

Vadim Knizhnik Memorial Conference

IHES, October 30-November 1, 2013

SUMMARY

Organisers:

Alexander Belavin (Moscow)

Nikita Nekrasov (Bures and Stony Brook)

Samson Shatashvili (Dublin and Bures)

This conference was dedicated to the memory of Vadim Knizhnik who passed away 25 years ago. In 2012 he would have been 50 years old. Knizhnik made outstanding contributions to modern theoretical and mathematical physics - Knizhnik-Zamolodchikov equation, Belavin-Knizhnik theorem, Knizhnik-Polyakov-Zamolodchikov quantization of 2d gravity and non-critical strings, Knizhnik supersymmetric vertex are just few to mention. These topics are central to modern string theory, quantum field theory, representation theory and many other fields of mathematics and theoretical physics.

Organisers invited 12 speakers who collaborated with Knizhnik or knew him personally. The list of speakers was very impressive and the lectures covered many modern subjects: relation between integrability and supersymmetry, quantum groups and representation theory, string theory, AdS/CFT correspondence, AGT correspondence, supergravity and conformal field theories.

Conference was very successful in bringing many researchers (about 50 participants) from Paris area and beyond to IHES. Talks were delivered by leaders in the subject of string theory, quantum field theory and related mathematics. This was a small conference, 2 days with 6 talks each day. The conference dinner was attended by all speakers and small speeches were delivered by Knizhnik's close colleagues after the dinner.

Conference was sponsored by ITGP ESF, IHES and Michale Bershadsky.

Description of the scientific content of and discussions at the event

A. Belavin spoke on minimal Liouville gravity from Douglas equation. This is a very old topic, originates in late '80's and Belavin showed how the correlators follow from string equation written by Douglas more that 20 years ago.

A. Polyakov spoke on quantum equilibrium, a topic he been working on last several years. It is hard to describe this talk in few words but here is a link:

<https://www.youtube.com/watch?v=VXlywVChU1w>

A. Zamolodchikov spoke about classical limit of conformal block's in Liouville theory, how the knowledge accumulated from Gauge/Bethe correspondence leads to classical conformal blocks and the appearance of Painleve IV equation.

S. Shatashvili reviewed the relation between quantum integrability and supersymmetric vacua.

John Schwarz formulated a conjecture relating the world-volume action of a D3-brane in as $AdS^5 \times S^5$ background to the effective action of N=4 Super yang-Mills theory on the Coulomb branch.

A. Neveu applied an integral transformation on a version of the Knizhnik-Zamolodchikov equation to obtain explicit representations of Liouville theory four-point conformal blocks for values of their external dimensions on a lattice where their expressions were not previously known.

L. Brink discussed the counterterms in gravity using the light-cone frame formulation and explained that also in this, fully gauge fixed, formulation one needs a local symmetry to find the correct counter terms.

D. Friedan gave an interim report on his long-running project to construct a mechanism that produces spacetime quantum field theory; to indentify possible exotic, non-canonical lowenergy phenomena in SU(2) and SU(3) gauge theories produced by this mechanism; and to calculate signals of these phenomena to see if they can be used to check whether the proposed mechanism operates in the real world.

V. Fateev explained that that sine-Lioville CFT, which is dual to Witten 2-d black hole model, has three different types of integrable perturbations. The corresponding theories also possess nontrivial duality properties. The first two models give the examples of weak-strong coupling dualities between charged fermions and bosons. The third type gives two different field theories, which are dual to massive and massless non-linear sigma models.

D. Bernard spoke on Real Time Imaging of Quantum and Thermal Fluctuations. As an illustration, he looked at quantum systems in contact with a heat bath subject to quantum transitions between energy levels upon absorption or emission of energy quanta. Isolating the two indispensable mechanisms in competition he described the main physical features of thermally activated quantum jumps.

F. Smirnov by means of the fermionic basis conjectured the formulae for the one-point functions of the primary fields and their descendants for sinh-Gordon model. The conjecture is checked against known results: low and high temperature limits, classical limit.

B. Feigin talked on extensions of usual and deformed vertex algebras. He explained that there are two natural ways to construct the new vertex algebras. One - as subalgebra in the known one (bosonisation is the special case of this construction). The second idea is opposite - to get the new algebras as extensions, in this case one adds to vertex algebra some combination of vertex operators. He discussed several examples some of which are related with AGT correspondence.

During the conference there were many discussions involving the speakers as well as participants - Maxim Kontsevich participated in discussions regarding the wall-crossing phenomena, Bernard Duplantier regarding the Kinizhnik-Polyakov-Zamolodchikov scaling and non-critical strings, Misha Gromov about Ricci flows, etc.

**Assessment of the results and impact of the event
on the future direction of the field**

Several talks on this conference were presented first time by authors, those by John Schwarz, A. Belavin, B. Feigin. Some talks were reviews and attracted attention of young participants, those by Polyakov, Shatashvili, Bernard, Friedan. In general the conference was of very high caliber in terms of the quality of the talks and the importance of the speakers for the development of the discipline.

The conference in particular showed that the subject is alive and is developing in various directions. It also demonstrated the strong interest of the leading researchers in the relation between integrability and supersymmetric gauge theories, AGT conjecture and AdS/CFT correspondence. In terms of future directions - all participants agreed, during the informal discussions, that it seems that in near future one shall expect the complete understanding of Liouville quantum field theory, that it is likely we will be able to understand the origin of integrability in certain supersymmetric gauge theories as well the origin of AdS/CFT correspondence.

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IHÉS, 30 -31 October 2013

Wednesday, October 30

- 9:25 IHÉS Director's Introduction
- 9:30 - 10:30 Alexander Belavin (*Landau Institute et IITP, Moscou*)
The correlation numbers in Minimal Liouville gravity from Douglas string equation
- 10:30 - 11:30 Alexander Polyakov (*Princeton Univ.*)
Out of equilibrium
- 11:30 - 11:45 *Coffee break*
- 11:45 - 12:45 Alexander Zamolodchikov (*Rutgers Univ.*)
Classical conformal blocks and Painleve IV
- 12:45 - 2:00 *Lunch*
- 2:00 - 3:00 Samson Shatashvili (*Trinity College, Dublin and IHÉS*)
Integrability and Supersymmetry
- 3:00 - 4:00 John Schwarz (*Caltech, Pasadena*)
N=4 Super Yang-Mills Theory on the Coulomb Branch
- 4:00 - 4:15 *Coffee break*
- 4:15 - 5:15 André Neveu (*Univ. de Montpellier*)
An integral transform for elliptic four-point conformal blocks in Liouville theory

Thursday, October 31

- 9:30 - 10:30 Lars Brink (*Chalmers Univ., Göteborg*)
Counterterms in gravity and N=8 Supergravity
- 10:30 - 11:30 Daniel Friedan (*Rutgers Univ.*)
Where does quantum field theory come from?
- 11:30 - 11:45 *Coffee break*
- 11:45 - 12:45 Vladimir Fateev (*Univ. de Montpellier*)
Integrable deformations of sine-Liouville model and duality
- 12:45 - 2:00 *Lunch*
- 2:00 - 3:00 Denis Bernard (*LPT, ENS-Paris*)
Real Time Imaging of Quantum and Thermal Fluctuations
- 3:00 - 4:00 Fedor Smirnov (*LPTHE, Univ. Pierre et Marie Curie, Paris*)
On one-point functions for sinh-Gordon model at finite temperature
- 4:00 - 4:15 *Coffee break*
- 4:15 - 5:15 Boris Feigin (*Landau Institute, Moscou*)
Extensions of usual and deform vertex algebras

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List of registered participants, speakers and organisers

Nom	Prénom	Institution
ABOU ZEID	Mohab	IHES
ADHIKARI	Subash	Tribhuvan University
ANDRADE	Julio	IHÉS
BABELON	Olivier	LPTHE, UPMC
BELAVIN	Alexander	Landau Institute et IITP, Moscou
BERNARD	Denis	LPT-ENS & CNRS
BERSHADSKY	Michael	
BOALCH	Philip	ENS/IHES
BOSSARD	guillaume	CPhT Polytechnique
BOURAOU	lazare	U_psud.ORSAY
BOUSLAMTI	Samir	upmc
BOUTET DE MONVEL	Anne	Institut de mathematiques de Jussieu IMJ
BRINK	Lars	Chalmers Univ., Göteborg
CHEMIKH	smail	école préparatoire science et technique alger
CHENG	Miranda	IMJ
DAMOUR	Thibault	IHES
DAVID	François	Institut de Physique Théorique CEA Saclay
DUPLANTIER	Bertrand	Institut de Physique Théorique Saclay
DUVAL	Antoine	IPhT
EYNARD	Bertrand	IPHT CEA Saclay
FANG	Xin	IHES
FATEEV	Vladimir	Univ. de Montpellier
FATHIZADEH	Farzad	Western University
FEIGIN	Boris	Landau Institute, Moscou
FRIEDAN	Daniel	Rutgers Univ.
GAO	Ziyang	Université Paris-Sud
GETMANENKO	Alexander	IHES
GETMANSKAYA	Marina	
KIMURA	Taro	CEA Saclay
KLARE	Claudius	IHES & CEA Saclay
KNIZHNIK	Elena	
KNIZHNIK	Gendrikh	
KNIZHNIK	Anna	
KOSMANN-SCHWARZBACH	Yvette	Ecole polytechnique
KOUNNAS	Costas	Laboratoire de Physique Théorique de l'ENS (LPT-ENS)
KUMANO	Yuta	Institute for Solid State Physics, University of Tokyo
LOESER	Francois	UPMC
MANSCHOT	Jan	Université Lyon 1
MICHEL	Florent	LPT Orsay
NAGAR	alessandro	IHES
NASRI	Rafik	Université Dr Tahar Moulay -Saida Algérie
NEKRASOV	Nikita	IHES and SCGP
NEVEU	André	Univ. de Montpellier
PALMKVIST	Jakob	IHÉS
PASQUIER	vincent	IPhT
PESCHANSKI	robi	IPhT saclay
POENARU	Valentin	Président Amis IHES
POLICASTRO	Giuseppe	Ecole Normale Supérieure, Paris
POLYAKOV	Alexander	Princeton Univ.
RIBAUT	Sylvain	IPhT Saclay
SANTACHIARA	raoul	LPTMS, Université Orsay
SCHWARZ	John	Caltech, Pasadena
SHATASHVILI	Samson	IHES and Trinity College, Dublin
SMIRNOV	Fedor	LPTHE
SOULE	christophe	IHES and CNRS
TYUTEREV	Vladimir	Professor of Physics at Reims University
WALLET	Jean-Christophe	Laboratoire de Physique Théorique d'Orsay
WINDEY	Paul	UPMC
ZAMOLODCHIKOV	Alexander	Rutgers Univ.
ZUBER	Jean-Bernard	LPTHE Université Pierre et Marie Curie Paris 6