Program Meeting
“Quantum Physics and Bethe Ansatz”

Monday, 8 October; Tuesday, 09 October; Wednesday, 10 October 2012
At the Dublin Institute for Advanced Studies - School of Theoretical Physics

Dr. Daniel An

Title:
Complete Set of Eigenfunctions of the Quantum Periodic Toda Chain

Abstract:
This is a review of a result I published in 2009. We deal with the Quantum Periodic Toda Chain in a mathematical analysis perspective. The main story is that the well-known eigenfunctions of the Quantum Periodic Toda Chain is complete as a consequence of the Liouville's theorem applied to the Baxter's equation.

Dr. Stefan Adams

Title:
A variational formula for the free energy of an interacting many-particle system

Abstract:
We consider N interacting Bosons at equilibrium in the canonical ensemble. The thermodynamic equilibrium is described by the symmetrised trace of $\exp(-\beta H_N)$, where H_N denotes the corresponding Hamilton operator. The well-known Feynman-Kac formula reformulates this trace in terms of N interacting Brownian bridges. Due to the symmetrisation, the bridges are organised in an ensemble of cycles of various lengths. The novelty of our approach is a description in terms of a marked Poisson point process whose marks are the cycles. This allows for an asymptotic analysis of the system via a large-deviations analysis of the stationary empirical field. The resulting variational formula ranges over random shift-invariant marked point elds and optimizes the sum of the interaction and the relative entropy with respect to the reference process. We outline further consequences of this probabilistic representation and show connections to the recently developed interlacements in dimensions d 3.

Dr. Mathieu Beau

Title:
Time-like interference for the slit experiment.

Abstract:
We propose a time-correlation model to treat the slit experiment problem considering the quantum problem for the directions along the slit as well as the direction of the propagation of the electron from the source to the screen. The aim of the talk is to give the motivations of this model and to give correct formulas for the propagator and for the probability for the quantum slit experiment. Then we discuss the differences with the semiclassical model by giving some interference patterns on the screen.

Prof. Jean-Bernard Bru
(joint work with W. De Siquiera Pedra and C. Kurig)

Title:
AC-Conductivity Measure from the Entropy Production of Fermions in Disordered Media

Abstract:
I will present a notion of "AC-conductivity measure" in linear response theory for free fermions on the lattice subjected to a random potential and an electric field that is time- and space-dependent. This notion is based on the positivity of the entropy production and Bochner's theorem. I will additionally explain Green-Kubo relations involving time-correlations of bosonic fields coming from current fluctuations in the system. General properties of the AC-conductivity measure, as its behavior at large, small and moderate randomness, will also be discussed.

Prof. Horia Cornean
Joint work with Mikkel Brynildsen (Aalborg) and Ira Herbst (Virginia).

Title:
Emerging spectral gaps for graphene-like materials in constant magnetic fields

Abstract:
We will review the spectral theory of Harper-like operators with magnetic fields and focus on the situation in which the unperturbed Bloch bands have a conical intersection. We prove that the spectrum of the magnetic Harper operator develops gaps which are proportional with the square root of the intensity of the external field.

Erik Eriksson

Title:
Entanglement entropy from boundary conformal field theory

Abstract:
Entanglement in quantum impurity systems can be studied analytically using boundary conformal field theory (BCFT). In particular, the large-distance effect from an impurity on the entanglement entropy of a surrounding region is governed by the boundary operator content of the model. We here present general results for the corrections to scaling of the Rényi entanglement entropies when perturbing a BCFT with boundary operators.

Prof. Holger Frahm

Title:
Persistent currents in the open Heisenberg chain

Abstract:
Non-parallel boundary magnetic fields can induce a longitudinal (spin) current into a quantum spin chain. Using Sklyanins Separation of Variables and the fusion method we formulate the spectral problem of the spin-$1/2$ Heisenberg model subject to a class of integrable boundary conditions in terms of an infinite hierarchy of nonlinear integral equations. From these equations we compute the finite size corrections to the ground state energy of the antiferromagnetic chain and the induced spin current for a certain range of boundary parameters.

Dr. Natalia Iyudu

Title:
On Hilbert series of quadratic algebras: some problems and some solutions.

Abstract:
We consider the class of quadratic algebras, which include, for example, Weyl algebras, Sklyanin algebras, Jordan plane, Jordan deformation of Gl_2, many other quantum groups, etc. We discuss several open problems about this class of algebras. In particular, the problem on attendance of the Golod-Shafarevich estimate on the number of relations defining the finite dimensional quadratic algebra. A complete solution in the class of semigroup quadratic algebras will be described. We link this to the properties of the Golod-Shafarevich (noncommutative Koszul) complex, and consider consequences for the properties of corresponding representation spaces. Namely, we give some new examples of noncommutative complete intersections (NCCI) which are also representational complete intersections (RCI).

Prof. Vladimir Korepin

Title:
LIEB -LINIGER MODEL OF ONE DIMENSIONAL ANYONS

Abstract:
Fractional statistics became important recently in condensed matter and quantum information. In order to braid anyons one has to use edge states of fqhe. This leads us to 1D anyons. I will consider one component and multi component model of anyons and show that physics is quite different.

Dr. Aleksey Kostenko

The talk is based on joint works with A. Sakhnovich and G. Teschl.
Research supported by the Austrian Science Fund (FWF) under Grant No. M1309.

Title:
Weyl-Titchmarsh-Kodaira theory for Schroedinger operators with strongly singular potentials

Abstract:
Our main aim is to develop Weyl-Titchmarsh-Kodaira theory for Schroedinger operators with strongly singular potentials such as perturbed spherical Schroedinger operators (also known as Bessel operators). In this talk we will show that it is possible to define a corresponding singular Weyl m-function for all values of angular momentum $l\ge -1/2$ and there is also an associated spectral transformation. We will derive an integral representation for this singular m-function and give a criterion when it is a generalized Nevanlinna function. We also find the high-energy asimptotics for singular m-functions and the associated spectral measures. We apply these results for establishing local Borg-Marchenko theorem for Bessel operators as well as uniqueness theorems for radial quantum scattering problem with nontrivial angular momentum.

Dr. Sonia Mazzucchi

Title:
Feynman Path Integrals as Infinite Dimensional Oscillatory Integrals

Abstract:
Since their introduction in the 40s Feynman path integrals have represented a suggestive and powerful tool for the description of the dynamics of several quantum system. On the other hand, it is commonly believed that they are ill defined from a mathematical point of view and represent just an heuristic computational tool. In this talk I shall give an overview of the possible rigorous mathematical definitions of Feynman path integrals, focusing on the ”infinite dimensional oscillatory integrals”, a generalization of classical oscillatory integrals to the case where the integration is performed on an infinite dimensional real separable Hilbert space.

Dr. Ciara Morgan

Title:
Towards a strong converse for the quantum capacity of degradable channels

Abstract:
The quantum capacity of a noisy quantum channel is defined as the maximum rate at which quantum information can be transmitted asymptotically faithfully over that channel. It can be viewed as a measure of the channels ability to preserve and transmit entanglement between the input system to the channel and a reference system or alternatively as its ability to generate entanglement between the sender and the receiver. In this talk we introduce the channel coding theorem for quantum channels and we discuss the elusive strong converse of the theorem for quantum information transmission. We then present some recent progress made towards proving a strong converse theorem for the quantum capacity of a particular class of quantum channels known as degradable channels. The latter is based on joint work in preparation with Andreas Winter.

Valentin Murg

Title:
Algebraic Bethe ansatz and tensor networks

Abstract:
The algebraic Bethe ansatz is a prosperous and well-established method for solving one-dimensional quantum models exactly. The solution of the complex eigenvalue problem is thereby reduced to the solution of a set of algebraic equations. Whereas the spectrum is usually obtained directly, the eigenstates are available only in terms of complex mathematical expressions. This makes it very hard, in general, to extract properties from the states, for example, correlation functions. In our work, we apply the tools of tensor-network states to describe the eigenstates approximately as matrix product states. From the matrix product state expression, we then obtain observables like the structure factor, dimer-dimer correlation functions, chiral correlation functions, and one-particle Green function directly.

Prof. Neil O'Connell

Title:
An interacting particle system related to the quantum Toda chain

Abstract:
I will describe an interacting particle system which can be solved via a connection to the open quantum Toda chain. The particle system can be regarded as a discretisation of the KPZ (or stochastic heat) equation and is closely related to a semi-discrete directed random polymer model in 1+1 dimensions. The connection to the quantum Toda chain yields an explicit integral formula for the Laplace transform of the distribution of the partition function associated with the polymer model.

Eoin Quinn

Title:
Hubbard-Shastry lattice models.

Abstract:
Two new lattice models for strongly correlated electrons, which are exactly-solvable in one dimension, are presented. Along with the Hubbard model and the su(2|2) spin chain, these are the only parity-invariant models that can be obtained from Shastry's R-matrix. One exhibits itinerant ferromagnetic behaviour, while for the other the electrons form bound pairs and at half-filling the model becomes insulating. We derive the thermodynamic Bethe ansatz equations, which capture the equilibrium properties of the models in one dimension, and obtain zero temperature phase diagrams.

Prof. Simon Ruijsenaars

Title:
Joint eigenfunctions for the relativistic Calogero-Moser Hamiltonians of hyperbolic type

Abstract:

We present a recursive scheme that is concerned with the explicit diagonalisation and Hilbert space transform theory for the relativistic generalisation of the hyperbolic N-particle Calogero-Moser system, as defined in terms of 2N commuting analytic difference operators. The first step of the scheme yields the previously known 2-particle eigenfunction, which amounts to a `relativistic' one-parameter generalization of the conical function specialization of the Gauss hypergeometric function. The work on the N>2 case (together with Martin Halln\"as) has not been completed thus far. We sketch the current state of affairs and our goals for future work.

Dr. Baptiste Savoie
This work was done in collaboration with H.D. Cornean

Title:
The Bohr-Van Leeuwen theorem revisited

Abstract:
The Bohr-Van Leeuwen theorem states that classical theory cannot account for diamagnetism. This result was firstly derived by N. Bohr in 1911, then independently by H. J. Van Leeuwen in 1919; both within the framework of the classical statistical mechanics. The aim of this talk is to give a rigorous proof of the B-VL theorem within the framework of the quantum statistical mechanics. The proof essentially is based on a geometric perturbation theory which boils down to a semiclassical analysis in a way.

Prof. Alexander Stolin

Title:
Classification of Lie bialgebras and possible applications to integrable models

Abstract:
In my talk I will explain how to classify Lie bialgebra structures on polynomial Lie algebras, in particular on sl(2,C[u]). This result can be used to deform XXX, XXZ and Gaudin models. Bethe Ansatz for the deformed Gaudin model will be considered.

Prof. Valentin Zagrebnov

Title:
About 1D Disordered BEC with Interaction

Abstract:
The effects of random scatterers on the ground state of the one-dimensional Lieb-Liniger model of interacting bosons is considered in the Gross-Pitaevskii regime. The Bose-Einstein condensation survives even in a strong random potential with a high density of scatterers. The character of the wave function of the condensate, however, depends in an essential way on the interplay between randomness and the strength of the two-body interaction.