May 25th

1x1h20’ lecture + 3x40’ invited talks + 2x25’ contributed talk

Room: F 206
10:00-10:30 Arrival + Discussions

Chair: Natalia Chepiga
10:30-11:50 Kareljan Schoutens (UvA, QuSoft)
Supersymmetric Lattice Models for CMT
11:50-12:30 Laurens Vanderstraeten (UGent)

12:30-13:50 Lunch + Discussions

Chair: Bernard Nienhuis
13:50-14:30 Lieven Vandersypen (TUDelft)
Simulating Fermi-Hubbard Physics with quantum dot arrays
14:30-15:10 Mikael Fremling (UU)
Sachdev-Ye-Kitaev physics in strained honeycomb iridates - Theory and byproducts.

15:10-15:50 Coffee + Discussions

Chair: Kareljan Schoutens
15:50-16:15 Misha Isachenkov (UvA)
Non-commutative geometry of the SYK model
16:15-16:40 Onno Huijgen (Radboud)
Conserved quantities in the closed XXZ chain

<u>May 31st</u>

1x1h20' lecture + 3x40' invited talks + 1x25' contributed talk

Room: F 206
10:00-10:30 Arrival + Discussions

Chair: Lars Fritz
10:30-11:50 Philippe Corboz (UvA)

11:50-12:30 Jordi Tura Bruguez (Leiden)
Preparation and verification of tensor network states

12:30-13:50 Lunch + Discussions

Chair: Philippe Corboz
13:50-14:30 Lars Fritz (UU)
Role of electron-hole pairs in hydrodynamic two-dimensional electrons
14:30-15:10 Juraj Hasik (UvA)
Simulating chiral spin liquids with iPEPS

15:10-15:50 Coffee + Discussions

Chair: Jordi Tura Brugues
15:50-16:15 Maarten Van Damme (UGent)
Dynamical scattering of quasiparticles in spin chains

June 2nd

4x40’ invited talks + 3x25’ contributed talks

Room: F 461.1 and F 461.2
10:00-10:30 Arrival + Discussions

Chair: Dirk Schuricht
10:30-11:10 Vladimir Gritsev (UvA)
Integrable dynamics
11:10-11:35 Denise Ahmed-Braun (TUE)
Analyzing post-quench dynamics of strongly interacting gases using cluster expansions
11:35-12:00 Lieuwe Bakker (UvA)
Time crystals and dissipative coupled bosons,
12:00-12:25 Jyong-Hao Chen (Leiden)
Bounds on quantum adiabaticity in driven many-body systems from generalized orthogonality catastrophe and quantum speed limit

12:30-13:50 Lunch + Discussions

New room: F 206

Chair: Vladimir Gritsev
13:50-14:30 Sander Otte (TUDelft)
Quantum simulation with atomically assembled spins
14:30-15:10 Jiri Minar (UvA)
Taming spin-boson systems

15:10-15:50 Coffee + Discussions

Chair: Jiri Minar
15:50-16:30 Dirk Schuricht (UU)
Phase diagram of an extended parafermion chain

List of participants:

Jordi Tura Brugues (Leiden)
Philippe Corboz (UvA)
Mikael Fremling (UU)
Lars Fritz (UU)
Vladimir Gritsev (UvA)
Juraj Hasik (UvA)
Bernard Nienhuis (Leiden)
Jiri Minar (UvA)
Sander Otte (TUDelft)
Kareljan Schoutens (UvA, Qusoft)
Dirk Schuricht (UU)
Laurens Vanderstraeten (UGent)
Lieven Vandersypen (TUDelft)
Denise Ahmed-Braun (TU Eindhoven)
Juan Diego Arias Espinoza (UvA)
Lieuwe Bakker (UvA)
Evgenii Barts (Groningen)
Yaroslav Blanter (TUDelft)
Liam Bond (UvA)

Mert Bozkurt (TUDelft)
Lander Burgelman (UGent)
Maarten van Damme (UGent)
Jyong-Hao Chen (Leiden)
Lukas Devos (UGent)
Emanuele Di Salvo (UU)
Ivo Gabrovski (Groningen)
Yaroslav Herasymenko (TUDelft, QuSoft)
Onno Huijgen (Radboud)
Rui-Zhen Huang (UGent)
Misha Isachenkov (UvA)
Bowy La Riviere (TUDelft)
Sebastian Miles (TUDelft)
Stephan Plugge (Leiden)
Artem Pulkin
Mykola Semenyakin (Leiden)
Jose Soto (TUDelft)
Ward Vleeshouwers (UvA)
Xin Zhang (QuTech, TUDelft)

Abstracts:

May 25th:

Kareljan Schoutens

Supersymmetric Lattice Models for CMT

This lecture will introduce supersymmetry as a remarkable and potent symmetry in lattice models in condensed matter. Our original proposal (Fendley, Schoutens, de Boer 2003) specifies a N=2 supersymmetric Hamiltonian on a general graph. This so-called M_1 model, which features hopping terms and local interactions, exhibits remarkable properties. In 1D it turns out to be integrable and critical, and it connects to a supersymmetric version of Conformal Field Theory, first considered in the String Theory literature. On many 2D lattices, the M_1 model shows superfrustration: a proliferation of zero-energy supersymmetric ground states. Generalizations such as M_k models and models with staggered supercharges enrich the supersymmetric landscape. The lecture will introduce the topic and end with two recent developments: a proposal for a quantum simulation of the 1D M_1 model using Rydberg atoms, and a connection with the quantum computational complexity of Topological Data Analysis.

Mikael Fremling

Sachdev-Ye-Kitaev physics in strained honeycomb iridates - Theory and byproducts.

In this seminar, I will discuss the possibility of having Sachdev-Ye-Kitaev (SYK) physics in strained honeycomb iridates. The SYK model needs three ingredients - Majoranas, flat bands, and random all-to-all interactions. The idea is quite simple: Some iridate materials can be modeled with the Kitaev Honeycomb model, and the low energy degrees of freedom are not spins but rather Majorana fermions. By applying strain, the kinetic energy of the Majoranas is quenched, creating flat bands. Finally, taking into account sample impurities and residual Heisenberg interactions, the random all-to-all interactions between the Majoranas will emerge. In our implementation of the above-described idea, we find a bipartite-cousin of the SYK model, which has tunable scaling dimensions and modified level statistics. The latter will lead to a deep dive into random matrix theory and some software development for the Julia language.

Misha Isachenkov

Non-commutative geometry of the SYK model

Sachdev-Ye-Kitaev model provides a solvable playground for understanding quantum many-body dynamics, as well as a convenient building block for models of non-Fermi liquid behaviour. I will discuss a class of SYK-like models in the specific double-scaled limit, where both the length q of the string of interacting Majorana fermions (or spins) and their number N tends to infinity, while q^2/N is kept constant. The limiting theory has an exactly solvable sector which opens up a window to the UV degrees of freedom of the dual theory of quantum gravity. I will discuss how tools from quantum groups and non-commutative geometry combine together to yield an interesting mathematical description of this regime.

Onno Huijgen

Conserved quantities in the closed XXZ chain

The integrability of the XXZ quantum chain is associated with the existence of an extensively long sequence of conserved quantities. In spite of the fact that the XXZ chain is one of the most studied integrable models, only few of its conserved quantities (CQ) have appeared in the literature. In an attempt to see a few more of them, we made use of the intimate relation of the closed XXZ chain to the (affine) Temperley-Lieb (TL) algebra. The transfer matrix can be formally expressed in the TL generators, and the CQ's can be obtained by multiple differentiation. In this way we were able to computer-generate the first ten CQ's explicitly, expressed in terms of the TL generators (at the expense of considerable computer power). Studying the regularities of these expressions suggested an effective recipe to formulate the entire sequence. This recipe allowed us to generate the next seven or so CQ's and verify (by computer) that they commute with the Hamiltonian, which is their defining property: a credible conjecture. Further study of the regularities and making use of the freedom in the precise definition of the sequence, we posed a closed form expression for the entire sequence and proved that the members of the sequence all commute with the Hamiltonian.

June 2nd:

Dirk Schuricht

Phase diagram of an extended parafermion chain

We study the phase diagram of an extended parafermion chain, which, in addi- tion to terms coupling parafermions on neighbouring sites, also possesses terms involving four sites. Via a Fradkin–Kadanoff transformation the parafermion chain is shown to be equivalent to the non-chiral Z3 axial next-nearest neigh- bour Potts model. We discuss a possible experimental realisation using hetero- nanostructures. The phase diagram contains several gapped phases, includ- ing a topological phase where the system possesses three (nearly) degenerate ground states, and a gapless Luttinger-liquid phase.

Reference: Jurriaan Wouters, Fabian Hassler, Hosho Katsura and Dirk Schuricht, SciPost Phys. Core 5, 008 (2022)

Denise Ahmed-Braun

Analyzing post-quench dynamics of strongly interacting gases using cluster expansions

We study post-quench dynamics in strongly interacting gases using the method of cumulants. This method separates clusters of atoms in many-body systems. Truncating at the doublet level, we focus on the application of this method to two different systems. First, we investigate the unitary Bose gas using a two-channel model, focusing on the effect of variations in the width of the Feshbach resonance due to density changes. We generally find that increasing the density leads to a corresponding increase in the production of closed channel molecules, a decrease in the build up of quantum depletion and a transition from linear to quadratic early-time growth of the two-body contact as well as the condensed pair fraction. Next, we comment on the ongoing analysis of the cumulant theory applied to a superfluid Fermi gas. Motivated by findings in the experimental setup of the Value group at Swinburne University of technology, we analyze the magnitude oscillations of the superfluid phase, which are known as the “Higgs mode” and study the effect of the presence of a trapping potential.

Lieuwe Bakker

Time crystals and dissipative coupled bosons

Abstract: In the past decade, the concept of time crystals was introduced as a possible new phase of matter. Whilst initial proposals have been proven to be impossible, the idea remained. In this talk, I would like to give a brief overview of time crystals and discuss their characteristics. I will then discuss a system of coupled driven-dissipative bosonic modes and show that this system exhibits a series of phase transitions between regular dissipative phases and time crystalline ones.

Jyong-Hao Chen

Bounds on quantum adiabaticity in driven many-body systems from generalized orthogonality catastrophe and quantum speed limit

Abstract: We provide new inequalities for estimating adiabatic fidelity in terms of two other more handily calculated quantities, i.e., generalized orthogonality catastrophe and quantum speed limit. Our approach, based on considering a two-dimensional subspace spanned by the initial ground state and its orthogonal complement, allows us to derive stronger bounds on adiabatic fidelity than those previously obtained. One of the two

inequalities is nearly sharp when the system size is large, as illustrated using a driven Rice-Mele model, which represents a broad class of quantum many-body systems whose overlap of different instantaneous ground states exhibits orthogonality catastrophe. Applications to adiabatic quantum computation will also be discussed.
Ref: Jyong-Hao Chen and Vadim Cheianov, arXiv:2112.06900

Jiri Minar

Taming spin-boson systems

Abstract: Most of the currently used platforms for quantum simulation, sensing and computing, including arrays of trapped ions and neutral atoms or superconducting qubits coupled to microwave resonators, can be effectively described as spin-boson systems. The inherent difficulty in treating the unbounded bosonic Hilbert space leads often to considering limiting cases of dispersive couplings and other perturbative approaches. Here an efficient theoretical treatment might allow to explore qualitatively different regimes of the spin-boson systems.
In this talk I will discuss motivating examples, including generation of novel quantum states beyond the paradigm of cat or squeezed states with two-photon micromasers, particularly suited for quantum metrology, or thermalization dynamics in arrays of Rydberg atoms in a facilitated regime. I will then expand on the use of a recently proposed variational ansatz based on non-Gaussian states, discuss the associated issues and outline possible future directions of this research program.