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

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Programmübersicht

(Seminarraum SPA SR125; Poster SPA Foyer)

Hauptvorträge

MP 6.1	Wed	14:00–14:40	SPA SR125	**Quantum fields, black holes and entanglement** — •Rainer Verch
MP 9.1	Thu	14:00–14:40	SPA SR125	**Construction of quantum field theories by deformation techniques** — •Gandalf Lechner

Fachsitzungen

MP 1.1–1.3	Mon	15:00–16:00	SPA SR125	**Quanten-Information I**
MP 2.1–2.3	Mon	16:30–17:30	SPA SR125	**Quanten-Information II**
MP 3.1–3.6	Tue	10:30–12:30	SPA SR125	**Quanten-Information III**
MP 4.1–4.2	Tue	16:30–17:10	SPA SR125	**Gravitation**
MP 5.1–5.3	Tue	17:15–18:15	SPA SR125	**Klassische Feldtheorie und Statistische Mechanik**
MP 6.1–6.1	Wed	14:00–14:40	SPA SR125	**HV Entanglement**
MP 7.1–7.2	Wed	14:40–15:20	SPA SR125	**Quantenfeldtheorie I**
MP 8.1–8.2	Thu	11:50–12:30	SPA SR125	**Quantenfeldtheorie II**
MP 9.1–9.1	Thu	14:00–14:40	SPA SR125	**HV Quantenfeldtheorie**
MP 10.1–10.4	Thu	14:40–16:00	SPA SR125	**Quantenfeldtheorie III**
MP 11.1–11.4	Thu	16:30–17:50	SPA SR125	**Quantenmechanik**
MP 12.1–12.4	Thu	17:50–18:50	SPA SR125	**Verschiedenes**
MP 13.1–13.8	Tue	8:00–18:00	SPA Foyer	**Poster (permanent Mo-Do)**

Symposium SYQE "Quantum Correlations Beyond Entanglement"

Tue 14:00-16:00 and 16:30-18:30 Audimax. See SYQE for the full program of the symposium. (Q, MP)

Symposium SYAW "Awards Symposium"

Wed 14:00-16:00 and 16:30-17:30 Kinosaal. David Ruelle (Max-Planck-Medaille): 15:30.

Symposium SYRE "Rare Events: optimal solutions and challenges"

Wed 16:30-18:30 Audimax. See SYRE for the full program of the symposium. (AKE, EP, MO, MP, Q)

Symposium SYQC "The Quantum-Classical Divide"

Thu 10:30-12:30 Audimax. See SYQC for the full program of the symposium. (AGPhil, GR, Q)

Symposium SYQS "Characterization and Control of Complex Quantum Systems"

Fri 10:30-12:30 and 14:00-16:00 Audimax. See SYQS for the full program of the symposium. (Q, A, MO, MP, MS, AGjDPG)

Mitgliederversammlung des FV Theoretische und Mathematische Grundlagen der Physik

Mittwoch 19. März 2013, 18:00–18:45, Raum SR 125

- Bericht
- Tagungen
- Verschiedenes

MP 1: Quanten-Information I

Time: Monday 15:00–16:00 Location: SPA SR125

MP 1.1 Mon 15:00 SPA SR125

Emergence of coherence and the dynamics of quantum phase transitions — Simon Braun[1,2], •Mathis Friesdorf[3], Sean Hodgman[1,2], Michael Schreiber[1,2], Jens Philipp Ronzheimer[1,2], Arnau Riera[3,4], Marco del Rey[5], Immanuel Bloch[1,2], Jens Eisert[3], and Ulrich Schneider[1,2] — [1]Max-Planck-Institut für Quantenoptik, Garching, Germany — [2]Ludwig-Maximilians-Universität München, Munich, Germany — [3]Freie Universität Berlin, Berlin, Germany — [4]Max Planck Institute for Gravitational Physics, Potsdam-Golm, Germany — [5]Instituto de Fisica Fundamental, CSIC, Madrid, Spain

We investigate the dynamical emergence of coherence when crossing the Mott to superfluid quantum phase transition in the precisely controllable setup of ultracold atoms, experimentally addressing long-standing questions on the dynamics of quantum phase transitions. For one-dimensional systems, we find perfect agreement between experimental observations and numerical simulations of homogeneous systems, thus performing a certified quantum simulation. For intermediate quench velocities, we observe a power-law behaviour of the coherence length, reminiscent of the Kibble-Zurek mechanism. Contrary to what the latter suggests, we find a complex behaviour, yielding exponents that strongly depend on the final interaction strength in the superfluid. By using the full power of the quantum simulation, we also explore the emergence of coherence in higher dimensions as well as for negative temperatures. We connect our findings with insights into the propagation of quasiparticles and close-to-adiabatic quantum evolutions.

MP 1.2 Mon 15:20 SPA SR125

Optimality of entropic uncertainty relations — •Kais Abdelkhalek[1], Jörg Duhme[1], Berthold-Georg Englert[2], Fabian Furrer[3], Hans Maassen[4], Philippe Raynal[2], René Schwonnek[1], and Reinhard F. Werner[1] — [1]Institut für Theoretische Physik, Leibniz Universität Hannover, Hannover, Germany — [2]Centre for Quantum Technologies and Department of Physics, National University of Singapore, Singapore — [3]Department of Physics, Graduate School of Science, University of Tokyo, Tokyo, Japan — [4]Department of Mathematics, Radboud University, Nijmegen, The Netherlands

We investigate the optimality of the entropic uncertainty relation proven by Maassen and Uffink and its generalisation to side information from Berta *et al* for observables, for which the lower bound attains its maximal value. Here, we call an uncertainty relation optimal if the lower bound can be attained for any value of either of the corresponding uncertainties. We show that the uncertainty relation with side information cannot be optimised. In the case of the Maassen-Uffink uncertainty relation, we disprove a conjecture by Englert *et al* and provide a characterisation of those states that parametrise the optimal lower bound. This leads to a new conjecture.

MP 1.3 Mon 15:40 SPA SR125

A Monte Carlo Time-Dependent Variational Principle — •Fabian W. G. Transchel, Ashley Milsted, and Tobias J. Osborne — Institut für Theoretische Physik, Appelstr. 2, Hannover, D-30167, Germany

We generalize the Time-Dependent Variational Principle (TDVP) to dissipative systems using Monte Carlo methods, allowing the application of existing variational classes for pure states, such as Matrix Product States (MPS), to the simulation of Lindblad master equation dynamics. The key step is to use sampling to approximately solve the Fokker-Planck equation derived from the Lindblad generators. An important computational advantage of this method, compared to other variational approaches to mixed state dynamics, is that it is *embarrassingly parallel*.

MP 2: Quanten-Information II

Time: Monday 16:30–17:30 Location: SPA SR125

MP 2.1 Mon 16:30 SPA SR125

Tomography beyond observable phenomena — •Adrian Steffens, Carlos Riofrío, Robert Hübener, and Jens Eisert — Dahlem Center for Complex Quantum Systems, Freie Universität Berlin, 14195 Berlin, Germany

Recent advances in the tomography of one dimensional quantum fields make it possible to reconstruct all n-point functions from lowest order correlations provided that certain requirements are fulfilled ["Wick's theorem for matrix product states", R. Hübener, A.Mari, J. Eisert, Phys. Rev. Lett. 110, 040401 (2013)]. The algorithms employed in the tomographic process even allow to extract the Hamiltonian behind the observed correlations, leading to a picture of a finite dimensional system interacting with the observed field. We will demonstrate—using the example of the Lieb-Liniger model—how structures of another, underlying model can be recovered from the correlations. Such a resulting model can be useful if, for example, not all phenomena or particles of a model are accessible to measurement or to 'give back' details to an effective model.

MP 2.2 Mon 16:50 SPA SR125

Tomography of Quantum Fields — •Carlos Riofrío, Adrian Steffens, Robert Hübener, and Jens Eisert — Freie Universität Berlin, Germany

Understanding the fundamental interactions in many-body physical systems is of great interest in current theoretical and experimental efforts. Of particular recent interest are quantum simulations of processes of non-equilibrium, equilibration and thermalization. In this context, the problem of developing tools for identifying and reconstructing the state of such systems has become interesting on a practical level. We will present a novel approach in that direction and discuss an application for reconstructing quantum field states from low order correlation functions measured in current atom chip experiments. We concentrate on one dimensional systems with spatially limited entanglement which are well described by the continuous matrix product state (cMPS) formalism, and employ recent mathematical theorems concerning their structure for tomographic access.

MP 2.3 Mon 17:10 SPA SR125

An improved Landauer Principle with finite-size corrections and applications to statistical physics — •David Reeb and Michael Marc Wolf — Department of Mathematics, Technische Universität München, 85748 Garching, Germany

Landauer's Principle necessitates a fundamental energy cost for the erasure of data in the form of heat dissipation. Theoretical justifications of this limit rely so far on specific models based on arguable assumptions and are often confined to classical physics. In this work, we clarify the minimal setup to formulate Landauer's Principle in precise terms, and provide a rigorous proof of an improved version of the Principle, which is formulated in terms of an equality rather than an inequality. The proof is based on quantum statistical physics concepts instead of thermodynamic reasoning. From this equality version we obtain explicit improvements of Landauer's bound that depend on the effective size of the reservoir. For this, we employ new entropy inequalities which also give energy-time tradeoffs in thermodynamic situations such as the Clausius Theorem and are of independent interest in information theory. Our treatment of Landauer's Principle furthermore implies a generalized Carnot efficiency bound.

MP 3: Quanten-Information III

Time: Tuesday 10:30–12:30 Location: SPA SR125

MP 3.1 Tue 10:30 SPA SR125

Operationally-Motivated Uncertainty Relations for Joint Measurability and the Error-Disturbance Tradeoff — Joseph M. Renes and •Volkher B. Scholz — Institute for Theoretical Physics, ETH Zurich, Wolfgang-Pauli-Str. 27, 8093 Zurich, Switzerland

We derive uncertainty relations for both joint measurability and the error-disturbance tradeoff in terms of the probability of distinguishing the actual operation of a device from its hypothetical ideal. Our relations provide a clear operational interpretation of two main aspects of the uncertainty principle, as originally formulated by Heisenberg. The first restricts the joint measurability of observables, stating that noncommuting observables can only be simultaneously determined with a characteristic amount of indeterminacy. The second describes an error-disturbance tradeoff, noting that the more precise a measurement of one observable is made, the greater the disturbance to noncommuting observables.

Our relations are explicitly state-independent and valid for arbitrary observables of discrete quantum systems, and are also applicable to the case of position and momentum observables. They may be directly applied in information processing settings, for example to infer that devices which can faithfully transmit information regarding one observable do not leak information about conjugate observables to the environment. Though intuitively apparent from Heisenberg's original arguments, only limited versions of this statement have previously been formalized.

MP 3.2 Tue 10:50 SPA SR125

Controlling atoms in a cavity - applications of infinite dimensional Lie-algebras — •Michael Keyl[1], Robert Zeier[2], and Thomas Schulte-Herbrüggen[2] — [1]Zentrum Mathematik, M5, Technische Universität München, Boltzmannstrasse 3, 85748 Garching, Germany — [2]Department Chemie, Technische Universität München, Lichtenbergstrasse 4, 85747 Garching, Germany

We consider control theory for a number of two-level atoms interacting with one mode of the electromagnetic field in a cavity. In the rotating wave approximation this provides a very useful toy-model to study several aspects of quantum control theory in infinite dimensions, in particular the emergence of infinite dimensional system algebras. In this context we provide a short discussion of problems arising with infinite dimensional Lie-algebras and Lie-algebras consisting of unbounded operators. For the models under consideration these problems can be solved by splitting the set of control Hamiltonians up into two groups: The first obeys an Abelian symmetry and can be treated in terms of infinite dimensional Lie-algebras and strongly closed subgroups of the unitary group of the system Hilbert space. The second breaks this symmetry and their discussion needs new arguments. At the end full controlability can be achieved in a certain strong sense. As an example we study a time dependent version of the Jaynes Cummings model and show that with an appropriate tuning of the coupling constants every unitary of the coupled system (atom and cavity) can be approximated with arbitrary small error.

MP 3.3 Tue 11:10 SPA SR125

Unifying Fixed-Point Engineering with the Stabiliser Formalism of Graph States and Topological States — •Thomas Schulte-Herbrüggen[1], Corey O'Meara[1], and Gunther Dirr[2] — [1]Dept. Chem., TU-München (TUM) — [2]Math. Inst., University of Würzburg

We present a unified practical Lie-framework for fixed-point engineering which includes as special cases the stabiliser formalisms for graph states and topological states.

Quantum evolution in open Markovian systems takes the form of an affine map with an illustrative geometry. It consists of a unital part ('rotation and compression') and a translational part, the latter representing the shift (if any) from the chaotic state (identity) towards fixed points of different type.

For a plethora of examples, we demonstrate how to exploit the geometry of such translations for systematic fixed-point engineering. In the framework of Lie-semigroups a unified practical view emerges: (1) It shows how to relate a desired target state via its centraliser (or commutant) to translations and, in turn, to the corresponding Lindblad noise generators driving the system into the desired targets. (2) Analogously, *graph states* can be obtained from their stabilisers (seen as elements of the maximally abelian subalgebra of the centraliser) cast into translations and the corresponding Lindblad generators. (3) *Topological states*, as for the toric code, are engineered likewise by turning the star and plaquette operators (seen as abelian centraliser elements) into translations and Lindblad generators.

MP 3.4 Tue 11:30 SPA SR125

Efficient achievability for quantum information theoretic protocols using decoupling theorems — •Christoph Hirche and Ciara Morgan — Leibniz Universität, Hannover, Germany

Proving achievability of protocols in quantum Shannon theory usually does not consider the efficiency at which the goal of the protocol can be achieved. Nevertheless it is known that protocols such as coherent state merging are efficiently achievable at optimal rate. We aim to investigate this fact further in a general one-shot setting, by considering certain classes of decoupling theorems and give exact rates for these classes. Moreover we compare results of general decoupling theorems using Haar distributed unitaries with those using smaller sets of operators, in particular ϵ-approximate 2-designs. We also observe the behavior of our rates in special cases such as ϵ approaching zero and the asymptotic limit.

MP 3.5 Tue 11:50 SPA SR125

Thermalization, quantum correlation and entanglement in exactly solvable models. — •Ming-Chiang Chung — National Chung-Hsing University, Taichung, Taiwan

The generalized Gibbs ensemble introduced for describing few body correlations in exactly solvable systems following a quantum quench is related to the way in which operators sample, in the limit of infite time after the quench, the quantum correlations present in the initial state. The emergence of the generalized Gibbs ensemble is thus analytically established for the quantum Ising and XX chains in the thermodynamic limit. For these models and for a broad class of initial states, which includes both translationally and non-translationally invariant states, the validity of the generalized Gibbs ensemble for simple correlation functions of both local and non-local operators is demonstrated provided certain conditions are met. The relation between quench dynamics and entanglement will be discussed. And a measurement of quantum entanglement through the quench dynamics will be proposed.

MP 3.6 Tue 12:10 SPA SR125

Haag Duality in Kitaev's Quantum Double Model for Finite Groups — •Leander Fiedler and Pieter Naaijkens — Institut für Theoretische Physik, Leibniz Universität Hannover, Germany

Kitaev's quantum double model for finite groups is a spin model on a 2D lattice that exhibits anyonic excitations. It is designed to perform quantum computations and in fact for certain groups it allows even for universal quantum computation. The latter is made possible by braid statistics of the anyons which are encoded in the superselection structure of the model.

We show that algebras of observables localized in cone-like regions fulfill Haag duality in the vacuum representation. This means that in the vacuum representation observables which commute with all observables outside the cone are exactly those localized inside the cone.

As an application we consider an analysis of the superselection structure of the model for finite abelian groups. We show that in this case the superselection structure is given by conelike localized endomorphisms describing single excitations of the model. The latter can be described by representations of Drinfeld's quantum double of the underlying group. This resembles analogue results for Kitaev's toric code model.

MP 4: Gravitation

Time: Tuesday 16:30–17:10 Location: SPA SR125

MP 4.1 Tue 16:30 SPA SR125

Observer dependent background geometries — •Manuel Hohmann — Tartu University, Estonia

Various approaches to quantum gravity suggest a breaking of general covariance or local Lorentz invariance via the introduction of preferred foliations of spacetime or preferred timelike vector fields. Physical quantities may then obtain a non-tensorial dependence on the observer performing their measurement. We discuss observer dependent geometries which may serve as backgrounds for physical theories, in particular for gravity, and can be described in the languages of Finsler and Cartan geometry.

MP 4.2 Tue 16:50 SPA SR125

Spectral dimension of quantum geometries — •Johannes Thürigen[1], Daniele Oriti[1], and Gianluca Calcagni[2] — [1]MPI für Gravitationsphysik, Potsdam — [2]CSIC Madrid

The spectral dimension is an indicator of geometry and topology of spacetime and a tool to compare the description of quantum geometry in various approaches to quantum gravity. This is possible because it can be defined not only on smooth geometries but also on discrete (e.g., simplicial) ones. In this paper, we consider the spectral dimension of quantum states of spatial geometry defined on combinatorial complexes endowed with additional algebraic data: the kinematical quantum states of loop quantum gravity (LQG). Preliminarily, the effects of topology and discreteness of classical discrete geometries are studied in a systematic manner. We look for states reproducing the spectral dimension of a classical space in the appropriate regime. We also test the hypothesis that in LQG, as in other approaches, there is a scale dependence of the spectral dimension, which runs from the topological dimension at large scales to a smaller one at short distances. While our results do not give any strong support to this hypothesis, we can however pinpoint when the topological dimension is reproduced by LQG quantum states. Overall, by exploring the interplay of combinatorial, topological and geometrical effects, and by considering various kinds of quantum states such as coherent states and their superpositions, we find that the spectral dimension of discrete quantum geometries is more sensitive to the underlying combinatorial structures than to the details of the additional data associated with them.

MP 5: Klassische Feldtheorie und Statistische Mechanik

Time: Tuesday 17:15–18:15 Location: SPA SR125

MP 5.1 Tue 17:15 SPA SR125

Thermal fluctuations and correlations in the Bose-Hubbard model — •Patrick Navez[1], Konstantin Queisser[2], Konstantin Krutitsky[1], and Ralf Schützhold[1] — [1]Universtät Duisburg-Essen, Lotharstrasse 1, 47057 Duisburg, Germany — [2]The University of British Columbia, 6224 Agricultural Road, Vancouver, BC V6T 1Z1, Canada

For the example of the Bose-Hubbard model in the (formal) limit of large coordination numbers Z, we calculate properties of the thermal state via an expansion into powers of $1/Z$. This method provides the thermal energy, the on-site reduced density matrix containing the thermal fluctuations as well as the thermal correlations between two lattice sites. Furthermore, it yields the thermal eigen-frequencies of the system and gives the phase boundary between the Mott and the superfluid state at finite temperature. Employing the hierarchy of correlations [1,2,3], these results provide the correct thermal initial state for a quantum quench of the Bose-Hubbard model.

Ref: [1] *Emergence of coherence in the Mott-superfluid quench of the Bose-Hubbard model*, P. Navez, R. Schützhold, Phys. Rev. A, **82** 063603 (2010); [2]*Quasi-particle approach for general lattice Hamiltonians*, P. Navez, F. Queisser, R. Schützhold, `arXiv:1303.4112`; [3]*Equilibration versus (pre) thermalization in the Bose and Fermi Hubbard models*, F. Queisser, K. Krutitsky, P. Navez, R. Schützhold, `arXiv:1311.2212`.

MP 5.2 Tue 17:35 SPA SR125

Isospinning hopfions and baby Skyrmions — •Yakov Shnir — BLTP JINR, Dubna, Russia — Institute of Physics, Carl von Ossietzky University Oldenburg, Germany

The problem of constructing internally rotating solitons of fixed angular frequency ω in the Faddeev-Skyrme model and in the planar baby Skyrme model is reformulated as a variational problem for an energy-like functional, called pseudoenergy, which depends parametrically on ω. This problem is solved numerically using a gradient descent method, without imposing any spatial symmetries on the solitons, and the dependence of the solitons' energy on ω, and on their conserved total isospin J, studied. We investigated patterns of the critical behavior of the solitons, and two different types of the soliton instability are discussed. A simple elastic rod model of time-dependent hopfions is developed which, despite having only one free parameter, accounts well for most of the numerical results.

MP 5.3 Tue 17:55 SPA SR125

Plane waves as tractor beams — Péter Forgács[1,2], •Árpád Lukács[1], and Tomasz Romanczukiewicz[3] — [1]Wigner RCP RMKI, Budapest, Hungary — [2]LMPT, Université de Tours, France — [3]Jagiellonian University, Krakow, Poland

It is shown that in a large class of systems plane waves act as *tractor beams*: i.e., an incident plane wave can exert a *pulling* force on the scatterer. The underlying physical mechanism for the pulling force is due to the sufficiently strong scattering of the incoming wave into another mode carrying more momentum, in which case *excess momentum* is created *behind* the scatterer. This *tractor beam* or *negative radiation pressure* (NRP) effect is found to be generic in systems with multiple scattering channels. In a birefringent medium electromagnetic plane waves incident on a thin plate exert NRP of the same order of magnitude as optical radiation pressure, while in artificial dielectrics (metamaterials) the magnitude of NRP can be even macroscopic. In two dimensions we study various scattering situations on vortices, and NRP is shown to occur by the scattering of heavy baryons into light leptons off cosmic strings, thereby reducing the friction acting on cosmic strings moving in a surrounding plasma of particles (the dominant energy loss mechanism for cosmic strings in the friction era). It is shown, that the famous enhancement of the small angle cross section for cosmic strings is another manifestation of this phenomenon, and that this enhancement also occurs for neutron scattering off vortices in the XY model.

MP 6: HV Entanglement

Time: Wednesday 14:00–14:40 Location: SPA SR125

Invited Talk MP 6.1 Wed 14:00 SPA SR125

Quantum fields, black holes and entanglement — •Rainer Verch — Institut für Theoretische Physik, Uni Leipzig

Some connections between black holes and entanglement will be reviewed from the perspective of quantum field theory/quantum information theory on curved spacetime manifolds.

MP 7: Quantenfeldtheorie I

Time: Wednesday 14:40–15:20 Location: SPA SR125

MP 7.1 Wed 14:40 SPA SR125

Generalization of the KMS condition in quantum field theory — •Michael Gransee — Institut für Theoretische Physik, Universität Leipzig — MPI für Mathematik in den Naturwissenschaften, Leipzig

The KMS condition characterizes thermal equilibrium states in quantum statistical mechanics and quantum field theory. It is based on certain analytical and periodicity conditions of correlation functions. The characterization of non-equilibrium states which locally still have thermal properties constitutes a challenge in quantum field theory. Analyzing the analyticity properties of KMS states, a proposal for a generalized KMS condition is made in the case of the free scalar field. The relations of that condition to a related proposal for characterizing local thermal equilibrium states by D. Buchholz et al. are investigated. This is joint work with Nicola Pinamonti (Genova) and Rainer Verch (Leipzig).

MP 7.2 Wed 15:00 SPA SR125

Low-dimensional quantum matrix models — •Robert Hübener[1], Yasuhiro Sekino[2], and Jens Eisert[1] — [1]Dahlem Center for Complex Quantum Systems, Freie Universität Berlin, 14195 Berlin, Germany — [2]KEK Theory Center, Tsukuba 305-0801, Japan

Matrix models play an important role in studies of quantum gravity, being candidates for a formulation of M-theory, but are notoriously difficult to solve. In this work, we present a fresh approach by introducing a novel exact model provably equivalent with low-dimensional bosonic matrix models. In this equivalent model significant structure becomes apparent and it can serve as a simple toy model for analytical and precise numerical study. We are able to derive a substantial part of the low energy spectrum, find a conserved charge, are able to derive numerically almost linear Regge trajectories, and thereby shed some light on the chaotic dynamics, as well as find a tentative solution for the whole spectrum. To exemplify the usefulness of the approach, we address questions of equilibration starting from a non-equilibrium situation in matrix models. We finally discuss possible generalisations of the approach.

MP 8: Quantenfeldtheorie II

Time: Thursday 11:50–12:30 Location: SPA SR125

MP 8.1 Thu 11:50 SPA SR125

Un-Casimir effect — •antonia micol frassino[1], piero nicolini[1], and orlando panella[2] — [1]Frankfurt Institute for Advanced Studies, Ruth-Moufang-Strasse 1, D-60438 Frankfurt am Main, Germany — [2]Istituto Nazionale di Fisica Nucleare, Sezione di Perugia, Via A. Pascoli, I-06123 Perugia, Italy

Following a recent conjecture, there could be a sector of the Standard Model that, although massive, can preserve scale invariance properties. The topic has intersected a huge variety of fields, from astrophysics to neutrino physics, AdS/CFT duality and quantum gravity. Such unlike kind of particles (shortly unparticles) has to be weakly interacting with the rest of the Standard Model.

In this talk we present the un-Casimir effect, namely the study of the Casimir energy related to the presence of an un-particle component in addition to the electromagnetic field contribution. We derive this result by considering modifications of the Feynman propagator in the unparticle sector.

The un-Casimir effect offers a reliable testbed for unparticle physics. We find bounds on the unparticle scale that are independent on the effective coupling constant describing the interaction between the scale invariant sector and ordinary matter.

MP 8.2 Thu 12:10 SPA SR125

Justification of the single-mode approximation for the quantum electrodynamics in a strong electromagnetic field — •Oleg Skoromnik[1] and Iliya Feranchuk[2] — [1]Max Planck Institute for Nuclear Physics, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Belarusian State University, 4 Nezavisimisty ave., 220030 Minsk, Belarus

The interaction Hamiltonian of an electron and a quasi-monochromatic pulse of a strong quantized electromagnetic field is examined. Canonical transformations of the field variables are found that allows the division of the system's Hamiltonian on two parts. The first one defines the interaction between an electron and a single collective mode of the field. Parameters of this mode correspond to the central lines of the resonant mode in the pulse. The second part describes the field fluctuations relatively to the collective mode. Estimation of the field intensity is found when the effective single-mode Hamiltonian can be used for the system's description.

MP 9: HV Quantenfeldtheorie

Time: Thursday 14:00–14:40 Location: SPA SR125

Invited Talk MP 9.1 Thu 14:00 SPA SR125

Construction of quantum field theories by deformation techniques — •Gandalf Lechner — Institut für Theoretische Physik, Universität Leipzig

This talk reviews recent approaches to constructing quantum field theory models on Minkowski spacetime by operator-algebraic deformation techniques. The links of this topic to (deformation) quantization, constructive quantum field theory, models in conformal QFT, massive integrable models, and non-commutative geometry will be discussed. An overview of the known results as well as an outlook to open questions will be given.

MP 10: Quantenfeldtheorie III

Time: Thursday 14:40–16:00 Location: SPA SR125

MP 10.1 Thu 14:40 SPA SR125

Araki-Haag Approach to Scattering in Quantum Field Theories without Mass Gap — •Maximilian Duell[1] and Wojciech Dybalski[1,2] — [1]Zentrum Mathematik, Technische Universität München, D-85747 Garching, Germany — [2]Institut für Theoretische Physik, Eidgenössische Technische Hochschule Zürich, 8093 Zürich, Switzerland

Haag-Ruelle scattering theory is a mathematical framework establishing an interpretation of quantum field theories in terms of scattering reactions of particles. Within the original Haag-Ruelle theory, relying on the mass-gap assumption, Huzihiro Araki and Rudolf Haag recognized the possibility to define a large family of asymptotic observables, which provide a mathematical modelling of experimental particle detectors. On the other hand, the Haag-Ruelle method for the construction of scattering states was adapted to the setting without mass gaps by Wojciech Dybalski building on previous work by Ira Herbst and Detlev Buchholz. In this framework, we extend the work of Araki and Haag to theories without mass gaps by proving the convergence of a family of Araki-Haag detectors on scattering states. Our proof relies on the decoupling assumption as introduced by Herbst, which is also required for the construction of scattering states. We further show, that the action of the asymptotic detectors on scattering states is completely described in terms of their action on the single-particle states, which provides additional evidence for the multi-particle interpretation of the scattering states.

MP 10.2 Thu 15:00 SPA SR125

Operator Product Expansion Algebra — •Jan Holland — CPHT, Ecole Polytechnique, Paris-Palaiseau, France

The Operator Product Expansion (OPE) is a theoretical tool for studying the short distance behaviour of products of local quantum fields. Over the past 40 years, the OPE has not only found widespread computational application in high-energy physics, but, on a more conceptual level, it also encodes fundamental information on algebraic structures underlying quantum field theories. I will review new insights into the status and properties of the OPE within Euclidean perturbation theory, addressing in particular the topics of convergence and "factorisation" of the expansion. Further, I will present a formula for the "deformation" of the OPE algebra caused by a quartic interaction. This formula can be used to set up a novel iterative scheme for the perturbative computation of OPE coefficients, based solely on the zeroth order coefficients (and renormalisation conditions) as initial input.

MP 10.3 Thu 15:20 SPA SR125

Characterisation of local nets by their representation category — •Luca Giorgetti — Institut für Theoretische Physik, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

In the axiomatic setting of Haag and Kastler, quantum fields are described by local nets of bounded operator algebras over space-time regions. We will discuss the representation theory of the net, more specifically the DHR superselection sectors of two-dimensional conformal field theories. These admit at the same time a large number of non-trivial models and a rich representation theoretical structure. DHR representations form a braided (modular) tensor category which we conjecture to be uniquely determined by a finite set of numerical invariants ('modular data'). Moreover, the category is realised in our setting as endomorphisms of the net. Based on our present understanding of the problem, we discuss to which extent one can reconstruct the local algebras from the category, together with its action on the net.

MP 10.4 Thu 15:40 SPA SR125

Phase Boundaries in Algebraic Conformal QFT — •Marcel Bischoff[1], Yasuyuki Kawahigashi[2], Roberto Longo[3], and Karl-Henning Rehren[1] — [1]Institut für Theoretische Physik, Universität Göttingen — [2]Department of Mathematical Sciences, The University of Tokyo — [3]Dipartimento di Matematica, Università di Roma "Tor Vergata"

We will describe the structure of local algebras in relativistic conformal QFT with phase boundaries (topological defects) in two spacetime dimensions. The phase boundary conditions are produced by the irreducible components of a certain universal construction.

MP 11: Quantenmechanik

Time: Thursday 16:30–17:50 Location: SPA SR125

MP 11.1 Thu 16:30 SPA SR125

First-order asymptotic corrections to the meanfield limit — •Matthias Christandl[1], Robert Matjeschk[2], Friederike Trimborn[2,3], and Reinhard Werner[2] — [1]Institute for Theoretical Physics, ETH Zürich, Wolfgang-Pauli-Strasse 27, CH-8093 Zürich, Switzerland — [2]Leibniz Universität Hannover — [3]Bundesministerium für Bildung und Forschung

We derive a complete algebraic theory for treating permutation invariant problems beyond separability to first order in the asymptotics. Our work builds on a C*-algebraic theory for permutation invariant operators on n-particles, with an algebraic description of the limit $n \to \infty$ (the *meanfield limit*). We use the fluctuation ansatz, a version of a non-commutative central limit, and derive a continuous-variable algebra (the *fluctuation algebra*) that asymptotically describes the $1/n$-corrections to this *meanfield* limit. Using the fluctuation algebra, we derive a method for estimating the ground-state energy of meanfield models up to first order, and for estimating the time-evolution of correlations between different particles. Moreover, we show that the meanfield ground-state problem is closely related to the finite de Finetti problem and therefore obtain a lower bound, complementing recent results in this direction.

MP 11.2 Thu 16:50 SPA SR125

Uncertainty relation for simultaneous measurements in a thermal environment — •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. In this sense the pointers behave like classical measurement devices. This novel approach leads us to a new kind of uncertainty relation for so-called open pointer-based simultaneous measurements of conjugate observables.

MP 11.3 Thu 17:10 SPA SR125

A Nonlinear Schrödinger Wave Equation With Linear Quantum Behavior — •Chris D. Richardson, Peter Schlagheck, John Martin, Nicolas Vandewalle, and Thierry Bastin — Département de Physique, University of Liege, 4000 Liege, Belgium

We show that a nonlinear Schrödinger wave equation can reproduce all the features of linear quantum mechanics. This nonlinear wave equation is obtained by exploring, in a uniform language, the transition from fully classical theory governed by a nonlinear classical wave equation to quantum theory. The classical wave equation includes a nonlinear classicality enforcing potential which when eliminated transforms the wave equation into the linear Schrödinger equation. We show that it is not necessary to completely cancel this nonlinearity to recover the linear behavior of quantum mechanics. Scaling the classicality enforcing potential is sufficient to have quantum-like features appear and is equivalent to scaling Planck's constant.

MP 11.4 Thu 17:30 SPA SR125

Classical trajectories of identical particles — •Stefan Fischer, Clemens Gneiting, and Andreas Buchleitner — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg

The number of permutations required to describe systems of identical particles grows very fast with the number of particles involved. In order to simplify the description of such systems, we resort to an idea put forward by J.M. Leinaas and J. Myrheim in 1977 [1]. They studied the consequences of restricting the configuration space of identical particles to the fundamental domain of the group of permutations of their coordinates. Upon utilizing this concept, we demonstrate for several examples that the quantum mechanical propagator, in this restricted space, can be obtained by a semi-classical treatment. Within this framework, a one-to-one correspondence between the solutions of the associated classical problem and the permutations of the particles arises. Thus, one obtains a clear picture as to whether a certain permutation may be neglected or significantly contributes to the propagation process.

[1] J.M. Leinaas and J. Myrheim, Nuovo Cimento B **37**, 1-23 (1977).

MP 12: Verschiedenes

Time: Thursday 17:50–18:50 Location: SPA SR125

MP 12.1 Thu 17:50 SPA SR125

Messen als Erkenntnisakt — •Helmut Hille — Fritz-Haber-Straße 34, 74081 Heilbronn

Ein Grundmuster des Erkennens ist das Vergleichen. Messen ist der mentale Vorgang des Kenntnisgewinns durch Vergleichen von kognitiv verschiedenwertigen Größen: einer bekannten - dem Maß - und einer unbekannten, die durch Messmittel zum Maß in Relation gesetzt wird, wodurch sie bekannt wird. Maße und ihre Einheiten selbst werden nicht gemessen sondern aufgrund eines Begriffs von Größe zweckmäßig definiert. Sie existieren nicht sondern sie gelten, sind also etwas Geistiges, mit deren Hilfe wir uns ein quantitatives Wissen aneignen können, denn alles Wissen ist geistiger Art. An der aus der nicht hintergehbaren kognitiven Grundsituation kommende Bedingung aller quantitativen Erkenntnis kann keine Theorie etwas ändern, weshalb die Situation zu akzeptieren ist. Zur Klarheit in der Wissenschaft ist es daher unverzichtbar, zwischen Mittel und Objekt der Forschung eindeutig zu unterscheiden. Ohne die Beachtung der Metrologie, der Maß- und Gewichtskunde, in der sich unsere kognitive Grundsituation niedergeschlagen hat, bliebe die Physik eine messende Wissenschaft ohne ein wirkliches Verständnis ihres messenden Tuns, was das Umsetzen von Messergebnissen in ein adäquates Verständnis verhindert.

MP 12.2 Thu 18:05 SPA SR125

On Track from Quantum Gravity and Its GUT Extension towards the General-Relativistic Version of Feynman Graphs — •Claus Birkholz — D-10117 Berlin, Seydelstr. 7

Based on QG, Dirac's special-relativistic formalism is reconstructed for GR. This again is doubling the number of spinor components to 8. This might be another hint towards some U(4,4) structure underlying the conservative U(2,2)-version of QG.

Dirac's old, 4-dimensional theory is reproduced in the limit of vanishing dark energy and by the law of great numbers. But his result proves to be inconsistent.

Feynman's concept is reanalysed. Its lack of more-body vertices is criticized. A new road map to include GR and the GUT is sketched, rescuing it from the arbitrariness of coupling constants.

By QG, both - general relativity and quantum field theories - proved to be applications of 2nd-order Casimir operators. The 3rd- and 4th-order Casimirs, in their lowest approximations are reproducing the old Lorentz invariants, but with spin and booster replaced by total angular momentum and by the total booster of spin and orbit.

The exact calculation provides plenty of modifications to be tested by experiment.

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

MP 12.3 Thu 18:20 SPA SR125

Unitäre Physik unter Einbeziehung der Klassenlogik — •Kurt Schwalbe — Paul-Junius-Str. 62, 10369 Berlin

Elementarteilchen sind Mengen der Stufen: 0 Photonen, 1 Lep tonen (Dipole), 2 Hadronen(Baryonen:3Quarks), 3 Dunkelmat Stufe => kleinste Dimension, kleinste Punktdichte. Elemente können emittiert und im Quantenfeld tranportiert werden,das ihre Dimension in Richtung der Wellennormalen verkürzt. Es treten Oberflächen-Muster fallender Dimension auf. Teilchen haben in jeder Hyperfläche gleiche Dimension. Quantenfeld in 4-dimensionaler Hyperfläche kann Teilchen bis zur Stufe 3, den Kosmos, transportieren. Vom Träger der Stufen k>3 wird abstrahiert. Funktionen der Teilchen können auf ihre Elemente oder auf deren Funktionen angewandt werden.Höchste Teilchenstufe 3 + Funktionenstufe 4 = Stufe und Dimension des Trägers. Ereignis-Impulse wandeln freie Raum- in Zeit- Dimension t0 um, definieren die Metrik der 4-dim. Raum-Zeit und die Massen der Teilchen. Funktionen-Impulse werden auf die Phasenlinien der Teilchen angewandt, Rotation der Welt linien, Translation der Impulslinien in der Zeit t1=>magne tische + elektrische Ladung + metrische Potentiale. Duale Vektoren definieren das Vorzeichen der Ladungen, 5-dim. projektiver Ereignisraum => elektromagnetisches Potential. Relativistische Quantenmechanik mit Zeitparameter t1,.,t5. Metriken=>Bosonen, (Funktionen)-Impulse=>Fermionen.

MP 12.4 Thu 18:35 SPA SR125

Die Exzeptionelle E8-Gruppe und ihre Anwendung in der Physik — •Norbert Sadler — Wasserburger Str, 25a ; 85540 Haar

Die E8-Gruppe ist in ihrer Anwendung ein mächtiges, mathematisches "Werkzeug" in der Teilchen-Physik (i)und der Kosmologie (ii).

Definition: Die E8-Grp. besitzt 248 Freiheitsgrade in der Drehung eines 57 dimensionalen geometrischen Objektes und ist selbst 8 dimensional.

E8=8x((453060**2;Matrix))x(2**(57/3);Polynome))=8.61x10**17

(i) In der Teilchen-Physik entspricht E8 einem "Quantenmikroskop", dass bei hoher Wechselwirkungsenergie und Auflösungsvermögen das Standardmodell der Teilchenphysik bestätigt und ergänzt.

Hierzu einige Ergebnisse:
Auflösungsvermögen:E8xBetrag(Prot.Rad.;0.9x10**-15=248xPi
Proton-Ruhemasse: m(Proton)=(57x alfa(QED)/(4/9))x1GeV/c**2
Elektronen Masse: m(Elektron)=alfa(QED)/((32x4/9)x1GeV/c**2
Neutrino-Masse= 57x(0.24)x1eV/(248x(0.0458))=1.2eV/c**2
(ii)Die E8-Grp. bestätigt das Standardmodell der Kosmologie.
Dazu einige Ergebnisse:
Hubble-Parameter: H=c/(E8x(5/9)x1Ls(m))=64.5km/Mpcs
Entropie d. Univ.:4/9)x57x(e**57)x1Prot(kg)=(0.24kg) Entropie
Weitere Information: www.cosmology-harmonices-mundi.com

MP 13: Poster (permanent Mo-Do)

Time: Tuesday 8:00–18:00 Location: SPA Foyer

MP 13.1 Tue 8:00 SPA Foyer

Dynamics of the quantum kicked oscillator coupled to a heat bath — •Pablo Carlos López Vázquez[1] and Thomas Gorin[2] — [1]Max Planck Insititute for the Physics of Complex Systems, Nöthnitzer Str. 38, 01187 Dresden, Germany — [2]Departamento de Física, Universidad de Guadalajara, Blvd. Marcelino García Barragán y Calzada Olimpica, 44840 Guadalajara, México

The problem of a two-level system coupled to a generic chaotic environment which is in turn coupled to a heat bath, has been studied by Gorin et al. In this study, they have used a random matrix description of the environment. They have observed the recovery of the coherence of the two-level system when the coupling between the random matrix model and the heat bath is increased. However, the results of this study were of limited physical value due to the restrictive approximations necessary in random matrix theory.

A more realistic description for this dynamics is presented in this work. Here, the environment is replaced by quantum kicked oscillator in contact with a heat bath. We show that in this model, the coherence of the two level system is also recovered, when the coupling between the kicked oscillator and the heat bath is increased.

In order to obtain a better understanding of these phenomena, we focus on the dynamics of the kicked oscillator coupled to a heat bath in the phase-space representation.

Finally, we explore the possibility of obtaining a final quasi-stationary state of the oscillator, despite of the non-equilibrium created by the kicks.

MP 13.2 Tue 8:00 SPA Foyer

On the quantization of the electromagnetic flux — •Enderalp Yakaboylu and Karen Z. Hatsagortsyan — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg,Germany

The complete description of a gauge theory can be constructed via the Wilson line. This leads to a path-dependent formulation of gauge theory, which replaces the gauge freedom of the theory with the path freedom. It is shown that this equivalent formulation of gauge theory can provide a very simple and geometric description of the electromagnetic flux quantization. The developed formalism is employed for a (1+1) dimensional spacetime in order to discuss electric charge quantization

[1].

[1] E. Yakaboylu, and K. Z. Hatsagortsyan, preprint arXiv:1309.0715

MP 13.3 Tue 8:00 SPA Foyer

Ab initio calculations of f-element compounds and solids with DFT+U method — •George Beridze[1], Ariadna Blanca-Romero[1,2], Yan Li[1], and Piotr Kowalski[1] — [1]Institute of Energy and Climate Research, Nuclear Waste Management and Reactor Safety, Forschungszentrum J\"ulich, Wilhelm-Johnen-Straße, 52428, J\"ulich, Germany — [2]Department of Chemistry, Imperial College London, London, United Kingdom

Safe storage of nuclear waste is a tough challenge facing today's society. It requires a deep understanding of chemistry and physics of complicated radionuclide-bearing systems. Nowadays, computational modelling is used alongside experiments to simulate behavior of these complex materials. Because of strong correlations, lanthanide- and actinide-bearing systems are not always well described by Density Functional Theory (DFT), which is the only computationally affordable method. We show results of DFT+U studies of different f-element-bearing oxides, phosphates, halogenides and zirconates that are of interest for nuclear waste management. We obtained the best description of these materials with the Hubbard U (and J) parameters derived for each cation and material using linear response method. Predicted structures of many of modelled materials agree surprisingly well with the measured ionic positions and lattice parameters. This is not seen when standard DFT methods are used. Our results indicate that simple modifications of DFT such as DFT+U, with properly estimated U parameter can successfully be used in computation of strongly correlated materials.

MP 13.4 Tue 8:00 SPA Foyer

Strong majorization entropic uncertainty relations — •Łukasz Rudnicki[1,2], Zbigniew Puchała[3,4], and Karol Zyczkowski[2,4] — [1]Freiburg Institute for Advanced Studies, Albert-Ludwigs University of Freiburg, Albertstrasse 19, 79104 Freiburg, Germany — [2]Center for Theoretical Physics, Polish Academy of Sciences, Aleja Lotników 32/46, PL-02-668 Warsaw, Poland — [3]Institute of Theoretical and Applied Informatics, Polish Academy of Sciences, Bałtycka 5, 44-100 Gliwice, Poland — [4]Institute of Physics, Jagiellonian University, ul Reymonta 4, 30-059 Kraków, Poland

We present new entropic uncertainty relations in a finite-dimensional Hilbert space. Using the majorization technique we derive several explicit lower bounds for the sum of two Rényi entropies of the same order. Obtained bounds are expressed in terms of the largest singular values of given unitary matrices. Numerical simulations with random unitary matrices show that our bound is almost always stronger than the well known result of Maassen and Uffink.

MP 13.5 Tue 8:00 SPA Foyer

Numerical solution to the Gross-Pitaevskii equation for dipolar Bose-Einstein condensates — Kishor Kumar R[1], Young-S. Luis E.[2], Dušan Vudragović[3], Antun Balaž[3], •Paulsamy Muruganandam[1], and Sadhan Kumar Adhikari[2] — [1]School of Physics, Bharathidasan University, Palkalaiperur Campus, Tiruchirappalli – 620024, Tamil Nadu, India — [2]Instituto de Física Teórica, UNESP – São Paulo State University, 01.140-70 São Paulo, São Paulo, Brazil — [3]Scientific Computing Laboratory, Institute of Physics Belgrade, University of Belgrade, Pregrevica 118, 11080 Belgrade, Serbia

Many of the static and dynamic properties of dipolar Bose-Einstein condensates are can be studied from the Gross-Pitaevskii equation, a nonlinear nonlocal (integro-differential) partial differential equation. Here we develop a combined split-step Crank-Nicolson and fast Fourier transform based numerical scheme for both stationary and non-stationary solutions of the time-dependent Gross-Pitaevskii equation describing the properties of dipolar Bose-Einstein condensates at ultra low temperatures. We present results from the numerical scheme for energy, chemical potential, root-mean-square sizes and density of the dipolar BECs and compare them with results of other authors.

MP 13.6 Tue 8:00 SPA Foyer

Distribution of the Proper Delay Times of an Andreev Quantum Dot — •Jonas Lammers[1], Francesco Mezzadri[2], and Reinhard F. Werner[1] — [1]Institut für Theoretische Physik, Leibniz Universität Hannover — [2]School of Mathematics, University of Bristol, UK

Andreev Quantum Dots (QDs) are mesoscopic conductors in contact with superconductors which allow for phase-coherent transport of individual electrons and whose intrinsic classical dynamics is fully chaotic (disordered conductor). Instead of trying to predict the behavior of an individual dot it is sensible to treat QDs as stochastic entities, using Random Matrix Theory (RMT) to obtain the statistics of their properties. One of the transport properties of interest is the time delay suffered by incoming particles due to the complex dynamics inside. This is intimately related to the Wigner-Smith time delay matrix $Q = -i\hbar S^\dagger(\partial S/\partial E)$, which is determined by the energy-derivative of the system's unitary scattering matrix $S(E)$. More specifically we are interested in the distribution of the eigenvalues of Q, known as Proper Delay Times (PDTs). Their average gives the Wigner Time Delay, the average time a particle spends inside the QD, and they can be used to determine a number of other quantities beyond the time delay problem.

We compute the distribution $P(\tau_1, \ldots, \tau_N)$ of the PDTs of Andreev QDs for all four Altland-Zirnbauer random matrix symmetry classes, D, DIII, C, and CI, depending on the presence/absence of time-reversal invariance and/or spin-rotation symmetry.

MP 13.7 Tue 8:00 SPA Foyer

Multiple solutions of the time-independent Gross-Pitaeskii equation — •Želimir Marojević, Ertan Göklü, and Claus Lämmerzahl — ZARM - Center of Applied Space Technology and Microgravity, Bremen

We present a new algorithm which is capable to find saddle point solutions of the Gross-Pitaeskii action for large nonlinearites. It turns out that some of these solutions have unexpected complex structures. This algorithm has been applied to different situations in 2D and 3D, i.e. BEC in a harmonic trap, gravitational trap and no trap with Dirichlet boundary conditions.

MP 13.8 Tue 8:00 SPA Foyer

Correlated thermal machines in the micro-world — •Rodrigo Gallego — Dahlem Center for Complex Quantum Systems. 14195 Berlin-Dahlem

How much work can be extracted from a heat bath using a thermal machine? The study of this question has a very long tradition in statistical physics in the weak-coupling limit, applied to macroscopic systems. However, the assumption that thermal heat baths remain uncorrelated with physical systems at hand is less reasonable on the nano-scale and in the quantum setting, where correlations and entanglement may be expected to be prevalent. In this work, we establish a framework of work extraction in the presence of quantum correlations. We show in a mathematically rigorous and quantitative fashion that quantum correlations and entanglement emerge as a limitation to work extraction compared to what would be allowed by the second law of thermodynamics. At the heart of the approach are operations that capture naturally non-equilibrium dynamics encountered when putting physical systems into contact with each other. We discuss various limits that relate to known results and put our work into context of approaches to finite-time quantum thermodynamics.