# Representation Theory and Integrable Systems

KdV Institute (SP107, room F3.20), Amsterdam 16-23 May

| Time | Tue 16 |
|---|---|
| 10:15 | Opdam: Introduction |
| 10:30 | Stokman |
| 12:00 | LUNCH |
| 14:00 | Semenyakin |
| 16:00 | Marshakov |
| 17:30 | discussion |

| Time | Wed 17 | Thu 18 | Fri 19 | Sat 20 |
|---|---|---|---|---|
| 10:00 | Khoroshkin | Labib | Carlet | |
| 11:30 | Bershtein | Shadrin | Feigin | Vilkovisky |
| 13:00 | LU | N | CH | Gonin |
| 14:00 | Shchechkin | Trofimova | Nurligareev | discussion |
| 16:00 | Bershtein | Povolotsky | Zhuravlov | |
| 17:30 | discussion | discussion | discussion | |

| Time | Mon 22 | Tue 23 |
|---|---|---|
| 11:00 | Caux | Nienhuis |
| 13:00 | LUN | CH |
| 14:00 | Gamayun | Gavrylenko |
| 16:00 | Liashyk | discussion |
| 17:30 | discussion | closing |

General scheme:

- Mornings (except for Wednesday 17th): lectures (see abstracts from the speakers);
- Afternoons: student and tutorial talks.

Some topics for the student and tutorial talks:

- Semenyakin (+ Marshakov): Cluster Poisson varieties and integrable systems.
- Shchechkin (+ Bershtein): Discrete Painleve and cluster transformations.
- Trofimova (+ Povolotsky): Interacting particle systems and Bethe ansatz.
- Khoroshkin-Bershtein: The q-difference Knizhnik-Zamolodchikov equation.
- Nurligareev-Zhuravlov: Sand model and logarithmic CFT.
- Gonin-Vilkovisky: q-Virasoro etc.

Titles and abstracts of the lectures:

- Jasper Stokman, *Correlation functions and harmonic analysis*
  Abstract: Correlation functions for WZW conformal field theory on the torus can be expressed in terms of weighted traces of products of affine Lie algebra intertwiners. This representation theoretic approach to conformal field theory has been developed with great success in works of Frenkel, Reshetikhin, Etingof, Kirillov, Varchenko and many others. In this talk I will indicate what happens, and what can be expected, if one considers matrix coefficients of products of affine Lie algebra intertwiners with respect to vectors that behave as one-dimensional representations for the action of a generalised Onsager subalgebra of the affine Lie algebra. This relates to boundary conformal field theory and to harmonic analysis on affine symmetric pairs. It is a line of investigation which I am currently exploring jointly with Nicolai Reshetikhin.

- Farrokh Labib, *Moduli space of curves and tautological relations via Wittens r-spin class.*
  Abstract: I will give a brief introduction to the moduli space of curves, its tautological ring and the concept of cohomological field theory. We will also look at Giventals R-matrix action which is an action on CohFTs. Then we will discuss specific examples of a CohFT (Wittens class and shifted Wittens class) and see how we can obtain relations by using an R-matrix action on the topological part of the shifted Wittens class. The relations obtained are the PPZ-relations (Pandharipande-Pixton-Zvonkine).

- Sergey Shadrin, *Further remarks on moduli spaces and tautological relations.*
  Abstract: This will be an informal extension of Farrokh's talk, I'll make an overview of some recent and no so recent results.

- Guido Carlet, *On the classification of Poisson and bi-Hamiltonian structures on formal loop spaces under Miura type transformations.*
  Abstract: Dispersive Poisson brackets and bi-Hamiltonian structures on formal loop spaces play a important role in the description of integrable hierarchies, especially in the setting of hierarchies of topological type. We will first review the general framework and motivation for the study of such objects, including the triviality theorem for Poisson structures and the notion of central invariants of a bi-Hamiltonian structure. We will then discuss our recent work, which include the proof, using spectral sequences techniques, of the triviality of the bi-Hamiltonian cohomology of semisimple Poisson brackets of hydrodynamic type. That in turn implies the existence of arbitrary order dispersive deformations, starting from any choice of central invariants. Finally we will briefly describe our recent results on the generalisation to the multivariable setting and outline some open problems. Based on joint works with H. Posthuma, S. Shadrin, M. Casati, R. Kramer.

- Jean-Sebastien Caux, *Dynamics and relaxation in integrable guantum systems*
  Abstract: Recent years have witnessed rapid progress in the use of integrability in characterizing the out-of-equilibrium dynamics of low-dimensional systems such as interacting atomic gases and quantum spin chains. This talk will provide an introduction to these developments, with a particular focus on the Quench Action method. Exact solutions to the interaction turn-on quench in the Lieb-Liniger model and to the Neel-to-XXZ quench in spin chains will be presented. Particular emphasis will be given to interesting open issues and challenges from the mathematical physics perspective, including overlaps between eigenstates of distinct Hamiltonians, the failure of the (local) Generalized Gibbs Ensemble to properly describe post-quench steady-state properties and the necessity to include quasilocal conserved charges to obtain correct answers.

• Bernard Nienhuis, *The I sing model and E8*

Abstract: The 2D classical Ising model, or equivalently the quantum Ising chain in a transverse field, is one of the simplest solvable models with a genuine phase transition. It is solved at all temperatures, but at zero values of the (longitudinal) field. In 1989 Zamolodchikov proposed that at the critical point, and perturbed with a small longitudinal field, the model has an integrable field theory (IFT) as scaling limit. The IFT has eight different stable particles with masses proportional to the elements of the positive eigenvector of the Cartan matrix of the E8 Lie algebra. This is much more structure than one would expect from the simple Ising model. A few years after Zamolodchikov we found a solvable lattice model that can be described as an Ising model in a magnetic field. More precisely it is a spin-1 Ising model with interactions involving the four spins around a square with a controllable up-down symmetry breaking, critical at the symmetric point. It turns out to have the appropriate massive excitations with the same ratios as Zamolodchikov's IFT, thus confirming his proposal. While these facts are old and accepted, there are still many unanswered questions. They became more urgent since the model appeared to have an experimental realisation. In the talk I will present background and the questions I would like to answer or see answered. The talk is intended to solicit collaborations on this subject, rather than to present recent achievements.