FOR 2316 – Correlations in Integrable Quantum Many-Body Systems

Opening workshop April 11-14 2016

This workshop will focus on the lattice realization of quantum field theories with non-compact degrees of freedom and on functional equations for the calculation of spectra and correlation functions of integrable lattice models.

ABSTRACTS

Form factors for staircase models.
— PATRICK DOREY — University of Durham

Off-diagonal correlations and Bose-Einstein condensation in coupled chains of interacting bosons.
— SEBASTIAN EGGERT — Technical University of Kaiserslautern

The emergence of new properties from low-dimensional building blocks is a universal theme in different areas in physics. The investigation of transitions between isolated and coupled low-dimensional systems promises to reveal new phenomena and exotic phases. Interacting 1D bosons, which are coupled in a two-dimensional array, are maybe the most fundamental example of a system which illustrates the concept of a dimensional phase transition. However, recent experiments using ultracold gases have shown a surprising discrepancy between theory and experiment [1]. We discuss how the off-diagonal correlations in isolated chains can be used to predict the nature of the phase transition to a Bose-Einstein condensate. Comparison with large scale quantum Monte Carlo simulations show surprising discrepancies at low filling, which demonstrate that a careful analysis of different non-commuting limiting cases is necessary.

[1] A. Vogler, R. Labouvie, G. Barontini, S. Eggert, V. Guarrera, and H. Ott, Phys. Rev. Lett. **113**, 215301 (2014)

Non-Linear Integral Equations with a singular kernel.
— YACINE IKHLEF — Université Pierre et Marie Curie

Non-Linear Integral Equations (NLIEs) were introduced in the 1990s as a powerful tool to study the scaling limit of integrable lattice models. Generically, the scaling theory describing the critical point of a spin chain is a Conformal Field Theory (CFT) with a discrete spectrum of scaling dimensions, which can be extracted from the NLIEs by a well-controlled procedure. In this talk, I will present a simple integrable spin-chain model whose Bethe Ansatz equations are governed by a singular kernel: I will explain how to derive the NLIEs in this situation, and how to treat the singularity to obtain the CFT spectrum. It turns out that the corresponding CFT is the $SL(2,R)/U(1)$ "black hole" WZW model, a toy model of CFT with non-compact target space.

Non-compact $a_2^{(2)}$ and $a_3^{(2)}$ spin chains and their physical applications.
— JESPER JACOBSEN — ENS Paris

We describe how non-compact continuum limits arise from $a_{N-1}^{(2)}$ spin chains based on the second baxterisation of the $so(N)$ Birman-Murakami-Wenzl algebra. These chains can be physically realised, for $N = 3$, as the Izergin-Korepin 19-vertex model or the dilute O(n) loop model, and for $N = 4$ as two coupled antiferromagnetic Potts models. The non-compact physics arises in the so-called regime III, which for $N = 3$ contains a theta point of polymers ($n \to 0$ limit) with self-attraction.

The continuum limit of these models is identified by a series of arguments, including level-rank duality, RSOS restrictions, and numerical resolution of the Bethe Ansatz equations. For $N = 3$, the corresponding conformal field theory turns out to be the Euclidean black hole sigma model. In particular, we show that the discrete states in the black hole model emerge from the non-compact continuum upon changing the twist of the spin chains. Some implications of non-compactness for the logarithmic behaviour of observables in the polymer problem are given.

Multi-state extension of the asymmetric simple exclusion process.
— CHIHIRO MATSUI — The University of Tokyo

There are few far-from-equilibrium systems which are analytically solvable. One of those examples is the asymmetric simple exclusion process (ASEP). The ASEP is an integrable two-state stochastic process in one dimension. The integrability of the model lies in the $U_q(sl_2)$-invariance of the bulk part. We consider the multi-state extension of the ASEP based on the fact that the Markov matrix of this process satisfies the Temperley–Lieb algebra. Besides the construction of steady states, we derive the exact expressions of particle-density profiles and currents on the steady states under the closed boundary condition. Although strong restrictions are imposed on hopping rates to keep integrability, we show that they are simplified in the limit q to 0.

On quantum loop algebras: q-oscillator vs. prefundamental representations.
— KHAZRETALI NIROV — University of Wuppertal and INR Moscow

Modern approaches to quantum integrable systems are based on the notion of quantum groups. Here, the choice of a representation in the auxiliary space defines an integrability object, and by a representation in the quantum space one fixes a model subject to consideration. The functional relations between integrability objects follow from the characteristics of the representations of the quantum group. We discuss various representations of quantum loop algebras giving rise to different integrability objects and functional relations. Specifically, we give a comparative analysis of q-oscillator and prefundamental representations of the corresponding Borel subalgebras.

Quantum quenches and excited state correlations in the XXZ spin chain.
— BALÁZS POZSGAY — Hungarian Academy of Sciences

In this talk we will discuss non-equilibrium situations of the XXZ chain, in particular time evolution from simple product states such as the Néel state or the dimerized state. The focus will be on calculating the long-time limit of local observables, which can be performed using the Quench Action method. Two very important ingredients for this method are the overlaps with the initial state and the calculation of short range correlators in arbitrary excited states. We will discuss the latter topic in detail, and

present a conjectured formula which calculates the correlation functions in arbitrary excited states of the finite XXZ chain. Our result builds on the theory of factorization of correlation functions, and it calculates the physical part of the construction using a finite set of Bethe roots. In the thermodynamic limit the formula leads to TBA-like sets of linear equations which can be solved effectively for arbitrary Bethe root distributions.

Integrability and the Conformal Bootstrap.
— VOLKER SCHOMERUS — DESY Theory

The conformal bootstrap programme relies on the expansion of 4-point functions into kinematically determined conformal blocks. I will explain that conformal blocks of scalar 4-point functions in a d-dimensional conformal field theory can mapped to eigenfunctions of a 2-particle hyperbolic Calogero-Sutherland Hamiltonian. The link makes considerable mathematical developments in integrability and the modern theory of special functions available for conformal field theory.

Fermionic basis and reflection relations.
— FEDOR SMIRNOV — Université Pierre et Marie Curie

In this talk I shall discuss the CFT limit of the fermionic basis and its connection with the reflection relations. Emphasis will be done on including the descendants created by the local integrals of motion.

Spinon expansion of correlation functions of the spin 1/2 XXZ model in massive regime.
— JUNJI SUZUKI — Shizuoka University

The recent advance on the form factor expansion approach to correlation functions of the spin 1/2 XXZ model in massive regime will be reviewed. We put emphasis on the advantage in starting from the finite temperature problem with a non-vanishing magnetic field. This yields relatively simple expressions, without complicate multiple contour integrals. The comparison with other numerical approaches will be briefly commented. The talk is based on a collaboration with M. Dugave, F. Göhmann and K. K. Kozlowski.

Heisenberg spin chains by separation of variables: recent advances.
— VERONIQUE TERRAS — Université Paris Sud

During the last decades, important progresses have been made concerning the computation of form factors and correlation functions of simple models solvable by algebraic Bethe Ansatz (ABA) such as the XXZ spin-1/2 chain or 1D Bose gas with periodic boundary conditions. However, the generalization of these results to more complicated models or different types of integrable boundary conditions is for the moment limited by the range of applicability of ABA or by some difficulties of the method.

In this talk, we discuss the solution of Heisenberg spin chains (XXX, XXZ or XYZ) in the framework of a complementary approach, Sklyanin's quantum Separation of Variables approach. This enables us notably to consider for these models various types of boundary conditions (quasi-periodic, open...) not directly solvable by Bethe ansatz. More precisely, we discuss in this framework some new results and open problems concerning the description of the spectrum by means of solutions of a functional T-Q equation (or equivalently in terms of Bethe-type equations). We also discuss the

problem of the computation of the eigenstates scalar products and of the form factors of local operators.

Magneto-thermal transport in the s=1/2 Heisenberg model - revisited.

— XENOPHON ZOTOS — University of Heraklion

I will discuss recent results on the evaluation of spin and thermal Drude weight in the spin-1/2 easy-axis Heisenberg chain and an application in far-out of equilibrium transport.

SCHEDULE

	Monday Apr 11	Tuesday Apr 12	Wednesday Apr 13	Thursday Apr 14
11:00 - 12:00	J. Suzuki	F. Smirnov	J. Jacobsen	Kh. Nirov
14:00 - 15:00	B. Pozsgay	V. Schomerus	S. Eggert	X. Zotos
15:30 - 16:30	V. Terras	J. Ikhlef	C. Matsui	P. Dorey
19:00		joint dinner		