conformal field theory. By employing spin duality transformations, we then cast these spin chains for arbitrary N into translationally invariant forms that all allow exact solution by the means of a Jordan-Wigner transformation. These models generalize 1D cluster models and show how the exotic $so(N)_1$ criticality can emerge by suitably perturbing symmetry protected topological order.

MP 1.2 Tue 9:50 HFT-FT 101

Many-body localization and quasi-local integrals of motion — •Giuseppe de Tomasi, Frank Pollmann, and Jens Bardarson — Max-Planck-Institut für Physik komplexer Systeme, Dresden

Anderson localization of single particle states in the presence of a random potential is a well understood result in theoretical condensed matter theory. Many-body localization (MBL) occurs when the localization remains in the presence of interactions. A defining property of MBL is the breakdown of the "eigenstate thermalization hypothesis" (ETH) and thus the impossibility to thermalize. Moreover it has been conjectured that in the MBL phase an extensive number of quasi-local integrals of motion exists. We will discuss our results on possibilities to numerically obtain these integrals of motion.

MP 1.3 Tue 10:10 HFT-FT 101

Random-matrix theory of phonon density of states in disordered solids — •Rico Milkus and Alessio Zaccone — Physics Department, Technische Universität München

The dynamical (Hessian) matrix of solids provides access to the thermal properties of materials, and to the vibrational phonon spectrum (density of states). In ordered crystalline lattices, the lattice periodicity allows for analytical diagonalization in reciprocal space owing to the periodicity and translational-rotational invariance of the lattice. With disordered solids, which lack periodicity, diagonalization can be done only numerically, in real space. We present a new numerical protocol to study the eigenmodes and phonon spectrum of continuous random networks, a realistic model for many amorphous materials. It is shown that the part of the spectrum controlled by randomness, which gives rise to the non-Debye boson peak in the density of states, cannot be described by analytical mean-field models. Yet analytical scaling laws can be extracted, and an analytic representation of the phonon spectrum can be obtained using random matrix theoretical tools. Our results clearly indicate that the origin of the non-Debye boson-peak anomaly in the spectrum is due to the interplay between phonon scattering by the randomness and non-affine elastic response related to connectivity of the network.

MP 1.4 Tue 10:30 HFT-FT 101

The geometrisation of thermodynamics via contact geometry — •Christine Gruber[1], Alessandro Bravetti[2], and Hernando Quevedo[2] — [1]Institut für Physik, Carl-v.-Ossietzky-Universität, Oldenburg, Deutschland — [2]Instituto de Ciencias Nucleares, Universidad Nacional Autonoma di Mexico, Mexico D.F., Mexico

We aim at developing a geometrical formulation of thermodynamics by employing contact geometry and associated notions. A geometric formulation of thermodynamics is of interest for several reasons. Firstly, geometry serves as a language in which every physical theory can be formulated, it provides geometric tools and notions which can be employed to infer new principles and ideas, and in general promotes mathematical beauty in physics. Secondly, a geometrisation of thermodynamical theories would help to systemize and unify the phenomenologically orientated formulations and derivations of thermodynamical phenomena and potentially be of great use in the description of non-equilibrium scenarios. And finally, due to the fundamental connection of the laws of black hole thermodynamics with their geometry, there is the hope that a geometric theory of thermodynamics could lead to new insights into black hole thermodynamics and the physical laws governing the physics of black holes.

In this talk, we will focus on the possible application of contact geometry and its geometric flows in non-equilibrium thermodynamics.

MP 2: Quanteninformation

Time: Tuesday 10:55–11:55 Location: HFT-FT 101

MP 2.1 Tue 10:55 HFT-FT 101

From discrete to continuous: finite dimensional approximations of continuous variables — •Michael Keyl — TU München, Fakultät Mathematik

Small fluctuations of a finite ensemble of qubits behave in the infinite particle limit like a continuous quantum system. This behavior is usually studied in terms of expectation values: Expectation values of certain fluctuation operators Q_N, P_N of a finite system converge for $N \to \infty$ against corresponding expectation values of canonical position and momentum Q and P. In this talk we will show that the finite dimensional quantities are related to the continuous variables in a much stronger sense, namely that the spectral measures of Q_N and P_N converge weakly against the spectral measures of Q, P. To derive this result we use the recently studied Schwartz operators, i.e. trace class operators which stay in the trace class after products with arbitrary polynomials in P and Q. They are a perfect framework for the discussion of operator moment problems, and provide in addition powerful methods to study quadratic forms in terms of distributions.

MP 2.2 Tue 11:15 HFT-FT 101

Tensor square representations of Lie algebras and quantum control theory — •Zoltán Zimborás[1], Robert Zeier[2], Thomas Schulte-Herbrüggen[2], and Daniel Burgarth[3] — [1]University College London, UK — [2]Technische Universität München, Germany — [3]Aberystwyth University, UK

We study how tensor products of representations decompose when restricted from a compact Lie algebra to one of its subalgebras. In particular, we are interested in tensor squares which are tensor products of a representation with itself. We show in a classification-free manner that the sum of multiplicites and the sum of squares of multiplicities in the corresponding decomposition of a tensor square into irreducible representations has to strictly grow when restricted from a compact semisimple Lie algebra to a proper subalgebra. The sum of squares of multiplicities is equal to the dimension of the commutant of all complex matrices commuting with the tensor square representation. Hence, our results offer a test whether a subalgebra of a compact semisimple Lie algebra is a proper one, which uses only linear-algebra computations on sets of generators without calculating the relevant Lie closures. At the end of the talk, we show that this test can be naturally applied in the control theory of quantum systems.

MP 2.3 Tue 11:35 HFT-FT 101

Fixpoint engineering and reachability in open Markovian quantum systems — •Thomas Schulte-Herbrüggen[1], Corey O'Meara[1], Gunther Dirr[2], and Luca Arceci[1,3] — [1]Dept. Chem., TU-München — [2]Math. Inst., University of Würzburg — [3]Dept.

Mathematics, TU-München

Lie groups and Lie semigroups with their symmetries provide a unified framework to pinpoint the dynamic behaviour of closed and open quantum systems under all kinds of controls.

Recently, we showed that all *Markovian quantum maps* can be represented by *Lie semigroups*. These semigroups come with the geometry of affine maps, whose translational parts determine the respective fixed points. We exploit this geometry for dissipative fixed-point engineering of unique target states. We extend our results from pure to mixed target states.

Finally, we elucidate the findings by their relation to control problems: particular light is shed on reachability and open-loop versus closed-loop control design.

MP 3: HV Osborne

Time: Tuesday 12:00–12:40 Location: HFT-FT 101

Invited Talk MP 3.1 Tue 12:00 HFT-FT 101

Quantum information measures for quantum fields — •Tobias Osborne — Institut für Theoretische Physik, Leibniz Universität Hannover, Hannover, Germany

I discuss how to endow the set of (cutoff) quantum field states with an operationally motivated information geometry using quantum information distance measures. This is done by recognising that all measurements are inherently imperfect so that microscopic details are effectively indistinguishable experimentally. A procedure to identify the corresponding induced equivalence classes of microscopic states will be described. These equivalence classes may be modelled with a simpler effective Hilbert space. Connections to the AdS/CFT correspondence will be sketched and I will explain how the resulting structure allows one to quantify information loss along RG trajectories.

MP 4: HV Gravitation (gemeinsam mit GR)

Time: Tuesday 9:30–11:30 Location: H 2013

Invited Talk MP 4.1 Tue 9:30 H 2013

Characteristic Cauchy problems in general relativity — •Piotr Chrusciel — Gravitational Physics, University of Vienna

I will discuss various aspects of the general relativistic Cauchy problem on light-cones, including the case where the vertex of the light-cone is located at past timelike infinity.

Invited Talk MP 4.2 Tue 10:10 H 2013

Mass and center of mass of asymptotically flat spaces — •Gerhard Huisken — Fachbereich Mathematik, Universität Tübingen, Auf der Morgenstelle 10, 72076 Tübingen

The lecture describes geometric constructions for the mass and the center of mass of isolated systems on asymptotically flat 3-manfifolds. In particular, recent existence and uniqueness results for radial foliations satisfying conditions on the mean curvature of their leaves are presented and discussed in relation to thier physical interpretation.

Invited Talk MP 4.3 Tue 10:50 H 2013

Loop quantum gravity – an unusual QFT — •Hanno Sahlmann — Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU)

I give a short introduction to loop quantum gravity, emphasizing the similarities and differences to other quantum field theories. Then I will highlight some recent developments regarding the dynamics of the theory and the description of black holes.

MP 5: Alternative Theorien

Time: Tuesday 15:00–15:30 Location: HFT-FT 101

MP 5.1 Tue 15:00 HFT-FT 101

Quantum Gravity and Its GUT Extension Explaining Neutrino Parities, the Particle Spectrum and the Detailed Slopes of Resonancess — •Claus Birkholz — Seydelstr. 7, D-10117 Berlin

Parity is a function of generators of a U(2,2), the covering group of fully quantized General Relativity in bent space-time.

A review of the hydrogen atom demonstrates how a non-valence part is generated by orbital excitations carrying parity. Asymptotically, for great accelerations, the non-valence term will converge to a 50:50 mixture of both parities - thus explaining the "maximal parity violation" by neutrinos.

The "Standard" Model denies the existence of a non-valence part. Hence, it defines parity exclusively by valence parts. As, by irreducibility, both parts are inseparable, the SM is inconsistent.

Its ban on hadrons to consist of more than 3 quarks is giving rise to additional inconsistencies preventing us from understanding the existence of 1) nuclei, 2) hadronic flavours.

In the GUT, there are exactly 64 stable states. They are expected to explain the entire particle spectrum of all resonances and nuclei by Clebsch-Gordon technique.

For more information on QG and GUT see www.q-grav.com.

MP 5.2 Tue 15:15 HFT-FT 101

"Emission & Regeneration" Field Theory — •Osvaldo Domann — Stephanstr. 42, D- 85077 Manching

The methodology of today's theoretical physics consists in introducing first all known forces by separate definitions independent of their origin, arriving then to quantum mechanics after postulating the particle's wave, and is then followed by attempts to infer interactions of particles and fields postulating the invariance of the wave equation under gauge transformations, allowing the addition of minimal substitutions.

The origin of the limitations of our standard theoretical model is the assumption that the energy of a particle is concentrated at a small volume in space. The limitations are bridged by introducing artificial objects and constructions like particle's wave, quarks, gluons, strong and weak forces, gravitons, dark matter, dark energy, big bang, etc.

The present approach models subatomic particles such as electrons and positrons as focal points in space where continuously Fundamental Particles (FPs) are emitted and absorbed, FPs where the energy of the electron or positron is stored as rotations defining longitudinal and transversal angular momenta (fields). Interaction laws between angular momenta of FPs are postulated in that way, that the basic laws of physics (Coulomb, Ampere, Maxwell, Gravitation) can be derived. This methodology makes sure, that the approach is in accordance with well proven experimental data. Also explanations for the Beta-decay and the confinement of particles with equal charge signs in atomic nuclei are deduced. All known four forces are derived from one field. www.odomann.com

MP 6: Quantenfeldtheorie I

Time: Wednesday 9:30–10:30 Location: HFT-FT 101

MP 6.1 Wed 9:30 HFT-FT 101

Twisted spectral triple for the standard model — •Pierre Martinetti — Università di Trieste

Because the Higgs mass is below 130 GeV, there is an instability in the electroweak vacuum which might be problematic for the coherence of the standard model of elementary particles. The stability can be restored by assuming there is another scalar field, suitably coupled to the Higgs. Recently, Connes and Chamseddine have noticed that this new field also makes the computation of the Higgs mass in commutative geometry compatible with the experimental mass. More specifically, into the spectral triple of the standard model, the new field is obtained by turning the neutrino Majorana mass into a field. However the usual way to turn a constant into a field (the so-called fluctuation of the metric) does to work in this case, because of one of the condition defining a spectral triple (the first order condition). We show how to overcome this difficulty by twisting the spectral triple, following a procedure proposed in a completely different context by Connes and Moscovici some years ago.

MP 6.2 Wed 9:50 HFT-FT 101

The BV formalism for the BRST quantization of matrix models: a noncommutative geometric approach. — •Roberta A. Iseppi — Radboud University, Nijmegen, The Netherlands

In recent years noncommutative geometry has given proof of being an interesting mathematical framework to describe gauge theories: the strong connection between noncommutative geometry and gauge theories lies in the fact that gauge theories are naturally induced by spectral triples, which are the main technical device in contemporary noncommutative geometry. It is then reasonable to try to insert in the setting of noncommutative geometry also procedures which have been developed for the analysis of gauge theories. One of these is the BV approach to the BRST quantization of non-abelian gauge theories.

We present a method to incorporate this approach in the framework of noncommutative geometry. We restrict to a U(2)-gauge invariant matrix model: through the introduction of a so-called BV-spectral triple we describe the minimally-extended theory, obtained by inserting the minimal number of ghost fields. An interesting aspect of this approach is that it gives a "geometric interpretation" for all the physical properties of the ghost fields such as their bosonic or fermionic character, which have a natural translation in terms of the spectral triple itself.

MP 6.3 Wed 10:10 HFT-FT 101

Hartle-Hawking-Israel states for radiating static black holes — •Ko Sanders — Universität Leipzig, ITP

The discovery of black hole radiation (Hawking, 1975) was soon followed by the conjecture that a free scalar quantum field on a (Schwarzschild) black hole admits a (unique) ground state, which restricts to a thermal state at the Hawking temperature in the exterior region (Hartle and Hawking, 1976; Israel, 1976). This conjecture was later extended to more general static black holes and interacting fields (Jacobson, 1994) and the state is known as the Hartle-Hawking-Israel state (HHI-state). In the cases where such a state exists, it provides a relatively simple and direct link between the geometry of (e.g.) a black hole and the thermal properties of the Hawking radiation.

After a brief review of previous results, we will discuss our recent proof of the existence of such a HHI-state and its main properties in the rather general setting of static spacetimes with a bifurcate Killing horizon (arXiv:1310.5537). The key idea of the proof is simple: the Killing time variable, which defines the Wick rotation, becomes ill-defined near the Killing horizon, so we systematically replace it by a Gaussian normal coordinate. The crucial task is to establish the analogs of analyticity and reflection positivity in this new coordinate. This requires detailed arguments from geometry and analysis.

MP 7: Integrable Strukturen

Time: Wednesday 10:35–10:55 Location: HFT-FT 101

MP 7.1 Wed 10:35 HFT-FT 101

Simplex and polygon equations — •Folkert Müller-Hoissen[1] and Aristophanes Dimakis[2] — [1]Max-Planck-Institut für Dynamik und Selbstorganisation, Göttingen — [2]Department of Financial and Management Engineering, University of the Aegean, 82100 Chios, Greece

Simplex equations extend the (quantum) Yang-Baxter equation to an infinite sequence of equations, where neighboring equations are related by a kind of integrability condition. The underlying structure is encoded in the higher Bruhat orders, originally introduced by Manin and Schechtman in 1986. The latter admit a decomposition into a higher Tamari order, the corresponding dual Tamari order, and a "mixed order". In the same way as the simplex equations correspond to higher Bruhat orders, there is a family of "polygon equations" realizing higher Tamari orders. They extend the well-known pentagon equation to an infinite sequence of equations, which we call polygon equations. The structure of simplex and polygon equations can be visualized in terms of deformations of maximal chains in posets forming 1-skeletons of polyhedra. The decomposition of higher Bruhat orders induces a reduction of the N-simplex equation to the $(N+1)$-gon equation, its dual, and a compatibility equation.

MP 8: HV van Suijlekom

Time: Wednesday 11:00–11:40 Location: HFT-FT 101

Invited Talk MP 8.1 Wed 11:00 HFT-FT 101

Semigroup of gauge fields from noncommutative geometry — •Walter van Suijlekom — Radboud University Nijmegen, Netherlands

Starting with an algebra, we define a semigroup which extends the group of invertible elements in that algebra. As we will explain, this semigroup describes inner perturbations of noncommutative manifolds, and has applications to gauge theories in physics.

We will present some elementary examples of the semigroup associated to matrix algebras, and to (smooth) functions on a manifold. This has applications to the Standard Model of particle physics and beyond.

MP 9: Quantenmechanik I

Time: Wednesday 11:45–12:45 Location: HFT-FT 101

MP 9.1 Wed 11:45 HFT-FT 101

Transfer matrices and excitations with matrix product states — •Valentin Zauner[1], Damian Draxler[1], Laurens Vanderstraeten[2], Matthias Degroote[2], Jutho Haegeman[2], Marek M Rams[3], Vid Stojevic[4], Norbert Schuch[5], and Frank Verstraete[1] — [1]University of Vienna, Vienna, Austria — [2]University of Ghent, Ghent, Belgium — [3]Krakow University of Technology, Krakow, Poland — [4]University College London, London, UK — [5]RWTH Aachen, Aachen, Germany

We investigate the relation between static correlations in the ground state of local many-body Hamiltonians and the low energy dispersion relations using the formalism of tensor network states. We show that the Matrix Product State Transfer Matrix (MPS-TM) – a central object in the computation of static correlation functions – provides important information about the location and magnitude of the minima of the low energy dispersion and present numerical data for one-dimensional lattice and continuum models as well as two-dimensional lattice models. We elaborate on the peculiar structure of the MPS-TM's eigenspectrum and give several arguments for the close relation between the structure of the low energy spectrum of the system and the form of static correlation functions. Finally, we discuss how the MPS-TM connects to the exact Quantum Transfer Matrix. We also present a renormalization group argument which allows to reinterpret variational MPS techniques (such as the Density Matrix Renormalization Group) as an application of Wilson's Numerical Renormalization Group along the virtual (imaginary time) dimension of the system.

MP 9.2 Wed 12:05 HFT-FT 101

Quantum interference in dangling bond loops — •Andrii Kleshchonok, Rafael Gutiérrez, and Gianaurelio Cuniberti — Institute for Materials Science, Dresden University of Technology, Hallwachstr. 3, 01069 Dresden, Germany

Dangling bonds can be produced with atomic precision by selectively removing hydrogen atoms from a Si passivated surface with a scanning tunneling microscope (STM). Dangling bond wires (DBW) and dangling bond loops open fascinating possibilities for becoming the building bocks of novel planar, atomic-scale electronic circuits and logic elements. We perform a realistic study of transport properties of the DBW connected to the carbon nanoribbon leads and quantum interference effects in DBW loops by combining density-functional based approaches with equilibrium and non-equilibrium Green function methods. We develop methodology to study different topologies (half row, full row, zigzag), length of the loops, lead coupling strength and position.

MP 9.3 Wed 12:25 HFT-FT 101

Pseudospin-driven spin relaxation mechanism in graphene. — •Dinh Van Tuan — ICN2 - Institut Catala de Nanociencia i Nanotecnologia, Campus UAB, 08193 Bellaterra (Barcelona), Spain

The extremely small intrinsic spin-orbit coupling (SOC) of graphene and the lack of hyperfine interaction with the most abundant carbon isotope have led to intense research into possible applications of this material in spintronic devices due to the possibility of transporting spin information over very long distances. However, the spin relaxation times are found to be orders of magnitude shorter than initially predicted, while the major physical process for spin equilibration and its dependence on charge density and disorder remain elusive. Experiments have been analyzed in terms of the conventional Elliot-Yafet and Dyakonov-Perel processes, yielding contradictory results. Here, we unravel a spin relaxation mechanism for nonmagnetic samples that follows from an entanglement of spin and pseudospin degrees of freedom driven by random SOC, which makes it unique to graphene and is markedly different to conventional processes. We show that the mixing between spin and pseudospin-related Berry's phases results in unexpectedly fast spin dephasing, even when approaching the ballistic limit, and leads to increasing spin relaxation times away from the Dirac point, as observed experimentally. This hitherto unknown phenomenon points towards revisiting the origin of the low spin relaxation times found in graphene. It also opens new perspectives for spin manipulation using the pseudospin degree of freedom, a tantalizing quest for the emergence of radically new information storage and processing technologies.

MP 10: HV Wipf

Time: Wednesday 15:00–15:40 Location: HFT-FT 101

Invited Talk MP 10.1 Wed 15:00 HFT-FT 101

Functional renormalization group for the scale-dependent effective action — •Andreas Wipf — Friedrich-Schiller-Universität Jena, Theoretische-Physikalisches-Institut, Max-Wien-Platz 1, 07743 Jena

After introducing and discussing the functional renormalizaiton group for the scale dependent effective action we present some recent applications to (supersymmetric) field theories. This include the study of phase transitions, critical behaviour and asymptotic safety scenario in quantum field theories with scalar and spin 1/2 fields.

MP 11: Quantenfeldtheorie II

Time: Wednesday 15:45–16:45 Location: HFT-FT 101

MP 11.1 Wed 15:45 HFT-FT 101

DHR categories and reconstruction of local nets — •Luca Giorgetti — Institut für Theoretische Physik, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

Rational chiral conformal field theories are described by local nets of algebras on the line in the axiomatic language of AQFT. Their representation theory (superselection sectors) can as well be translated into algebra by means of the corresponding category of DHR endomorphisms. These categories all share the structure of abstract braided C* tensor categories and, in this sense, it is known that non isomorphic models can yield equivalent categories. We investigate the problem of making the correspondence 1:1 by adding on top of the DHR category its action on the global algebra of observables, and we show duality relations between local algebras and localized endomorphisms pointing in this direction. We ask if every (modular) braided C* tensor category is realized as DHR category of some (rational) net of algebras.

MP 11.2 Wed 16:05 HFT-FT 101

Wedge-local fields in integrable QFT with bound states — •Yoh Tanimoto — Graduate School of Mathematical Sciences, The University of Tokyo, Tokyo, Japan

For a class of 1+1-dimensional QFT which have factorizing S-matrices with poles, we construct observables localized in wedge regions. This is a first step towards the full construction of Haag-Kastler nets.

MP 11.3 Wed 16:25 HFT-FT 101

A rigorous approach to $O(N)$-invariant nonlinear sigma-models — •Sabina Alazzawi[1] and Gandalf Lechner[2] — [1]Technische Universität München, Deutschland — [2]Universität Leipzig, Deutschland

Particular attention has been paid to nonlinear sigma-models in 1+1 dimensions since they serve as a useful laboratory for the study of more realistic theories. Building on recently developed construction methods in the operator-algebraic framework of quantum field theory, a

rigorous formulation of $O(N)$-invariant nonlinear sigma-models is presented in this talk. Our approach is based on the factorizing S-matrix of the model and aims at verifying the modular nuclearity condition. By means of the latter the Reeh-Schlieder property and hence the existence of local field operators can be proven under certain conditions. Infinitely many other integrable models can be constructed in the same manner by considering a certain family of initial factorizing S-matrices.

MP 12: Quantenmechanik II

Time: Wednesday 16:50–17:30 Location: HFT-FT 101

MP 12.1 Wed 16:50 HFT-FT 101

Lieb-Robinson bounds and Haag-Ruelle scattering theory for gapped quantum spin systems — Sven Bachmann[1], Wojciech Dybalski[2], and •Pieter Naaijkens[3] — [1]Mathematisches Institut der Universität München, Deutschland — [2]Zentrum Mathematik, Technische Universität München, Garching, Deutschland — [3]Institut für Theoretische Physik, Leibniz Universität Hannover, Deutschland

We consider translation invariant gapped quantum spin systems satisfying the Lieb-Robinson bound and containing single particle states in a ground state representation. Following the Haag-Ruelle approach from relativistic quantum field theory, we construct states describing collisions of several particles and the corresponding S-matrix. We discuss the main technical difficulties in translating results from relativistic QFT to lattice systems, and dicusss how Lieb-Robinson bounds can be used to solve these problems.

MP 12.2 Wed 17:10 HFT-FT 101

On uncertainty relations for angular momentum — Lars Dammeier, •René Schwonnek, Kais Abdelkhalek, and Reinhard F. Werner — Institut für Theoretische Physik, Leibniz Universität Hannover

We report on quantifying uncertainty for operators satisfying the angular momentum algebra. This is a natural example of how the concept of uncertainty can be generalised to the case of more than two noncommuting observables.

We present our results for the case of preparation uncertainty. Using variances as a figure of merit, the concept of uncertainty can be captured by characterising the set of all tuples of variances which can be attained by a quantum state in a measurement of angular momentum components. Uncertainty relations then correspond to lower bounds on this set.

The shape of this set strongly depends on the total spin of system. For spin 1/2 and 1 we provide an exact characterisation of these sets. Additionally, we investigate the behavior for very large spin.

MP 13: Klassische Feldtheorie

Time: Wednesday 17:35–17:55 Location: HFT-FT 101

MP 13.1 Wed 17:35 HFT-FT 101

Gauged Hopfions and Baby Skyrmions — •Yakov Shnir — BLTP JINR, Dubna, Russia — Carl von Ossietzky University Oldenburg, Germany

We discuss the U(1) gauged versions of the models from the Skyrme family in 2+1 dim and in 3+1 dim, the baby Skyrme model and the Faddeev-Skyrme model, respectively, supplemented by the Maxwell term. We show that there exist static solutions coupled to the noninteger toroidal flux of magnetic field, which revert to the usual baby Skyrmions and Hopfions of lower degrees $Q = mn$ in the limit of the gauge coupling constant vanishing. The masses of the static gauged configurations are found to be less than the corresponding masses of the usual ungauged solitons, they become lighter as gauge coupling increases. The dependence of the solutions on the gauge coupling is investigated. We find that in the strong coupling regime the gauged low-dimensional Skyrmion is coupled to a magnetic flux whereas an axially-symmetric Hopfion carries two magnetic fluxes, which are quantized in units of 2π, carrying n and m quanta respectively. The first flux encircles the position curve and the second one is directed along the symmetry axis. Effective quantization of the field in the gauge sector may allow us to reconsider the usual arguments concerning the lower topological bound.

MP 14: Mathematische und Philosophische Grundlagen (gemeinsam mit AG Phil)

(Gemeinsame Sitzung der AG Phil und des FV MP)

Time: Thursday 9:30–10:30 Location: HFT-FT 101

MP 14.1 Thu 9:30 HFT-FT 101

Classical Field Theory and Intertheoretic Reduction — •Samuel C. Fletcher — Munich Center for Mathematical Philosophy, LMU Munich, Germany

In 1986, Ehlers set out a program on how to understanding the approximative relationships between different physical theories. However, he essentially only investigated the case of classical and relativistic spacetime theories, which have a number of special features that distinguish them from broader classes of physical theories. To what extent, then, can the Ehlers program be successful? I outline some of the challenges facing the program's generalization and argue that they can largely be overcome for classical gauge theories, i.e., theories described by connections on principal bundles, once the program is understood geometrically.

The general strategy is to cast the successfully treated case of general relativity and Newtonian gravitation - really, the geometrized version thereof, Newton-Cartan theory - as a reduction between two gauge theories. Under this guise, one can understand its relation to the theory of group contraction, to associated vector bundles representing matter fields, and to different notions of convergence encoding different ways the matter fields of the limit theory may approximate those of the limiting theory.

MP 14.2 Thu 10:00 HFT-FT 101

Versuch einer Machschen Quantenmechanik — •Bernadette Lessel — Mathematisches Institut der Georg-August-Universität Göttingen

Nach dem Machschen Prinzip sollte eine physikalische Theorie berücksichtigen, dass die Bewegung eines Körpers im Raum nur in Bezug zu allen Körpern im Raum gemessen werden kann und nicht relativ zu einem absoluten Raum stattfindet.

Julian Barbour ist es mit Hilfe der Einführung seiner "Best matching"-Metrik, welche nur den Abstand der Form, "Shape", von Teilchenkonfigurationen misst, ohne Rückgriff auf die Position der einzelnen Teilchen relativ zu einem absoluten Raum zu nehmen, gelungen, das Machsche Prinzip mit der Newtonschen Theorie zu verbinden.

Andererseits ist durch Max von Renesse bekannt, dass die mathematische Theorie des Optimalen Transportes von Wahrscheinlichkeitsmaßen dazu taugt die Schrödinger-Gleichung derart umzuschreiben, dass sie die Form einer Newtonschen Bewegungsgleichung hat. Gleichzeitig nimmt sie damit aber Bezug auf die Existenz eines absoluten Raumes.

Ähnlich zur Vorgehensweise von Julian Barbour verändern wir die durch den Optimalen Transport definierte Wasserstein-Metrik auf eine Art und Weise, dass sie nur noch den Abstand der "Form" der Wahrscheinlichkeitsmaße misst, aber deren genaue Lokalisation im Raum unberücksichtigt lässt. Wir untersuchen die sich so ergebende geodätische Struktur und deren Konsequenzen für eine Machsche Formulierung der Quantenmechanik.

MP 15: HV Zahn

Time: Thursday 10:35–11:15 Location: HFT-FT 101

Invited Talk MP 15.1 Thu 10:35 HFT-FT 101
Applications of local gauge covariance: Anomalies and QED in external potentials — •Jochen Zahn — Universität Leipzig, Institut für Theoretische Physik, Brüderstr. 16, 04103 Leipzig

The framework of locally covariant field theory proved extremely fruitful for QFT on curved space-times. It can be straightforwardly generalized to more general non trivial background fields, in particular gauge connections. I will present two applications of this framework. The first is an elementary computation of the chiral anomalies, directly on Lorentzian space-times. The second is QED in external potentials, where I compare the locally covariant definition of the current to other definitions and consider it in concrete cases.

MP 16: Gravitation

Time: Thursday 11:20–12:20 Location: HFT-FT 101

MP 16.1 Thu 11:20 HFT-FT 101
Spacetime symmetries in the language of Cartan geometry — •Manuel Hohmann — Institut für Physik, Universität Tartu, Estland

I discuss how apparently different geometrical descriptions of spacetime geometry - in particular, affine geometry, metric geometry and Finsler geometry - can commonly be reformulated in terms of Cartan geometry. In the main part of my talk I show how this common Cartan geometric description can be used to formulate spacetime symmetries under the action of continuous diffeomorphism groups, represented by Killing-like vector fields. As an illustrative example I discuss the case of axial, spherical and cosmological symmetry. These calculations can be applied in the construction of symmetric solutions of gravity theories based on these different geometric descriptions.

MP 16.2 Thu 11:40 HFT-FT 101
Counting of Manifold Triangulations — •Benedikt Krüger and Klaus Mecke — Institut für Theoretische Physik, Staudtstr. 7, 91058 Erlangen

Each topological manifold in 2d and 3d permits a finite number of non-equivalent discretisations into combinatorial manifolds or triangulations with given number of vertices or maximal simplices. This number of distinct triangulations is important for questions arising in topology, geometry and physics. E.g., the scaling behaviour of this number determines whether the quantum gravity model of causal dynamical triangulations [1] is well-defined.

Until now the best method for counting of combinatorial manifolds was the isomorphism free enumeration of all possible triangulations for vertex numbers below 15 [2]. Here, we use Monte-Carlo algorithms for estimating the number of triangulations of two- and three-dimensional manifolds and show that the accessible regime of triangulation counts can be increased by several magnitudes. We give numerical evidence that the number of surface triangulations scales exponentially with the vertex number and that the rate of growth depends linearly on the genus of the surface. Additionally we address the question whether the number of triangulations of the 3-sphere scales exponentially with the number of tetrahedra, and whether these triangulations are computationally ergodic.

[1] J. Ambjörn, J. Jurkiewicz, and R. Loll, Phys. Rev. D 72, 064014 (2005); [2] T. Sulanke and F. H. Lutz, Eur. J. Comb. 30, 1965 (2009)

MP 16.3 Thu 12:00 HFT-FT 101
Defining equidistance in finite and discrete geometries — •Alexander Laska, Benedikt Krüger, and Klaus Mecke — Institut für Theoretische Physik, Staudtstr. 7, 91058 Erlangen

In order to replace the continuous smooth manifold of general relativity by a suitable discrete structure, we tried to practice physics within finite – affine and projective – geometries. They might be the discrete analog to tangential and cotangential spaces to the manifold. In order to implement a lightcone the notion of one quadric per point does not suffice to encode length (and thus causal relations) in all directions. But a pair of quadrics – a biquadric – has to be employed per point. The scope of this talk is to present how and to what extent these biquadrics might encode length, causal relations, and furthermore curvature for arbitrary dimensions and signatures in order to be able to retrieve back the general theory of relativity – or a close approximation – in terms of a continuum limit.

MP 17: Poster (permanent Di-Do)

Poster-Flächen im Foyer HFT-FT, erste Etage

Time: Tuesday 9:30–18:00 Location: HFT-FT 101

MP 17.1 Tue 9:30 HFT-FT 101
A generalized approach to quantum mechanics in its hydrodynamical formulation — •Christoph Tempel and Wolfgang P. Schleich — Institut für Quantenphysik

Already formulated by Madelung in 1926 [1], the hydrodynamical formulation of quantum mechanics underwent several revivals since then. It was at the core of Bohm's interpretation of nonrelativistic quantum mechanics and now again gains influence in various fields of quantum theory. A most recent example would be the description of Bose-Einstein condensates in harmonic traps as well as under free evolution [2]. The outstanding property of the formulation is position space which it owes its name by comparison with classical hydrodynamics.

We start from a more general setting and examine the properties of Quantum Hydrodynamics in a selection of continuous Hilbert spaces and visualize our results on the prime example of textbook quantum mechanics: a single particle in the box.

[1] Madelung, Erwin, Z. Phys A **40.3**, 322 (1927).
[2] Dalfovo, Franco, et al., Rev. Mod. Phys. **71.3**, 463 (1999).

MP 17.2 Tue 9:30 HFT-FT 101
Entropic uncertainty relation for open pointer-based simultaneous measurements — •Raoul Heese and Matthias Freyberger — Institut für Quantenphysik, Universität Ulm, D-89069 Ulm, Germany

Uncertainty relations for simultaneous measurements of conjugate observables date back to the theory of Arthurs and Kelly, who considered a model of two pointer systems, which are coupled to a quantum system to be measured and act as the measurement apparatus. We extend this classic model by including a thermal environment in which the pointers behave as coupled particles under Brownian motion. Additionally, we use information entropy to determine the measurement accuracy. This novel approach leads us to a new kind of entropic uncertainty relation for so-called open pointer-based simultaneous measurements of conjugate observables.

MP 17.3 Tue 9:30 HFT-FT 101

Multiple-scale expansions for the Boltzmann equation — •Olga Chekmareva[1] and Igor Chekmarev[2] — [1]Aachen, Germany — [2]Aachen, Germany

The nondimensional Boltzmann equation is considered for small Knudsen number. The aim is to represent the solution by the first term of the asymptotic expansion that provides a good approximation for all times of interest. In this case each term in expansion must be a small correction to the preceding terms over long time interval. Thus, it is necessary not only to define the first approximations but examine the higher terms and eliminate the sources of singularities at each step of asymptotic procedure. To attain results we use the multiple-scale technique. Such approach applied to the Boltzmann equation in the limit of small Knudsen reduces to the regular gas-dynamic-type relations for the leading terms and determines the limits of their application. In particular, those equations define the damping and the dispersion of the sound wave. From other hand, the Navier-Stokes equations in the rare gas case contain itself a small parameter and can lead to singular solutions. It is shown the asymptotic equivalence of the Boltzmann equation and the Navier-Stokes system within the framework of the used models.

MP 17.4 Tue 9:30 HFT-FT 101

Subwavelength solitary waves in modulated plasmonic lattices — •Yao Kou and Jens Förstner — Department of Electrical Engineering, University of Paderborn, Warburger Str. 100, 33102 Paderborn, Germany

We numerically investigated the properties of optical solitons in modulated plasmonic lattices. The important characteristics, including band-gap spectrum, soliton existence domain, spatial concentration and propagation length are examined. The results show potential of use these subwavelength entities in active photonic control.

MP 17.5 Tue 9:30 HFT-FT 101

Rotating Bosons on a ring: A continuous matrix product state approach — •Damian Draxler — University of Vienna-Austria

A variational method for simulating (1+1)-dimensional quantum field theories with periodic boundary conditions is presented. The method is based on the Time-Dependent-Variational-Principle (TDVP) for continuous matrix product states. In particular we study interacting bosons confined on a ring in the presence of an artificial U(1) gauge field.

MP 17.6 Tue 9:30 HFT-FT 101

Extended global symmetries for four-dimensional supersymmetric gauge theories — •Ilmar Gahramanov — Humboldt-University Berlin, Berlin, Germany

I will discuss the prescription for studying extended global symmetries via the so-called superconformal index technique. The superconformal index is the non-trivial generalization of the Witten index and it is one of the most efficient tools in the study of supersymmetric gauge theories. The superconformal index of a theory with flavor group F has the Weyl group symmetry $W(F)$. In cases when the theory has a hidden extended symmetry, the coefficients in the decomposition of the index into characters of the flavor group are sums of dimensions of irreducible representations of the larger symmetry group. Using this property one can study symmetry enhancements for supersymmetric gauge theories.