Poster Session
Présentations par affiches

MAZEN AL-GHOUL, American University of Beirut
Nonequilibrium Partition Function in the Presence of Heat Flow

In the literature on extended thermodynamics, the nonequilibrium partition function in the presence of a heat flux appears in a divergent form, which has been usually evaluated by expanding the divergence causing exponential factor involving the heat flux and by arbitrarily truncating the resulting divergent series of the integrals. In this paper, we show how to cast the nonequilibrium partition function in the presence of a heat flux into a convergent form and then calculate such a convergent nonequilibrium partition function in the case of a nonequilibrium dilute monatomic gas. We have used three different methods of evaluation. Thus one of the nagging problems is resolved that arises in the 13 moment approximation to irreversible processes in the nonequilibrium statistical mechanics of extended thermodynamics.

LIOR ALON, Technion, Israeli institute of technology
On the nodal distribution of quantum graphs

The nodal surplus is the suitably normalized number of zeros of a Laplacian eigenfunction. Berkolaikos remarkable nodal-magnetic connection implies that the nodal surplus of a metric graph eigenfunction is equal to the stability index of its eigenvalue under magnetic perturbations. It has been suggested that the distribution of the nodal surplus contains information about the geometry of the underlying domain. We study the nodal surplus distribution for metric graphs. The existence of the distribution is established, along with its symmetry. One consequence of the symmetry is that a topological quantity - the Euler characteristic of the graph can be recovered as twice the average nodal surplus of its eigenfunctions. Furthermore, for graphs with disjoint cycles it is proven that the distribution has a universal form - it is binomial over the allowed range of values of the surplus.

LEA BOSSMANN, University of Tübingen
Derivation of the 1d Gross-Pitaevskii equation from the 3d quantum many-body dynamics of strongly confined bosons

We consider the dynamics of N interacting bosons initially exhibiting Bose-Einstein condensation. Due to an external trapping potential, the bosons are strongly confined in two spatial directions, with the transverse extension of the trap being of order ε. The non-negative interaction potential is scaled such that its scattering length is positive and of order $(N/\varepsilon^2)^{-1}$ and the range of the interaction scales as $(N/\varepsilon^2)^{-\beta}$ for $\beta \in (0,1]$. We prove that in the simultaneous limit $N \to \infty$ and $\varepsilon \to 0$, the condensation is preserved by the dynamics and the time evolution is asymptotically described by a nonlinear Schrödinger equation in one dimension. The strength of the nonlinearity depends on the interaction and on the shape of the confining potential. For $\beta = 1$, the effective equation is a physically relevant one-dimensional Gross-Pitaevskii equation, where the coupling parameter contains the scattering length of the unscaled interaction. For our analysis, we adapt an approach by Pickl to the problem with dimensional reduction.

PIETER W. CLAEYS, Ghent University
Floquet resonances from integrability in driven Richardson-Gaudin models

Adiabatically varying the driving frequency of a periodically-driven many-body quantum system can induce controlled transitions between resonant eigenstates of the time-averaged Hamiltonian, corresponding to adiabatic transitions in the Floquet spectrum and presenting a general tool in quantum many-body control.

While it is generally impossible to obtain the exact Floquet Hamiltonian in driven interacting systems, we exploit Richardson-Gaudin integrability to show how techniques from quantum quenches can be used to explicitly construct the Floquet Hamiltonian in a restricted many-body basis of Bethe states and model the resulting Floquet resonances. Using the central spin model as an application, we show how such controlled driving processes can lead to a polarization-based decoupling of the central spin from its decoherence-inducing environment at resonance.

FABIO DEELAN CUNDEN, University College Dublin

Universality of the weak pushed-to-pulled transition in systems with repulsive interactions

We consider a d-dimensional gas in canonical equilibrium under pairwise screened Coulomb repulsion and external confinement, and subject to a volume constraint. We show that its excess free energy displays a generic third-order singularity separating the pushed and pulled phases, irrespective of range of the pairwise interaction, dimension and details of the confining potential. The explicit expression of the excess free energy is universal and interpolates between the Coulomb (long-range) and the delta (zero-range) interaction. The order parameter of this transition - the electrostatic pressure generated by the surface excess charge - is determined by invoking a fundamental energy conservation argument.

Joint work with Paolo Facchi, Marilena Ligabo' and Pierpaolo Vivo.

MALAK DAYEH AND MAZEN AL-GHOUL,

Cahn-Hilliard Approach for a Precipitation Reaction–Diffusion System Exhibiting Pattern Formation

We use the Chan-Hilliard equation to study the newly reported spotted patterns in a periodic precipitation system, which is modeled via a scenario analogous to spinodal decomposition. This pattern emerges as a transition from the classical Liesegang rings to spots with square/hexagonal symmetry in a system, which consists of sulfide/hydroxide ions diffusing into a gel matrix containing dissolved cadmium(II) ions. The phase diagram delineating the onset of the transition and the regions of various patterns is presented. The transition threshold, wavelength, and size of the resulting spots are shown to be controllable by adjusting the initial concentrations of the diffusing electrolytes. We show that the Cahn–Hilliard equation, coupled to reaction-diffusion equations, is able to capture the experimental results.

SOUROUR KARIMI DEHBOKRI, Technische Universitat Braunschweig

Renormalization Group flow

Almost two decades ago, Renormalization Group flow defined by the smooth Feshbach-Schur map was shown by V. Bach, Chen, Fröhlich, and Sigal to possess a codimension-one contractivity property. This contractivity insures that the iterative application of R_ρ (the Renormalization Transformation depends on a scaling parameter ρ) generates a (time-discrete) dynamical system on D (small ball of Banach space of operators, that is the domain of definition of the RG map) with a fixed point manifold of dimension one. Now we improved scheme that is (fully) contracting and has no marginal directions anymore. This allows for characterizing the properties on the fixed point much more precisely. This is joint work with V. Bach.

DANILO DIAZ, UNAB, Chile

Listen to the CFT Weyl anomaly with gravity

We propose a recipe - arguably the simplest - to compute the holographic type-B Weyl anomaly for general higher-derivative gravity in asymptotically AdS spacetimes. In 5 and 7 dimensions we identify a suitable basis of curvature invariants that allows to read off easily, without any further computation, the Weyl anomaly coefficients of the dual CFT. We provide few examples,where the anomaly coefficients have been obtained by other means, to illustrate the effectiveness of our prescription. We also examine the implications of these findings in the holographic description of 4D and 6D conformally invariant powers of the Laplacian (GJMS operators) and 4D conformal higher spins (CHS).

MAXIMILIAN DUELL, Technische Universität München

N-Particle Scattering in Wedge-local QFT

I will present my results on the construction of Haag-Ruelle-type scattering states with arbitrarily many particles in the general operator-algebraic setting of massive wedge-local quantum field theory. In this context, wedge-geometrical obstructions invalidate conventional Haag-Ruelle arguments beyond the two-particle case. These geometrical limitations are overcome in my work by wedge-duality arguments. Ample testing grounds for my results are provided by various recently constructed wedge-local models with non-trivial scattering on four-dimensional Minkowski space-time (Grosse-Lechner, Buchholz-Lechner-Summers). These models are presently being investigated regarding qualitative particle-phenomenological features such as asymptotic completeness. (partially based on arxiv:1711.02569, to appear in CMP)

FIONA GOTTSCHALK, Technische Universität Braunschweig
Infrared Bounds for Ferromagnetic Models without Translation Invariance

Subject of our considerations are the infrared bounds established by Fröhlich, Simon, and Spencer in 1976 for classical statistical mechanical lattice systems with a continuous symmetry. These bounds imply the existence of a phase transition at sufficiently low temperature in three or more spatial dimensions.
Instead of using reflection positivity, we reproduce and generalize the result by means of the Helffer-Sjöstrand Formula and the Witten Laplacian, allowing for weaker assumptions on translation invariance. This is joint work with V. Bach.

BHARATH H.M., Georgia Institute of Technology
Non-Negative Symmetric Polynomials and Entangled Bosons

The fundamental relation between quantum entanglement and convex algebraic geometry has unveiled a set of powerful tools, imported from the former to the study the latter. The space of separable mixed states is convex and so is the space of the corresponding observable values. Therefore, the problem of determining whether a set of observable values come from an entangled state is tantamount to checking for membership in a convex set, of a point with coordinates given by the set of observable values.

Here, we use techniques from convex algebraic geometry to develop powerful criteria for entanglement in a many-body system of Bosonic atoms with a non-zero spin . The experimentally accessible observables are the spin expectation values $\langle S_i \rangle$ and $\langle \{S_i, S_j\} \rangle$ which, upon truncating at rank two, are 9 independent quantities in general. Recently, entanglement criteria in terms of 2 of these 9 quantities have been derived [1]. We develop entanglement criteria using all of these 9 quantities. If we consider these numbers as coordinates of a point in a 9 dimensional space, those with a separable parent state lie within a convex region, also known as the moment cone. Therefore, the problem is to characterize this moment cone. Owing to the bosonic exchange symmetry, this moment cone is the dual of the cone of non-negative symmetric polynomials. Together with a characterization of this cone, we also develop an entanglement criterion that is asymptotically tight, for large atom numbers.

[1] Giuseppe Vitagliano et al, New J. Phys., 19, 013027.

ALEXANDER HACH, TU Braunschweig
Suppression of decoherence of a Spin-Boson system by time-periodic control

We consider a finite-dimensional quantum system coupled to a bosonic radiation field and subject to a time-periodic control operator. Assuming the validity of a certain dynamic decoupling condition we study the system's time evolution with regard to the non-interacting dynamics. For sufficiently small coupling constants g and control periods T we show that a certain deviation between coupled and uncoupled propagator as a measure for quantum decoherence may be estimated by $\mathcal{O}(gtT)$. Our approach relies on the notion of Kato stability and general theory of non-autonomous linear evolution equations.

BENJAMIN HINRICHS, Friedrich Schiller University Jena
On the Non-Relativistic Limit of Quantum Electrodynamics

We consider the model of a massless bosonic photon field interacting with a fermionic Dirac field of mass M in the charge $Q = 1$ sector, described by the self-adjoint Hamilton operator H. The non-relativistic limit $M \to \infty$ of the resolvent $(H-z)^{-1}$ for appropriate choice of spectral parameter $z \in \mathbb{C} \setminus \mathbb{R}$ is studied.

We discuss the rise of the one-particle Pauli-Fierz operator, known from the model of non-relativistic quantum electrodynamics, as the effective Hamilton operator in this limit. The emerging error terms and their physical interpretation are sketched. The idea of proof for the main theorems will also be presented.

MICHAEL HOTT, The University of Texas at Austin
A cookbook for deriving the NLS

When describing very large (Quantum) systems, it is essential to pass to an effective description. In the case of Bosons and in the regime of low temperatures, this led to the notion of Bose-Einstein condensation. I will present a list of ingredients that can be used to both derive the NLS and adjust certain mathematically and physical important parameters in the derivation.

MICHAL JEX, Karlsruher Institut für Technologie
Trace Hardy Inequality for Euclidian Space with Cut

We obtain trace Hardy inequalities for the Euclidean space with a bounded or an unbounded cut. In this novel geometric setting the respective trace Hardy inequality non-typically holds also in the two-dimensional case. The obtained results are applied to the heat equation on the Euclidean space with an insulating cut. They imply an estimate on the large time decay for the weighted L^2-norm of the temperature jump across the interface of the insulator.

KENICHI KAMIJO, Graduate School of Life Sciences, Toyo University, Japan
Fractal Structure in Random Walk on n-Dimensional Hypersurface

Discrete random walk on n-dimensional hypersurface has been carried out by computer simulation and its fractal structure has also discussed. As an example in a 3-dimensional hypersurface, when coordinates (x, y, z) are given, the tracks of the random walk based on random variables x, y, and z can be interpreted as a kind of discrete orbit. In this work, we newly define and calculate the local fractal dimension (LFD) in a finite short processing window with a duration consisting of 30 epochs placed on the orbit of the 3-dimensional hypersurface. And then the moving LFD can easily be obtained by sliding the said processing window along the orbit one epoch at a time. It is evident that the same procedure can easily be expanded to general random walk on n-dimensional hypersurface. Specifically, a mathematical method has been proposed for the said discrete orbit on the n-dimensional hypersurface using LFD to evaluate the fractal structure of the random walk system. Normal and uniform random walk have been investigated in detail by computer simulation with results showing that the probability distribution of the moving LFD becomes almost a normal distribution in both cases. The proposed method can also be applied to the analysis of general random processes or statistical quality control in factories or plants using similar procedures.

Keywords: random walk, n-dimensional hypersurface, local fractal dimension, discrete orbit, statistical quality control, fractal structure

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MARKUS LANGE, Karlsruhe Institute of Technology
Renormalization Analysis for Degenerate Ground States

We consider a quantum mechanical system, which is modeled by a Hamiltonian acting on a finite dimensional space with degenerate eigenvalues coupled to a field of relativistic bosons. Provided a mild infrared assumption holds, we prove that the ground-state eigenvalue and the corresponding eigenprojection are analytic functions of the coupling constant in a cone with apex at the origin. In order to show this we extend operator theoretic renormalization to degenerate situations.

JINYEOP LEE, KAIST
Rate of Convergence towards Hartree Dynamics with Singular Interaction Potential

We consider a system of N-Bosons with a two-body interaction potential $V \in L^2(\mathbb{R}^3) + L^\infty(\mathbb{R}^3)$, possibly more singular than the Coulomb interaction. We show that, with $H^1(\mathbb{R}^3)$ initial data, the difference between the many-body Schrödinger evolution in the mean-field regime and the corresponding Hartree dynamics is of order $1/N$, for any fixed time. The N-dependence of the bound is optimal.

KYUSUP LEE, Seoul National University
Application of a New Solution Method for Fredholm Integral Equation to Geminate Recombination of Hole-Electron Pair

We have proposed a new approximate solution method for the Fredholm integral equation of the second kind with nonzero kernel function. The new solution method has been found to be very useful in the problems of diffusion-influenced chemical kinetics. Here, we consider the effects of external electric field and anisotropic long-range reactivity on the recombination dynamics of a geminate charge pair. A closed-form analytic expression for the ultimate separation probability of the pair is presented. In previous theories, analytic expressions for the separation probability were obtained only for the case where the recombination reaction can be assumed to occur at a contact separation. For this case, Noolandi and Hong obtained an exact solution, but their expression for the separation probability was too complicated to evaluate. Hence an approximate analytic expression proposed by Braun has been widely used. However, Braun's expression overestimates the separation probability when the electric field is large. In this work, we present an approximate analytic expression that is accurate enough for all parameter values. In addition, the expression is also applicable when the interaction between the geminate charge pair is described by screened Coulombic potential, and the recombination reaction has an anisotropic and long-range reactivity. We also provide the expression for the separation probability when the initial separation between the geminate charge pair is larger than the contact distance.

SANGYOUB LEE, Seoul National University
A New Method of Solution for the Fredholm Integral Equation of the Second Kind

When no useful solution is available for a Fredholm integral equation of the second kind, one is apt to resort to a power series solution that can be generated by the method of successive approximations. If the kernel function contained a smallness parameter, this might give a numerically good result. Otherwise, the series can converge very slowly or may even diverge. In such cases, one usually employ the Padé approximant to the series. Usually, this provides a numerically easier procedure than dealing with the resolvent function expressed in terms of Fredholm determinants. Recently, we have proposed a new approximate solution method for the Fredholm integral equation of the second kind with nonzero kernel function. Except that the kernel function must not be zero, the method is general and provides an approximate analytic solution to the problem. Moreover, it gives numerically more accurate results than the Padé approximation method for the same computational cost. Our new solution method has been found to be very useful in the problems of diffusion-influenced chemical kinetics. More recently, we have also found that a similar strategy can be employed to resum the Brillouin-Wigner perturbation series in quantum mechanics.

CAO LINGLING, Ecole des Ponts et Chaussées
The reduced Hartree-Fock model for extended defects in a Fermi sea

Studying the defects in materials remains an important subject in condensed matter physics. Localized defects have been well understood in insulators [Cancès et al, 2008][Lahbabi, 2014]. In this article, we establish a new mean-field model to study the extended defects in metals (modeled by the Fermi sea), where electron-electron interactions are separately modeled by Yukawa and Coulomb interactions. These extended defects typically correspond to taking out a slab of finite width in a three-dimensional perfect material. We work under the framework of reduced Hartree-Fock description [Solovej, 1991], i.e., the Hartree-Fock model without the exchange term. Inspired by the techniques developed in [Frank et al., 2013] in order to study perturbations in a Fermi sea, and in [Hainzl et al., 2005 a, b, 2007, 2009] for the purpose of studying the mean-field perturbations of Dirac sea in quantum electrodynamics, we justify the model by showing the existence of minimizers, and the convergence of Yukawa minimizers (resp. energy) to Coulomb minimizers (resp. energy) when Yukawa parameter tends to zero. Furthermore, we give the characterization of Yukawa minimizers. Finally, we give numerical illustrations of Friedel oscillations [Friedel, 1952], which are oscillations due to the screening of impurities for quantum many-body fermionic systems. We show that the model-generated Friedel oscillation coincides with the theoretic prediction of Friedel oscillation formula.

LING ALFONSO SEQUERA MARIN, Universidad de los Andes

Topological characterization of phase transitions

In this work we study phase transitions from the point of view of topology. Topological invariants (of index-theory type) can characterize phases of matter for some of quantum, as well as classical systems. A paradigmatic example is given by the (classical) Ising model, for which the phase transition can be characterized in terms of basis projections and related $\mathbb{Z}_2$-index, as shown by H. Araki and D. Evans (1983). In joint work with S. Tabban and A.F. Reyes-Lega, we have established an alternative characterization of the phase transition in terms of the $\mathbb{Z}_2$-index that naturally arises in the context of the Shale-Stinespring theorem. This approach allows us to make an explicit connection between the current approaches to topological quantum matter (based on the study of topological invariants) and the operator-algebraic approach of Araki and Evans.

On the other hand, for some kind of topological systems it is possible to express the relevant invariants through local formulas (i.e Chern numbers) using K-theory elements. Recently, Kauffman et al. (2016) have proposed a formula of this type for theories in the frame of Clifford algebras using quaternionic K-theory. We verify the validity of this local index formula for the particular case of the Ising model, taking into account the connection with the CAR and Clifford algebras.

TRIPTI MIDHA, Indian Institute of Techology Ropar

Theoretical investigation of interactions in multi-channel transport processes

Stimulated by the evidence of interactions in the collective dynamics of molecular motors and vehicular traffic in several lanes, we propose and discuss an open two-lane symmetrically coupled interactive totally asymmetric simple exclusion process (TASEP) model that incorporates interaction in the thermodynamically consistent fashion. We study the effect of both repulsive and attractive interaction on the system's dynamical properties using 1- vertical cluster mean-field analysis, 2- vertical cluster mean-field analysis and extensive Monte Carlo simulations. We found that the interactions induce correlations into the system that decreases due to the lane changing of particles. We produce the steady-state phase diagrams for symmetrically split interaction strength. We also analyze the behavior of the maximal particle current concerning the interaction energy E for different coupling rates and interaction splittings. The results suggest that for strong coupling and large splittings, the flow of the motors is maximum at a weak attractive interaction strength known experimentally to exist among kinesin motor protein.

TOMASZ MILLER, Warsaw Univ. of Technology and Univ. of Gdańsk

Causal evolution of probability measures

The causal structure of a spacetime $\mathcal{M}$ is usually described in terms of a binary relation $\preceq$ between events called the casual precedence relation. In my poster I will present a natural extension of $\preceq$ onto the space $\mathcal{P}(\mathcal{M})$ of (Borel) probability measures on $\mathcal{M}$, designed to rigorously encapsulate the common intuition that probability can only flow along future-directed causal curves.

Using the tools of the optimal transport theory adapted to the Lorentzian setting, one can utilize thus obtained notion of "causality between probability measures" to model a causal time-evolution of a spatially distributed physical entity in a globally hyperbolic spacetime. In the poster I will define what it means that a time-dependent probability measure $\mu_t \in \mathcal{P}(\mathcal{M})$ evolves causally. I will also explain how such an evolution can be understood as a "probability measure on the space of worldlines". Moreover, some preliminary results concerning the relationship between the causal time-evolution of measures and the continuity equation will be highlighted.

[1] M. Eckstein, T. Miller, Ann. Henri Poincaré 18(9), 3049–3096 (2017), doi:10.1007/s00023-017-0566-1

[2] T. Miller, J. Geom. Phys. 116, 295–315 (2017), doi:10.1016/j.geomphys.2017.02.006

[3] M. Eckstein, T. Miller, Phys. Rev. A 95, 032106 (2017), doi:10.1103/PhysRevA.95.032106

ALIP MOHAMMED, Khalifa University

Eigenvalue problem of the inhomogeneous pluriharmonic system for the third boundary condition on the unit polydisc

The explicit eigenvalues and eigenfunctions of the inhomogeneous pluriharmonic functions for the third boundary condition on the unit polydisc are studied. Particular solution, compatibility and solvability conditions are also considered. It is shown that for each eigenvalue k of the problem, there are multiple number of eigenfunctions (k order homogeneous polynomials) and for the number of solutions an interesting recurrence relation is provided.

JORDAN MOODIE, University of Birmingham
An exact power series representation of the Baker-Campbell-Hausdorff formula

The Baker-Campbell-Hausdorff formula is well known and given by $Z = \log(e^X e^Y) = X + Y + \frac{1}{2}[X,Y] + \frac{1}{12}[X,[X,Y] + \frac{1}{12}[Y,[Y,X]] + \cdots$, where it is not obvious what the dots represent. Considering the symmetric form of this formula, namely $S(A,B) = \log(e^{A/2}e^B e^{A/2})$, we find an exact power series representation in the matrix B. We find closed form A-dependent coefficients in the form of hyperbolic functions for all orders of B. Each of these coefficients represent an infinite number of terms in the original expansion, making truncation of the series much more controllable for small B but arbitrary A.

NAZIFE KOCA, Sultan Qaboos University
Explicit Construction of the Voronoi and Delaunay Cells of W(An) and W(Dn) Lattices and Their Facets

Please see the source file: http://arxiv.org/abs/1804.05836

Voronoi and Delaunay (Delone) cells of the root and weight lattices of the Coxeter-Weyl groups W(an) and W(dn) are constructed. The face centered cubic (fcc) and body centered cubic (bcc) lattices are obtained in this context. Basic definitions are introduced such as parallelotope, fundamental simplex, contact polytope, root polytope, Voronoi cell, Delone cell, n-simplex, n-octahedron (cross polytope), n-cube and n-hemicube and their volumes are calculated. Voronoi cell of the root lattice is constructed as the dual of the root polytope which turns out to be the union of Delone cells. It is shown that the Delone cells centered at the origin of the root lattice An are the polytopes of the fundamental weights w1, w2,. . . , wn and the Delone cells of the root lattice Dn are the polytopes obtained from the weights w1, wn-1, wn. A simple mechanism explains the tessellation of the root lattice by Delone cells. We prove that the (n-1) facet of the Voronoi cell of the root lattice An is (n-1) -dimensional rhombohedron and similarly the (n-1) - facet of the Voronoi cell of the root lattice Dn is a dipyramid with a base of (n-2) cube. Volume of the Voronoi cell is calculated via its (n-1) -facet which in turn can be obtained from the fundamental simplex. Tessellations of the root lattice with the Voronoi and Delone cells are explained by giving examples from lower dimensions. Similar considerations are also worked out for the weight lattices An* and Dn*.

JAN NOVÁK, Technical University in Liberec
Linkage of rings and an approach to quantum gravity

We review basic postulates of causal set approach to quantum gravity. We show the emergence of cosmological constant in this theory, which is in concordance with observations and we study the notion of particles and fields. We introduce a different approach to quantum gravity in the second part. We mention that the longstanding problem of general relativity is the continuity of the spacetime. We argument for discretization of space to loops, which we call rings. We define basic processes for these rings, which could be considered like basic laws of quantum gravity. We present the problems, which can be solved inside this theory. We discuss the problem of background independence and arrow of time in this theory. We formulate one interesting mathematical problem from topology at the end.

MAXIMILIAN PECHMANN, FernUniversität in Hagen
Bose–Einstein condensation in the Luttinger–Sy model with contact interaction

We study bosons on the real line in a Poisson random potential (Luttinger–Sy model) with contact interaction in the thermodynamic limit at absolute zero temperature. We prove that generalized Bose–Einstein condensation (BEC) occurs almost surely if the intensity ν_N of the Poisson potential satisfies $[\ln(N)]^4/N^{1-2\eta} \ll \nu_N \lesssim 1$ for arbitrary $0 < \eta \leq 1/3$. We also show that the contact interaction alters the type of condensation, going from a type-I BEC to a type-III BEC as the strength of this interaction is increased. Furthermore, for sufficiently strong contact interactions and $0 < \eta < 1/6$ we prove that the mean particle density in the largest interval is almost surely bounded asymptotically by $\nu_N N^{3/5+\delta}$ for $\delta > 0$.

ROBERT RAUCH, Technische Universität Braunschweig
Orthogonalization of Fermion k-Body Operators and Representabilty

The reduced k-particle density matrix (k-RDM) of a density matrix ρ on fermion Fock space $\mathcal{F}$ can be defined as the image under the orthogonal projection

$$\pi_k : \mathcal{L}^2(\mathcal{F}) \to \mathcal{O}_k \subset \mathcal{L}^2(\mathcal{F})$$

onto the space $\mathcal{O}_k$ of k-body observables on $\mathcal{F}$ within the space of Hilbert-Schmidt operators $\mathcal{L}^2(\mathcal{F})$. A proper understanding of π_k is intimately related to the *representability problem*, a long-standing open problem in computational quantum chemistry, which amounts to give a computationally efficient characterization of the cone $\pi_k(\mathcal{P})$ of *representable* k-RDMs, where $\mathcal{P}$ denotes the cone of positive trace-class operators on $\mathcal{F}$.

The goal of this joint work with V. Bach is the derivation of new representability conditions and the characterization of π_k in the finite-dimensional case. We have recently completed the first step towards this goal by explicitly constructing a distinguished orthonormal basis of $\mathcal{L}^2(\mathcal{F})$ which restricts to a basis adapted to the flag $0 \subsetneq \mathcal{O}_1 \subsetneq \mathcal{O}_2 \subsetneq \cdots$ of k-body observables. This orthonormal basis serves as a tool for the study of the cone $\pi_k(\mathcal{P})$ of representable density-matrices.

SOUAD MARIA TABBAN SABBAGH, Universidad de Los Andes, Colombia
Quantum Entropic Ambiguities and Tomita-Takesaki Theory

Given an algebra of observables $\mathcal{A}$ and a state ω, a density matrix ρ_ω acting on $\mathcal{H}_\omega$ can be obtained through the GNS construction $(\mathcal{H}_\omega, \pi_\omega)$ that gives rise to the same expectation values as ω for elements $a \in \mathcal{A}$, i.e., $\omega(a) \equiv \mathrm{Tr}_{\mathcal{H}_\omega}(\rho_\omega \pi_\omega(a))$. An entropy can be assigned to the state ω by computing the von Neumann entropy of the density matrix $S(\rho_\omega) = -\mathrm{Tr}_{\mathcal{H}_\omega}(\rho_\omega \log \rho_\omega)$. This has proved to be useful, e.g., in the study of entanglement properties of identical particles. However, there are situations for which this density matrix is not unique, thus leading to an entropy ambiguity. This occurs whenever the irreducible components of the representation π_ω appear in $\mathcal{H}_\omega$ with multiplicities (Balachandran et al 2013). In the present work, we develop an interpretation of this phenomenon as a gauge symmetry arising from the action of unitaries in the commutant of the representation via Tomita-Takesaki modular theory. In the finite-dimensional case, a complete characterization of the ambiguity can be given in terms of the modular data, and a physical interpretation can be obtained in terms of an equivalent description of the system as a bipartite system. We will also obtain the ambiguity in the analogue problem of a bipartite system through a cyclic vector induced isomorphism $\mathcal{H}_\omega \to \mathcal{H} \otimes \mathcal{H}$. Here both the state on the full system and its restriction on the gauge system will show the phenomena. We extend our analysis to the case of group transformation C^*-algebras describing the algebras of observables of quantum systems obtained by quantization on configuration spaces of the form G/H, with G a compact Lie group and H a finite, non-abelian subgroup. This is part of a joint work with A.P. Balachandran, I. Burbano Aldana and A.F. Reyes-Lega.

NATASHA SHARMA, Department Of Mathematics, Indian Institute Of Technology, Ropar, Punjab, India-140001
Phase segregation and symmetry breaking in out-of-equilibrium stochastic bidirectional transport systems

Motivated by the connections between the entrance and exit of several physical and biological stochastic transport mechanisms, we studied an open system of a two-species totally asymmetric simple exclusion process with narrow entrances, which assimilate the synergy of the particles with the surrounding environment through attachment/detachment process. We analyzed the model within the framework of mean-field theory, and examined complex steady state phenomena including boundary-induced phase segregation and spontaneous symmetry breaking for varied range of attachment and detachment rates. Our finding displays a prolific behavior, highlighting the crucial effect of attachment / detachment rates on symmetry breaking phenomenon. It is found that for their lower orders, the number of symmetrical and asymmetrical phase increases notably, while for their higher orders asymmetrical phases disappears, revealing the significant impact of bulk non-conserving processes on resuming or breaking of the symmetry between the two species. The theoretical findings are validated by extensive Monte Carlo simulations.

The effect of the system size and symmetry breaking incident on the Monte Carlo simulation results has also been examined based on particle density distributions. The proposed framework provides a natural means to enhance our insight about various non-equilibrium systems present in nature.

OLIVER SIEBERT, FSU Jena
Existence of ground states of translation-invariant Pauli-Fierz models

We consider a translation-invariant non-relativistic QED model describing an electron interacting with a quantized electromagnetic field. Due to the translation-invariance one can decompose the Hamiltonian into a direct integral such that one obtains an operator for each fixed total momentum. For zero total momentum we show the existence of a ground state for all values of the coupling constant by using a compactness argument. In the case of non-zero momentum one has to pass to a coherent state representation inequivalent to the Fock representation in order that a ground state exists. Then we can prove the same result for almost all total momenta being small enough.

PALWINDER SINGH, Lyallpur Khalsa College/ I.K.G Punjab Technical University
Qualitative approach for the study of Impulsive delay dynamical systems

The qualitative study of Impulsive delay dynamical systems is of great importance as it represents many real life problems in physics, engineering, dynamical systems, control systems etc. But qualitative study of such systems is very difficult due to the dependence on previous data and sudden changes at impulsive moments. An alternate approach for the delay differential systems with impulses at fixed moments is presented. The result shows that the present method is more efficient and accurate as compared to the existing in literature. The application of this method is illustrated with the help of an example.

DAVID SVOBODA, Perimeter Institute for Theoretical Physics
A unique connection for Born geometry

In this work, we prove an analog of the fundamental theorem of Riemannian geometry for Born geometry, which describes a target space of a manifestly T-duality covariant effective string theory. We show that there exists a unique connection which preserves structures of the Born geometry and which is torsionless in a generalized sense. This resolves a fundamental ambiguity that is present in the double field theory formulation of effective string dynamics.

GUO CHUAN THIANG, University of Adelaide
Index theory, T-duality, and bulk-boundary correspondence

A powerful heuristic that has emerged from the field of topological matter is that "boundary zero modes detect bulk topology". In fact, the topology-analysis duality in such bulk-boundary correspondences is precisely an expression of index theory in real physical systems. A careful study of crystallographic topological phases even produces new mod 2 index theorems and "crystallographic T-duality".

ANH-KHOI TRINH, McGill University
$\mathcal{N} = 4$ Supersymmetric Yang-Mills Correlators from Supergravity

Computational techniques to study $AdS_5 \times S^5$ supergravity are limited by standard quantum field theory techniques in curved backgrounds. One may hope to bootstrap non-trivial results from the $\mathcal{N} = 4$ supersymmetric Yang-Mills (SYM) conformal field theory (CFT) dual since conformal theory correlators are fully specified by their spectrum and operator product expansion coefficients. Thanks to the recent discovery of inversion integrals based on the classic Froissart-Gribov dispersion inversion formula, one can now extract the CFT data as an analytic function of spin. By utilizing general bootstrap techniques, we present a framework to analytically study the large-N supergravity limit of $\mathcal{N} = 4$ SYM by describing the spectrum of intermediate double-trace operator exchange from a four-point function half-BPS scattering process.

PETRI TUISKU, University of Helsinki
The energy two-point function in the toric Ising model

We present an on-going joint work with Konstantin Izyurov (University of Helsinki) to study the correlations of the two dimensional critical square lattice Ising model on a torus. We present a general approach to studying the correlations of the model through discrete holomorphic observables, and showcase this method for the energy two-point function. Our goal is to calculate the leading order asymptotics of the energy two-point correlator (that is, the energy two-point function) as the mesh size of the square grid embedded on the torus goes to zero.

JOONAS TURUNEN, University of Helsinki
Critical Ising model on infinite random triangulation of the half-plane

We consider the Boltzmann random triangulation of a polygon coupled to Ising model with Dobrushin boundary conditions, which can be viewed as a discrete model of Liouville quantum gravity with matter. We derive an explicit expression of the partition function of the finite triangulations at the critical point. Especially we find an asymptotic perimeter exponent different from the one of the pure gravity universality class. Moreover, we show that the local limit of the Boltzmann Ising-triangulations exists in the sense of Benjamini-Schramm as the boundary size tends to infinity one segment after another, which by using a peeling process can be characterized as an explicit Ising-decorated infinite random triangulation. We also show that the infinite component of the interface only touches the boundary a finite number of times as the boundary size tends to infinity. A scaling limit result concerning the size of the interface is also obtained. This is a joint work with Linxiao Chen (University of Helsinki).

ATUL KUMAR VERMA, Department of Mathematics, Indian Institute of Technology Ropar, India-140001.
A statistical model to study stochastic transport systems with finite resources

There are many real-life physical as well as biological phenomena which depend upon the limited availability of resources. For instance, finite medium engrossed in vehicular and pedestrian dynamics and ribosomes involved in translation process during protein synthesis etc. In particular, biological transport involving molecular motors is also far from being infinite. Motor proteins namely kinesin, dynein and myosin, execute active motion along microtubule filaments serving as macromolecular highways to and from within far-away locations. The transit progression of systems entrusting on the availability of resources requires a balance between available amount and requirement. This circumstance results in the competition for finite resources, thereby influencing the system dynamics considerably.

In this presentation, I will talk about a statistical model namely two-lane asymmetrically coupled Totally Asymmetric Simple Exclusion Process with Langmuir Kinetics to study the impact of the limited supply of particles on stochastic transport systems. We propose a generalized mean-field theory to solve the resulting complex system using singular perturbation technique which is able to explain the rich dynamics arose due to the significant effect of limited resources. Moreover, we have shown that extensively performed Monte Carlo simulation results are in good agreement with simulation results validating our theoretical findings.

AMANDA YOUNG, University of Arizona
On the stability of frustration-free gapped ground states of quantum lattice systems

Gapped quantum spin systems with topologically ordered ground states have been of interest due to their potential for developing fault-tolerant quantum codes. A key feature of such models is that the spectral gap remains open in the presence of small, local perturbations. Several results in this direction are due to Bravyi-Hastings-Michalakis (2010), Bravyi-Hastings (2011), and Michalakis-Zwolak (2013). These results, however, are only proved for quantum spin models with periodic boundary conditions and a unique infinite volume frustration-free ground state. Our work extends these results in several directions: including to quantum spin systems with more general boundary conditions, quantum spin systems with discrete symmetry breaking, and lattice fermion models.