9th Bologna Workshop on CFT and Integrable Models

Monday, September 15, 2014 - Thursday, September 18, 2014

Dept. of Physics and Astronomy

Bologna Workshop on:

CFT AND INTEGRABLE MODELS

and their applications to Quantum Field Theory, Statistical Mechanics and Condensed Matter Physics

Book of Abstracts

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Q-functions and classical affine Toda Field Theories

Author: Panagiota Adamopoulou[1]

Co-author: Clare Dunning [1]

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We discuss a connection between classical (1+1)-dimensional A_{n}^{(1)} affine Toda field theories (ATFTs) and Bethe Ansatz systems. We show that the connection coefficients for specific solutions of the associated linear problem for the classical ATFTs satisfy certain functional relations. This way we enlarge the so-called ODE/IM correspondence.

Based on: P. Adamopoulou, C. Dunning 2014 Bethe Ansatz equations for the classical A_{n}^{(1)} affine Toda field theories, J. Phys. A: Math. Theor. 47 205205

Monday morning / 14

Correlation functions in Minimal Liouville Gravity from Douglas string equation

Author: Alexander Belavin[1]

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I am going to present some results about (p,q) Minimal Liouville gravity.

It is assumed that the generating function of the correlators in genus zero in Minimal Liouville gravity (MLG) is nothing but logarithm of the Sato tau-function for dispersionless Gefand-Dikii hierarchy with the special initial condition given by Douglas string equation.

Using the connection between MLG and Frobenious manifold structure we get an explicit and useful expression for log Sato tau-function corresponding Douglas string equation in dispersionless limit.

We argue that the MLG correlators are the expansion coefficients of Log tau-function in respect to the new variables connected with KdV variables by a special noliniear "resonance" transformation in such a way that the MLG correlators satisfy to the necessary fusion rules.

Wednesday morning / 41

Entanglement Entropy of Forrester-Baxter RSOS Models

Author: Davide Bianchini[1]

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We analytically evaluate the R´enyi entropy for the Forrester-Baxter RSOS models in the regime III. These models are lattice realisations of non-unitary minimal models of CFT. By studying the

leading term of this expression it is possible to probe conformal properties of the ground state. Our results agree completely with recent CFT redictions for the entanglement entropy of non-unitary systems. Furthermore we discuss a class of possible quantum Hamiltonian related to off-critical RSOS models.

Discussion - Posters / **27**

Junctions of one-dimensional hard-core bosons

Author: Francesco Buccheri[1]

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We map a system of one-dimensional guides containing bosons with strongly repulsive interaction onto the topological Kondo model. We study the thermodynamic properties by computing the ground state energy and the temperature dependence of the free energy shift due to the junction.

Wednesday morning / **40**

Entanglement Entropy of the Lee-Yang Model from Branch Point Twist Fields

Author: Olalla Castro Alvaredo[1]

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In this talks I will present new (unpublished) results regarding the entanglement entropy of one of the simplest integrable models: the Lee-Yang theory. Despite its simplicity, the Lee-Yang theory is non-unitary. One of the most famous consequences of this non-unitarity was the realization by Zamolodchikov that the form factor expansion of correlation functions is now given in terms of an alternating series. In my talk I will explain how form factors of twists fields and their correlators may be computed for this model which enter an expression for the entanglement entropy of the theory. I will show how this form factor expansion reproduces the predicted CFT behaviour for short distances and how next-to-leading order corrections to the entanglement entropy of large subsystems differ from those found for unitary models.

Wednesday morning / **15**

Entanglement Entropy of non-Unitary Conformal Field Theory

Author: Benjamin Doyon[1]

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In this talk I will show that the entanglement entropy of a region of large size ℓ in a one-dimensional non-unitary critical model behaves as $S\sim(c_{\rm eff}/3)\log\ell$, where $c_{\rm eff}=c-24\Delta>0$ is the effective central charge, c (which may be negative) is the central charge of the conformal field theory and $\Delta\leq 0$ is the lowest holomorphic conformal dimension in the theory. This result generalize the well known expressions for unitary models. I will provide a general proof, as well as numerical evidence for a non-unitary spin chain (an analytical computation using the corner transfer matrix method for a non-unitary lattice model will be discussed by Davide Bianchini). I will show how a new algebraic technique can be used for studying the branching that arise within the replica approach, and find a new expression for the entanglement entropy in terms of correlation functions of twist fields that is valid for non-unitary models. This expression will be further generalized in Olalla Castro-Alvaredo's talk to the massive Yang-Lee model of integrable quantum field theory.

Monday afternoon / **34**

Universal dynamics of a soliton after a quantum quench

Author: Fabio Franchini[1]

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We propose a new type of experimentally feasible quantum quench protocol. A quantum system is prepared in a coherent, localized excited state of a Hamiltonian, whose interaction strength is characterized by a control parameter. At some point during the evolution of this solitonic excitation, the parameter is suddenly changed. We study the dynamics of solitons after this global quench in a semi-classical, hydrodynamic, limit, for a wide class of systems, and we find it to be universal at short times, i.e. not depending on the microscopics of the physical system.
Numerical support for these results is presented using the Calogero model and the non-linear Schroedinger equation, relevant for the implementation of the proposed protocol with ultracold bosons. Finally, it is shown that the effects of integrability breaking by a parabolic potential and by a power-law non-linearity do not change the universality of the short-time dynamics.

Wednesday morning / **39**

Constraints on CFTs in Diverse Dimensions from the Bootstrap Mechanism

Author: Ferdinando Gliozzi[1]

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Recently an efficient numerical method has been developed to implement crossing symmetry and unitarity on the operator dimensions and on OPE coefficients in CFTs in various dimensions.
These calculations can be done only for theories lying at the boundary of the allowed parameter space. I illustrate an alternative method that can be applied to a larger class of CFTs, whether unitary or not, though the obtained results are not yet as precise as in the usual method.
Examples of this kind of calculations, where the usual method cannot be applied, include the CFTs associated with the Yang-Lee edge singularity in $D<6$ or with the ordinary surface transition in 3D Ising model.

Tuesday morning / **36**

QCD Pomeron and AdS/CFT Integrability

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Form factor approach to correlation functions in massless quantum integrable models

Author: Nikolai Kitanine[1]

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We study the asymptotic behaviour of the dynamical correlation functions of massless quantum integrable models. We develop an approach based on the summation of the appropriate (critical) form factors. We show that this approach gives rise to a number of new hypergeometric identities. These identities lead to the leading terms of the asymptotics for the two-point and multi-point correlation functions as well as to the analysis of the edge behaviour of the dynamical structure factors.

Monday afternoon / 16

Energy flow correlations in CFT

Author: Gregory Korchemsky[1]

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We present a new approach to computing energy flow correlations in a generic CFT. These infrared finite observables are familiar from collider physics studies and describe the angular distribution of energy in outgoing radiation created from the vacuum by some source. The energy correlations can be expressed in terms of Wightman correlation functions in a certain limit. We explain how to compute these quantities starting from their Euclidean analogues by means of a non-trivial analytic continuation which, in the framework of CFT, can elegantly be performed in Mellin space. We illustrate the general formalism in N=4 SYM, making use of the well-known results on the four-point correlation function of half-BPS scalar operators.

Monday afternoon / 10

Large-N asymptotic expansion of multiple integrals related to the quantum separation of variables method

Author: Karol Kozlowski[1]

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The scalar products and certain correlation functions of models solvable by the quantum separation of variables

can be expressed in terms of N-fold multiple integrals which can be thought of as the partition function of a one dimensional
gas of particles trapped in an external potential V and interacting through repulsive two-body interactions of the type
$\ln \left[\sinh[\pi$
$om_1($
$la - \mu)] \cdot \sinh[\pi$
$om_2($
$la - \mu)]\right]$.
The analysis of the large-N asymptotic behaviour of these integrals is of interest to the description of the continuum limit of the
integrable model.
Although such partition functions present certain structural resemblances with those arising in the context of the so-called
be-ensembles,
their large-N asymptotic analysis demands the introduction of several new ingredients. Such a complication in the analysis
is due to the lack of dilation invariance of the exponential of the two-body interaction.
In this talk, I shall discuss the main features of the method of asymptotic analysis which we have developed.
The method utilises large-deviation techniques on the one hand and the Riemann–Hilbert problem approach to
truncated Wiener-Hopf singular-integral equations on the other hand.
This is a joint work with G. Borot and A. Guionnet.

Tuesday afternoon / 28

Correlations after quantum quenches in the XXZ spin chain: Failure of the Generalized Gibbs Ensemble

Author: Márton Mestyán[1]

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In closed integrable systems, thermalization after a quantum quench is precluded by the existence of infinitely many conserved charges. The idea of the generalized Gibbs ensemble (GGE) is to include all local conserved charges into the canonical density operator with appropriate Lagrange-multipliers to ensure conservation of local charges. It is a nontrivial question whether the GGE correctly describes all local observables in post-quench steady states. While the validity of the GGE among free theories has been established, we showed that it breaks down for certain quenches of the spin-1/2 XXZ Heisenberg spin chain.

We studied local correlations in the steady state of the XXZ chain after quenches starting from the Majumdar–Ghosh dimer product and Néel states. We computed the correlations using a quench action approach (QA) variant of the thermodynamic Bethe ansatz (TBA) and independently using an infinite time-evolving block decimation (iTEBD) algorithm which simulated the real time evolution of correlations. While the steady-state correlations obtained through the QA and the iTEBD methods agreed consistently, predictions of the GGE failed to reproduce these values. Therefore the GGE, in its present form, is not a generally valid statistical description of post-quench steady states of closed integrable systems.

References:
[1] B. Pozsgay, M. Mestyán, M. A. Werner, M. Kormos, G. Zaránd and G. Takács. Phys. Rev. Lett., in press, arXiv:1405.2843 (2014)

[2] M. Mestyán and B. Pozsgay. J. Stat. Mech.: Theor. Exp., in press, arXiv:1405.0232 (2014)

[3] B. Pozsgay. arXiv:1406.4613 (2014)

Tuesday afternoon / **37**

Quantum Quench Dynamics

Corresponding Author: giuseppe.mussardo@ts.infn.it

I will discuss in simple terms some topics emerging from recent studies of quantum systems driven away from equilibrium. Particular emphasis will be given to the integrable/non-integrable nature of the Hamiltonian and to its local properties.

Wednesday afternoon / **29**

Excited state entanglement in conformal field theory: extensivity and the role of microscopic detail

Author: Tamas Palmai[1]

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We study the excited state subsystem purity (equivalent to 2nd Renyi entropy) as a measure of entanglement in 1+1d conformal field theories. In order to access the highly excited states we generalize the replica approach and develop a systematic framework to treat arbitrary states (in particular descendants) by means of novel CFT techniques including transformation of descendant fields under conformal mappings and exact evaluation of descendant n-point functions. By examining a number of individual states in the critical Ising and three-state Potts models we uncover a new interesting regime of the subsystem purity as a function of the relative subsystem size: when the subsystems are comparable purity decays exponentially with an exponent depending only on the excitation energy and in a nonlinear way. For the Renyi entropy this translates as a quasi thermodynamic entropy, that is extensive but obeys a nonlinear 1st law analog. As an additional application of the present framework we show preliminary results for ground and excited state Renyi entropies in the massive Ising model using a truncated conformal space approach.
arXiv:1406.3182 [hep-th]

Tuesday afternoon / **33**

Revealing elementary excitations of one-dimensional Bose gases through their dynamical structure factor

Author: Milosz Panfil[None]

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Interactions are known to have dramatic effects on bosonic gases in low dimension: Not only does the ground state transform from a condensate-like state to an effective Fermi sea, but new fundamental excitations are predicted to appear which do not have any higher-dimensional equivalents. In this work, we trace these elusive excitations via their effects on the dynamical structure factor of arrays of one-dimensional strongly-interacting Bose gases at low temperature, probed by energy deposition through low-momentum Bragg excitations. The experimental signals are compared to recent theoretical predictions for the dynamical structure factor of the Lieb-Liniger model at finite temperatures. Our results demonstrate that the main contribution to the spectral widths can be explained from the dynamics of the interaction-induced excitations in the gas.

Thursday morning / **38**

Logarithmic Minimal Models: Logging Progress

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Discussion - Posters / **42**

On the scattering over the GKP Vacuum

Author: Simone Piscaglia[None]

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Within the framework of the AdS_5 /CFT_4 correspondence,
the GKP string living on a AdS_5 ⊗ S^5 background finds a counterpart in
the antiferromagnetic vacuum state for the spin chain, fruitfully employed to
investigate the dual N = 4 SYM superconformal gauge theory. Integrability
underlying such a model allows us to analyse the excitations over the vacuum
considered, by computing their scattering matrices and dispersion relations.

Thursday morning / **35**

Breaking the area law in deformed critical spin chains

Author: German Sierra[1]

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Thursday morning / **19**

”Off-critical interfaces in two dimensions. Exact results from field theory”

Author: Alessio Squarcini[1]

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We will consider interfaces of systems of classical statistical mechanics in two dimensions. Interfaces at criticality are conformally invariant random curves and SLE together with field theory have been successfully applied to several models. On the other hand, below criticality exact results are available only from lattice calculations which are restricted to the Ising model, a circumstance that raises the question about the role of Ising solvability. Our aim is to fill this gap, presenting a new, exact, field-theoretic description of interfaces in two dimension which works directly in the continuum. Finally this framework allow us to clarify the role of integrability.
In particular we show how field theory yields the exact description of intermediate phases in the scaling limit close to a first order phase transition point. The ability of a third phase to form an intermediate wetting layer or only isolated bubbles is explicitly related to the spectrum of excitations

of the field theory. The order parameter profiles are determined and interface properties such as passage probabilities and internal structure are deduced from them. The theory is illustrated through the application to the q-state Potts model and Ashkin-Teller model. The latter is shown to provide the first exact solution of a bulk wetting transition. The whole technique can be applied also to the study of interfaces at boundaries. We will develop the exact theory of phase separation in a two-dimensional wedge from the properties of the order parameter and boundary condition changing operators in field theory. For a shallow wedge we determine the passage probability for an interface with endpoints on the boundary. For generic opening angles we exhibit the fundamental origin of the filling transition condition and of the property known as wedge covariance. The limit of a straight opening angle corresponds to an interface on the half plane, the midpoint average distance of the interface from the boundary grows as the square root of the distance between the endpoints, unless the reflection amplitude of the bulk excitations on the boundary possesses a stable bound state pole. The contact angle of the phenomenological wetting theory is exactly related to the location of this pole. Results available from the lattice solution of the Ising model are recovered as a particular case.
References
[1] G. Delfino and A.S., Interfaces and wetting transition on the half plane. Exact results from field theory, J. Stat. Mech. P05010 (2013)
[2] G. Delfino and A.S., Exact theory of intermediate phases in two dimensions, Annals of Physics 342, 171 (2014)
[3] G. Delfino and A.S., Phase separation in a wedge. Exact results, [arXiv1403.1138], to appear in Physical Review Letters

Tuesday morning / 11

The Quantum Spectral Curve of the ABJM theory

Author: Roberto Tateo[1]

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The discovery of integrability in the planar limit of AdS/CFT has
triggered a renewed interest toward the study of finite-size corrections of exactly solvable systems. In this talk, I will present a very recent idea which has made possible the reduction of the complicated Thermodynamic Bethe Ansatz equations for the anomalous dimensions of composite operators in AdS_5/CFT_4 and in AdS_4/CFT_3 to much simpler nonlinear matrix Riemann-Hilbert problems.

Wednesday afternoon / 31

Recurrence Relation for Conformal Blocks

Author: Emilio Trevisani[1]

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We generalize the idea of 1307.6856 to build conformal blocks of a generic CFT (in dimension d>2) using a recurrence relation, idea which has roots in a paper by Zamolodchikov (1984) originally applied to Virasoro blocks in 2 dimensions.

Generalizing this construction we are able to find a recurrence relation to build conformal blocks associated to the four point function of vector operators.

Discussion - Posters / **20**

Two-loop cusp anomaly in ABJM at strong coupling

Author: Edoardo Vescovi[1]

Co-authors: Alexis Brès [2]; Lorenzo Bianchi [1]; Marco S. Bianchi [1]; Valentina Forini [1]

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We compute the null cusp anomalous dimension of ABJM theory at strong coupling up to two-loop order. This is done by evaluating corrections to the corresponding superstring partition function, weighted by the AdS4xCP3 action in AdS light-cone gauge. We compare our result, where we use an anomalous shift in the AdS4 radius, with the cusp anomaly of N=4 SYM, and extract the two-loop contribution to the non-trivial integrable coupling h(λ) of ABJM theory. It coincides with the strong coupling expansion of the exact expression for h(λ) recently conjectured by Gromov and Sizov. Our work provides thus a non-trivial perturbative check for the latter, as well as evidence for two-loop UV-finiteness and quantum integrability of the Type IIA AdS4xCP3 superstring in this gauge. Based on arXiv:1407.4788.

Wednesday afternoon / **17**

Discretely holomorphic observables in the chiral Potts model

Author: Robert Weston[1]

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Monday morning / **9**

Non-Conformal Holography and Localization

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