XXXI WORKSHOP ON GEOMETRIC METHODS IN PHYSICS

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Białowieża, POLAND, 24 June – 30 June 2012

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LIST OF ABSTRACTS

Plenary lectures

1. **Iakovos ANDROULIDAKIS** — *University of Athens, Greece*

   The leafwise Laplacian and its spectrum: the singular case

   The leafwise Laplacian of a (regular) foliation was studied by Connes and Kordyukov. It turns out that the very existence of a longitudinal pseudodifferential calculus shows that this Laplacian is essentially self-adjoint and has the same spectrum in every (irreducible) representation. Moreover, using the K-theory of the holonomy groupoid C^*-algebra, Connes managed to calculate the spectrum of this Laplacian in some cases. In this talk we report on recent work with G. Skandalis generalizing the ingredients of this theory to any singular foliation.

2. **Daniel BELTIŢĂ** — *Institute of Mathematics "Simion Stoilow" of the Romanian Academy, Romania*

   Symbolic calculus on coadjoint orbits of nilpotent Lie groups

   We use coherent states methods for investigating the Weyl–Pedersen calculus for unitary irreducible representations of nilpotent Lie groups. The focus is on finding ways of linking growth properties of the symbols on a coadjoint orbit to boundedness properties of the corresponding operators in the representation space.

3. **Pierre BIELIAVSKY** — *Université Catholique de Louvain, Belgium*

   Oscillatory integrals and Calderon–Vaillancourt estimates for Lie groups and symmetric spaces

   Let G be a Lie group admitting a left-invariant negatively curved Kahlerian structure. Consider any tempered action of G on a Fréchet algebra A. In the case G is Abelian and the action isometrical, Marc Rieffel proved in that Weyl's operator symbol composition formula yields a deformation of A through Fréchet algebra structures on the space of smooth vectors of the action. In this work, we prove the analogous statement in the general negatively curved Kahlerian group and (non-isometrical) "tempered" action case. The construction relies on combining a non-Abelian version of oscillatory integral on tempered Lie groups with geometrical objects coming from invariant WKB-quantization of solvable symplectic symmetric spaces. If time permits, I will also explain how to extend the above construction to C^*-algebras i.e. in such a way the deformed algebras are not only Fréchet but C^* as soon as one starts with a C^*-algebra A. The latter result relies on a curved non-Abelian version of the Calderon–Vaillancourt theorem for pseudo-differential operators. Joint work with V. Gayral.

4. **Michel CAHEN** — *Université Libre de Bruxelles, Belgium*

   Symplectic Dirac operators

5. **Ludwig FADDEEV** – *St. Petersburg Department of the Steklov Mathematical Institute, Russia*

Volkov's pentagon relation for the modular quantum dilogarithm

The new form of the pentagon equation for the quantum dilogarithm, introduced by Alexandre Volkov is rederived for the modular variant of this object using the standard operator technique.

6. **Simone GUTT** – *Université Libre de Bruxelles, Belgium*

Mp^c **structures and symplectic geometry**

7. **Kirill MACKENZIE** – *University of Sheffield, United Kingdom*

Duality for multiple vector bundles

Given a vector bundle E on base M, applying the tangent functor to the addition and scalar multiplication of E gives TE a vector bundle structure on base TM in addition to its structure as the tangent bundle of E. These two structures commute in the sense that the addition, etc, of $TE \to TM$ are vector bundle maps with respect to the other structures, and conversely.

In general a double vector bundle is a manifold D with two vector bundle structures, over bases A and B which are themselves vector bundles over a manifold M, and which commute in this sense. A double vector bundle can be dualized in two distinct ways and each results in a double vector bundle in which one structure has base C^* , where C is the intersection of the kernels of the two bundle projections of D. Remarkably, these two duals are themselves dual over C^* and the two dualizations generate the symmetric group on A, B and C^*.

For triple vector bundles, Gracia-Saz and the speaker (Lett. Math. Phys. 90, 2009, 175–200) showed that the three dualization operations generate a group of order 96, a nonsplit extension of the symmetric group on four elements by the Klein four-group.

Ordinary duality may be described by the relation $X^2 = 1$ and the duality of doubles by $X^2 = Y^2 = (XY)^3 = 1$. In the case $n = 4$ the authors have shown that further relations emerge, and appear to be sufficient for all $n \geq 4$.

8. **Motohico MULASE** – *University of California, Davis, USA*

The Laplace Transform, Mirror Symmetry, and the Topological Recursion of Eynard–Orantin

The topological recursion is a formalism presented by Eynard and Orantin. Marino, and then Bouchard–Klemm–Marino–Pasquetti, proposed that the formalism would provide a universal B-model for toric Calabi–Yau three-folds (the Remodeling Conjecture). The effectiveness of the topological recursion has been seen in non-Calabi–Yau type counting problems, such as counting lattice points of the moduli of curves, double Hurwitz numbers, and Gromov–Witten invariants of Fano varieties. More recently, it has been applied to knot invariants, Seiberg–Witten invariants, and quantization of Riemann surfaces. In this talk, a concrete mathematical framework of the theory is presented, based on the speaker's recent joint works with Dumitrescu, Hernandez–Serrano, Sorkin, and Sulkowski. The relation to integrable systems becomes apparent through the quantization process of Gukov–Sulkowski.

9. **Yurii NERETIN** – *Institute for Theoretical and Experimental Physics, Russia*

   Infinite symmetric group, two-dimensional simplicial bordisms, and Feynman diagrams

10. **Michael SEMENOV-TIAN-SHANSKY** – *Université de Bourogne, France*

   Poisson structure of difference Lax equations and Difference Galois groups

11. **Nikita SLAVNOV** – *Steklov Mathematical Institute, Russia*

   Form factor approach to the correlation functions of integrable models

   Correlation functions of quantum models can be presented as sums of the form factors of local operators. Evaluation of such sums is a long standing problem. We explain how this problem can be solved in the case of integrable critical models.

12. **Mikhail VASILIEV** – *Lebedev Physical Institute, Russia*

   Holography, Unfolding and Higher-Spin Theory

   Interpretation of unfolded dynamics as a far going extension of Fedosov quantization will be given. Holographic duality will be argued to relate classes of models that have equivalent unfolded formulation, hence exhibiting different space-time visualizations for the same theory. This general phenomenon will be illustrated by the AdS_4 higher-spin gauge theory shown to be dual to the theory of $3d$ conformal currents of all spins interacting with $3d$ conformal higher-spin fields of Chern–Simons type.

13. **Stanisław Lech WORONOWICZ** – *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

   R-matrix in the theory of locally compact quantum groups

   Let G be a quasitriangular locally compact quantum group and C^*_G be the category of C^*-algebras with actions of G. We shall show C^*_G is equipped with a natural associative crossed product '$\boxtimes$' that is a functor from $C^*_G \times C^*_G$ into C^*_G. The theory of locally compact quantum groups involved in the game is based on the concept of manageable multiplicative unitaries, in particular we do not assume the existence of Haar weights. Joint work with Ralf Meyer and Sutanu Roy.

Contributed lectures

14. **Syed Twareque ALI** – *Concordia University, Canada*

   Some complex polynomials associated to non-commutative quantum mechanics

   We discuss some interesting families of bi-orthogonal polynomials which are naturally associated to non-commutative quantum mechanics for a system with two degrees of freedom. Such systems can also be looked upon as arising from a three-fold central extension of $\mathbb{R}^4$. The polynomials so obtained go over to the well-known complex Hermite polynomials, when the non-commutativity parameter parameter is set equal to zero, i.e., in the limit of ordinary quantum mechanics.

15. **Anatolij ANTONEVICH** – *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

On mappings with separable dynamics

Let A be the weighted shift operator, generated by a certain mapping. There exist mappings such that operators $A-\lambda I$ can be one-sided invertible for some spectral values of λ. A description of this class of mappings will be given. The result is obtaned in colaboration with Anjela Akhmatova from Belarus State University.

16. **Vladimir BAVULA** – *University of Sheffield, United Kingdom*

An analogue of the Conjecture of Dixmier is true for the algebra of integro-differential operators

In 1968, Dixmier posed six problems for the algebra of polynomial differential operators, i.e. the Weyl algebra. In 1975, Joseph solved the third and sixth problems and, in 2005, I solved the fifth problem and gave a positive solution to the fourth problem but only for homogeneous differential operators. The remaining three problems are still open. The first problem/conjecture of Dixmier (which is equivalent to the Jacobian Conjecture as was shown in 2005-07 by Tsuchimito, Belov and Kontsevich) claims that the Weyl algebra 'behaves' as a finite field extension. In more detail, the first problem/conjecture of Dixmier asks: is it true that an algebra endomorphism of the Weyl algebra an automorphism? In 2010, I proved that this question has an affirmative answer for the algebra of polynomial integro-differential operators. In my talk, I will explain the main ideas, the structure of the proof and recent progress on the first problem/conjecture of Dixmier.

17. **Stefan BERCEANU** – *"Horia Hulubei" National Institute of Physics and Nuclear Engineering, Romania*

A useful parametrization of Siegel-Jacobi manifolds

We determine the homogeneous Kähler transform which splits the Kähler two-form on the Siegel-Jacobi ball (Siegel-Jacobi upper half plane) $\mathcal{D}^J_n = \mathbb{C}^n \times \mathcal{D}_n$ ($\mathcal{X}^J_n = \mathbb{C}^n \times \mathcal{X}_n$) ball into the sum of the Kähler two-form on $\mathbb{C}^n$ and the Kähler two-form on the Siegel ball $\mathcal{D}_n$ (Siegel upper half plane $\mathcal{X}_n$, respectively). In the new variables, the classical motion and the quantum evolution on the Siegel-Jacobi ball (Siegel-Jacobi upper half plane) determined by a linear Hamiltonian in the generators of the Jacobi group G^J_n ($G^J_n(\mathbb{R})$) separates into independent motions on $\mathbb{C}^n$ and on the Siegel ball (Siegel upper half plane, respectively).

18. **Marco BERTOLA** – *Concordia University, Canada*

Poles of Painlevé transcendents and special structures in integrable systems

The connection between Painlevé equations and integrable systems is well known and multi faceted. Here I will show two situations: focusing nonlinear Schroedinger and orthogonal polynomials, where special solutions of the first Painlevé equation play a role in certain asymptotic regimes. In particular the poles of the solutions are connected to special structures of the semiclassical asymtptotic for NLS or the recurrence coefficients for the orthogonal Polynomials. The location of those poles (in several cases) are the subject of interest (e.g. Dubrovin's conjecture for the tritronquee solution of P1) but in general little is known. I will show a sharp (and simple) result of mine on the location of the pole-free region for the Ablowitz–Segur family of solutions of Painlevé II.

19. **Elena BUNKOVA** – *Steklov Mathematical Institute, Russia*

Heat equation and polynomial dynamical systems

This talk is devoted to the one-dimensional heat equation and the non-linear ordinary differential equations associated to it.

Using the anzats connecting the classical elliptic theta-function and the Weierstrass sigma-function, we come to a family of solutions of the heat equation, parametrized by the initial data of the Cauchy problem for the Chazy-3 equation. The same anzats in the general case leads us to a construction of a sequence of families of solutions to the heat equation. This solutions are constructed from homogeneous polynomial dynamical systems in the n-dimensional space. We demonstrate the matches between such systems and non-linear ordinary differential equations of a special type and describe the algorithm that brings the solution of such an equation to a solution of the heat equation. The classical fundamental solution of the heat equation corresponds to the case $n = 0$ in terms of our construction. Solutions of the heat equation defined by the elliptic theta-function lead to the Chazy-3 equation and correspond to the case $n = 2$. The special family of homogeneous ordinary differential equations we have obtained contains as well the Chazy-4 and Chazy-12 equations. Remark that a more general anzats for solutions of the heat equation gives no restrictions on the homogeneous ordinary differential equation.

The results presented in the talk were obtained in collaboration with V.M. Buchstaber. For details on the results see arXiv:1204.3784v1.

The work is supported by program of presidium of RAS "Fundamental problems of non-linear dynamics".

20. **Martin BUREŠ** – *Masarykova Univerzita, Czech Republic*

Stability of the Hydrogen Atom in 4D Compactified Space

We explore the consequences of additional compactified dimensions for the stability of the nonrelativistic hydrogen atom. We used a local modification of the Hardy inequality and the KLMN theorem to prove that the 4D hydrogen atom in a compactified universe is stable for $Z < 1$, i.e. with the same critical charge as in the non-compactified version.

21. **Goce CHADZITASKOS** – *České Vysoké Učení Technické v Praze, Czech Republic*

Title to be announced

22. **Syed CHOWDHURY** – *Concordia University, Canada*

On the symmetry groups of Noncommutative Quantum Mechanics

In the first half of the paper, we discuss how centrally extended $(2 + 1)$ Galilei group arises in the context of Noncommutaive two plane. We show that the coherent state quantization of the phase space variables due to the motion of a point paricle in $\mathbb{R}^2$ under the symmetry of Galilei group makes the underling plane noncommutative. In the later half of the paper, the symmetry groups of NCQM with the precise group multiplication rule and explicit unitary irreducible representations on the relevant Hilbert spaces are investigated using inequivalent local exponents of the group of translations in $\mathbb{R}^4$.

23. **Alireza DEHGHANI** – *Payame Noor University, Iran*

Title to be announced

24. **Michał DOBRSKI** – *Politechnika Łódzka, Poland*

Geometric noncommutative gravity from deformtion quantization of endomorphism bundle

Using Fedosov formalism for deformation quantization of endomorphism bundle we construct some models of pure geometric, deformed vacuum gravity, corresponding to an arbitrary symplectic noncommutativity tensor. Coordinate covariant field equations are given and their solutions (corrections to an arbitrary Ricci-flat metric up to the second order of the deformation parameter) are pointed out. The relation to the theory of the Seiberg-Witten map and the correspondence to the spacetime noncommutativity described by the Fedosov *-product of functions is also explained.

25. **Valeriy DVOEGLAZOV** — *Universidad de Zacatecas, Mexico*

How to construct self/anti-self charge conjugate states? Discrete Symmetries, P, C, T and all that

We construct self/anti-self charge conjugate (Majorana-like) states for higher spins within the quantum field theory. The problems of basis rotations and that of the selection of phases are considered. Meanwhile, dark matter physics requires scalar fields. We show that the non-linear realization of the antisymmetrictensor fields may provide such states with $S = 0$.

26. **Laszlo FEHER** — *Wigner RCP, RMKI and University of Szeged, Hungary*

Some applications of the reduction method to integrable many-body systems

One of the successful approaches to integrable Hamiltonian systems consists in realizing the systems of interest as reductions of simple "free systems" having large symmetries. We report on recent applications of this method to the compactified trigonometric Ruijsenaars–Schneider system and (if time permits) to a generalized Sutherland system of charged particles interacting according to a rule dictated by the $BC(n)$ root system.

27. **Hathout FOUZI** — *Saïda Univeristy, Algeria*

Basic Čech Cohomology and Applications

Let M be a compact oriented manifold endowed with two orthogonal Riemannian foliations F_1 and F_2 respectively of codimensions $n_1 = 4l_1$ and $n_2 = 4l_2$ ($n = n_1 + n_2$). We give relation between the Čech cohomology of M and the Basic (or transverse) Čech cohomology of foliations F_1 and F_2 and as application we deduce results in the case of spin structure and the signature of M basic signatures of the foliations F_1 and F_2.

28. **Gerald GOLDIN** — *Rutgers University, USA*

Conformally compactified Minkowski space and nonlinear electrodynamics

The conformal compactification $M^{\#}$ of (3 + 1)-dimensional Minkowski spacetime is a beautiful mathematical construct, and carries a nonsingular action of the conformal group. As is well-kown, Maxwell's equations respect conformal symmetry, and $M^{\#}$ can be identified with the projective light cone in (4 + 2)-dimensional spacetime so that conformal transformations act as the group $SO(4, 2)$. Then a much-studied construction involves writing an analogue of Maxwell's equations in $4 + 2$ dimensions, and recovering (3 + 1)-dimensional electromagnetism together with some additional fields by a dimensional reduction procedure. We review some interesting coordinatizations of $M^{\#}$ and related spaces, and show how to extend the theory to include general nonlinear electrodynamics. This talk is based on joint work with Steven Duplij and Vladimir Shtelen.

29. **Axel DE GOURSAC** — *Université Catholique de Louvain, Belgium*

Non-formal star-exponential of Kahlerian Lie groups

Recently, a non-formal left-invariant deformation quantization has been constructed for Kahlerian Lie groups with negative curvature. We will present here the star-exponential for such deformed products and give some applications of this construction.

30. **Irena HINTERLEITNER** — *Vysoké učení technické v Brně, Czech Republic*

On holomorphically projective mappings of e-Kahler manifolds

We study fundamental equations of holomorphically projective mappings of e-Kahler manifolds (i.e. classical, pseudo- and hyperbolic Kahler manifolds) with respect to the smoothness class of metrics. We show that holomorphically projective mappings preserve the smoothness class of metrics.

31. **Norbert HOUNKONNOU** — *University of Abomey-Calavi, Republic of Benin*

$\Theta(x,p)-$deformation quantization of harmonic oscillator on a $2D-$phase space

This work addresses a study of a harmonic oscillator in a noncommutative phase space endowed with a generalized commutation relation depending on both position and momentum. Related deformed states and energy spectrum are investigated in different representations.

32. **Jiří HRIVNÁK** — *České Vysoké Učení Technické v Praze, Czech Republic*

Discretization of new Weyl group orbit functions

We discuss the orthogonality of recently discovered special functions related to the Weyl groups. These functions, called S^s- and S^l-functions, are together with $C-$ and $S-$functions a generalization of the common cosine and sine functions. The S^s- and S^l-functions are 'half invariant and half skew-invariant' under the action of the Weyl group. We sample these functions on finite fragments F^s_M and F^l_M of a lattice in any dimension and of any density controlled by M. The symmetry of the lattice is inherited from a compact simple Lie group with two different lengths of roots. An explicit description of their pairwise discrete orthogonality and application to interpolation is given.

33. **Evgeny IASHAGIN** — *Kazan Federal University, Russian Federation*

Extensions of semigroup S and point derivatives of semigroup algebras $l^1(S)$

34. **Dmitry KAPARULIN** — *Tomsk State University, Russian Federation*

Lagrange Anchor and Characteristic Symmetries of Free Massless Fields

A Poincaré covariant Lagrange anchor is found for the non-Lagrangian relativistic wave equations of Bargmann and Wigner describing free massless fields of spin $s > 0$ in four-dimensional Minkowski space. By making use of this Lagrange anchor, I establish a symmetry-to-conservation law correspondence for massless higher spin fields.

35. **Dalibor KARÁSEK** — *České Vysoké Učení Technické v Praze, Czech Republic*

Lie algebras as symmetry algebras of a system of ODEs

36. **Karol KOZŁOWSKI** — *Institut de Mathématiques de Bourgogne, France*

Asymptotic behavior of series of multiple integrals

Quantum integrable models in one dimension constitute a class of non-trivial many-body quantum Hamiltonians where a great number of calculations is feasible to the very end, this without any approximations. It has been shown over the years that it is possible to give a precise description of the spectrum of these model. Recently, there appeared various techniques allowing one to provide representations for the correlation functions in terms of series of multiple integrals. These depend on various parameters (distance, time, coupling constant,...) characterizing the correlator and can be thought of as generalizations of the Fredholm series for a determinant. In this talk, I will briefly discuss the structure of such series of multiple integrals and then overview the recent developments in respect to the extraction of the large-distance and/or long-time asymptotic behavior out of such representations. These results allow one to access to the long-time/large-distance asymptotic behavior of the two-point functions in the so-called non-linear Schrödinger model.

37. **Jerzy LUKIERSKI** — *Uniwersytet Wrocławski, Poland*

Quantum Deformations of $D = 4$ SuperPoincaré algebras and their Euclidean counterparts

We describe a large class of $D = 4$ Euclidean and supersymmetric (Poincaré and Euclidean) classical r-matrices. In our method we start from the complexification of S. Zakrzewski results for the classification of $D = 4$ Poincaré classical r-matrices. The considered deformations lead to such noncommutative superspaces which are covariant under the suitably chosen Hopf-algebraic quantum supersymmetry.

The presentation based on the paper by A. Borowiec, J. Lukierski, M. Mozrzymas and V.N. Tolstoy, arXiv:1112.1936,v.2, JHEP, in press.

38. **Ian MARSHALL** — *High School of Economics, Russia*

Title to be announced

39. **Josef MIKEŠ** — *Univerzita Palackého v Olomouci, Czech Republic*

Fundamental equations of geodesic and holomorphically projective mappings

40. **Ivaïlo MLADENOV** — *Bulgarian Academy of Sciences, Bulgaria*

Unduloid-Like Equilibrium Shapes of Carbon Nanotubes Subjected to Hydrostatic Pressure

In this talk we will consider the problem of explicit determination of possible equilibrium shapes of carbon nanotubes subjected to hydrostatic pressure. The literature in this field is abundant but therein it is generally assumed that the deformed nanotube is a cylindrical surface and only the shape of the tube directrix changes. In this study, using the continuum approach to the analysis of carbon nanostructures suggested by Tu and Ou-Yang, we find that non-cylindrical equilibrium shapes of carbon nanotubes under hydrostatic pressure also exist. Several examples of such shapes that are axially symmetric unduloid-like surfaces are presented.

41. **Vladimir MOLCHANOV** — *Derzhavin Tambov State University, Russia*

Berezin transform and a deformation decomposition

In construction of quantizations in the spirit of Berezin on symplectic spaces G/H the main role belongs to the Berezin transform. Problems for it one has to solve are the following: (a) to express it in terms of Laplace operators on G/H, in fact it is the same as to determine the Plancherel formula for a canonical representation on G/H; (b) to write its asymptotic decomposition when $h \to 0$ (h being the Planck constant). Two first terms of the decomposition give the corresponding principle. Berezin carried out it for Hermitian symmetric spaces G/K. We succeeded in solving these problems for para-Hermitian symmetric spaces of rank one and some spaces of rank two (also for some other rank one symmetric spaces). We write a *full* asymptotic decomposition explicitly. We decompose not into powers h^k, but we use another system of functions. In particular, for polynomial quantization on para-Hermitian symmetric spaces of rank one with genus n we use $1/(\mu^{[k]})$ where $\mu = -n + 1/h$, $\mu^{[k]} = \mu(\mu + 1) \dots (\mu + k - 1)$. Coefficients in the decomposition are some explicitly written polynomials in the Laplace–Beltrami operator on G/H.

42. **Petr NOVOTNY** — *České Vysoké Učení Technické v Praze, Czech Republic*

Graded contractions of representations of Lie algebra $sl(3;\mathbb{C})$

The classification of all representations of a given solvable Lie algebra presents an open problem even in the case of three dimensional Euclidean Lie algebra e(2). We present the concept of graded contractions for representations of Lie algebras, which allows one to construct representations of some solvable Lie algebras from known irreducible representations of simple Lie algebras. We focus on the construction of faithful indecomposable representations and mutually nonequivalent representations. As an example we contract one class of irreducible representations of simple Lie algebra $sl(3;\mathbb{C})$ to the representations of seven dimensional solvable Lie algebra.

43. **Alexandre ODESSKI** – *Brock University, Canada*

Inhomogeneous systems of hydrodynamic type possessing Lax representations

We consider $1+1$-dimensional non-homogeneous systems of hydrodynamic type that possess Lax representations with movable singularities. We present a construction, which provides a wide class of examples of such systems with arbitrary number of components. In the two-component case a classification is given.

44. **Alexander ORLOV** – *Laboratory of Nonlinear Wave Processes, P.P. Shirshov Institute of Oceanology, Russia*

Ginibre and interpolating ensembles as special solutions of integrable hierarchies

I will show that a number of popular matrix models are related to integrable systems. The rusults are new ones.

45. **Zbigniew OZIEWICZ** – *Universidad Nacional Autónoma de México, Mexico*

Groupoid category, relativity groupoid and center-of-inertia

Center-of-inertia of many-body system within isometric relativity depends on auxiliary reference system and therefore is not intrinsic [Landau and Lifshitz; Synge 1956]. Groupoid category, Brandt's groupoid, offers intrinsic center-of-inertia for many-body rotating and interacting system, and intrinsic reduced internal energy (reduced mass). In the limit of the infinite speed of the light the groupoidal expressions collapse to the Newtonian limit.

46. **Sergei PARKHOMENKO** – *L.D. Landau Institute for Theoretical Physics, Russia*

Fermionic screening currents and chiral de Rham complex on toric manifolds.

We represent a generalization of Borisov's construction of chiral de Rham complex for the case of line bundle twisted chiral de Rham complex on toric manifold. We generalize the differential associated to the polytope Δ of the toric manifold by allowing nonzero modes for the screening currents forming this differential. It is shown that the numbers of screening current modes define the support function of toric divisor of a line bundle that twists the chiral de Rham complex on the toric manifold.

47. **Krishna PATHAK** – *Raipur Institute of Technology, India*

Title to be announced

48. **Ivo PETR** – *České Vysoké Učení Technické v Praze, Czech Republic*

Poisson sigma models as constrained Hamiltonian systems

We analyze a class of topological sigma models given by the Poisson structure on a manifold, and show that the Hamiltonian approach leads to a set of constraints which Poisson-commute. We examine the algebra of gauge transformations generated by the constraints, and show how the models incorporate gauge theories, such as Yang-Mills or gravity.

49. **Marcin PIĄTEK** – *Uniwersytet Szczeciński, Poland*

Liouville theory, N=2 gauge theories and accessory parameters

The correspondence between the semiclassical limit of the DOZZ quantum Liouville theory and the Nekrasov–Shatashvili limit of the $N = 2$ (Omega-deformed) $U(2)$ super-Yang–Mills theories is used to calculate the unknown accessory parameter of the Fuchsian uniformization of the 4-punctured sphere. The computation is based on the saddle point method. This allows to find an analytic expression for the $N_f = 4$, $U(2)$ instanton twisted superpotential and, in turn, to sum up the 4-point classical block. It is well known that the critical value of the Liouville action functional is the generating function of the accessory parameters. This statement and the factorization property of the 4-point action allow to express the unknown accessory parameter as the derivative of the 4-point classical block with respect to the modular parameter of the 4-punctured sphere. It has been found that this accessory parameter is related to the sum of all rescaled column lengths of the so-called 'critical' Young diagram extremizing the instanton 'free energy'. It is shown that the sum over the 'critical' column lengths can be rewritten in terms of a contour integral in which the integrand is built out of certain special functions closely related to the ordinary Gamma function.

50. **Barbara PIETRUCZUK** – *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

Resonance phenomenon for potentials of Wigner–von Neumann type

The topic of presentation is behavior of solutions to second order differential equations possesing a certain resonance effect known for Wigner–von Neumann potential. A class of potentials generalizing that of Wigner–von Neumann will be presented.

51. **Rakeshwar PUROHIT** – *Mohanlal Sukhadia University, India*

Some Tilted Bianchi Type IX Dust Fluid Cosmological Model in General Relativity

Tilted Bianchi type IX perfect fluid cosmological model is investigated. To get a determinate solution, it has been assumed that the universe is filled with dust together with . The various physical and geometrical aspects of the model are also discussed.

Keywords: Bianchi type IX universe, Dust fluid, Tilted cosmological model.

2000 Mathematics Subject Classification: 83C50, 83F05.

PACS: 98.80.Jk, 98.80.-k.

52. **Jakub REMBIELIŃSKI** – *Uniwersytet Łódzki, Poland*

Title to be announced

53. **Nasrin SADEGHZADEH** – *Qom University, Iran*

Finsler Ricci flow and Einstein metrics

In this paper we try to get a Finsler Einstein metric with non-constant Ricci scalar. We will produce the conditions under which the Finsler metric is Einstein metric of non-constant Ricci scalar. The main idea is to start with an initial Finsler metric on a manifold and deform it along its Ricci tensor, in fact we use Ricci flow equation in Finsler geometry.

54. **Baraket SAMI** – *King Saud University, Arabia Saudia*

Singular limits for 2-dimensional elliptic problem involving exponential nonlinearity with nonlinear gradient term

Abstract. Given a bounded open regular set $\Omega \subset \mathbb{R}^2$ and $x_1, x_2, \dots, x_m \in \Omega$, we give a sufficient condition for the problem $-\mathrm{div}(a(u)\nabla u) = \rho_2 f(u)$ to have a positive weak solution u in Ω with $u = 0$ on $\partial\Omega$, which is singular at each x_i as the parameter ρ tends to 0 and under suitable assumptions on exponential functions $a(u)$ and $f(u)$.

Mathematics Subject Classification (2000). 35J60, 53C21, 58J05.

Keywords. Singular limits, Green's function, Nonlinear domain decomposition method.

55. **Martin SCHLICHENMAIER** — *Université de Luxembourg, Luxembourg*

An elementary proof of the vanishing of the second Lie algebra cohomology of the Witt and Virasoro algebra with values in the adjoint module

The formal deformations of a Lie algebra L is governed by the second Lie algebra cohomology $H^2(L, L)$. I present an elementary proof of the vanishing of the algebraic cohomology spaces for the Witt- and Virasoro algebra. Hence these algebras are formally rigid. I will also recall some joint results together with Alice Fialowski about the fact, that nevertheless there exist nontrivial geometric deformation families for these algebras given by Krichever Novikov type algebra. This is a typical effect which could only occur for infinite-dimensional Lie algebras.

56. **Svetlana SELIVANOVA** — *Sobolev Institute of Mathematics, Russia*

Local geometry of Carnot-Caratheodory spaces and its applications in nonlinear control theory

Carnot–Caratheodory spaces are a wide generalization of sub-Riemannian manifolds which model nonholonomic physical processes and naturally arise in many applications. We consider the case of arbitrary weighted filtration of the tangent bundle (it generalizes the sub-Riemannian framework of a bracket-generating distribution) and study the local geometry, including metric and algebraic properties, of such spaces in a neighborhood of nonregular points, which is important for nonlinear control theory and subelliptic equations.

57. **Ekaterina SHEMYAKOVA** — *Western University, Canada*

Proof that Darboux Wronskians give all Darboux transformations of total order two

We consider operators of the form $L = D_x D_y + a(x,y)D_x + b(x,y)D_y + c(x,y)$.

Darboux transformation takes L into some L_1 of the same form if there some linear partial differential operator N and M, s.t. $NL = L_1 M$.

As in many other cases, Wronskians formulas imply a large class of such transformations built on some number of partial solutions of initial $L\psi = 0$. In many cases these are proved to be the only known Darboux transformations or simply no exceptions are known. Interestingly, in the case of operators $L = D_x D_y + a(x,y)D_x + b(x,y)D_y + c(x,y)$ there are two famous counter examples, Laplace transformations, which are defined by $M = D_x + b(x,y)$ and $M = D_y + a(x,y)$. The latter transformations are "the best" of all other Darboux transformations of total order one.

Here we prove that 1. Laplace transformations are the only counter example among Darboux transforamtions of total order one. 2. If the transformations is total order strictly two then there is no counter examples. The proof reduces to solution of a large non-linear system of PDEs which is solved using invariant theory spiced with some elegant tricks.

58. **Jan SMOTLACHA** — *České Vysoké Učení Technické v Praze, Czech Republic*

Graded contractions of 3-dimensional representations of $sl(2,\mathbb{C})$

A theory of grading preserving contractions of representations of Lie algebras has been developed. In this theory, grading of the given Lie algebra is characterized by two sets of parameters satisfying a derived set of equations. Here we introduce a list of resulting 3-dimensional representations for the $\mathbb{Z}_3$-grading of the $\mathfrak{sl}(2)$ Lie algebra.

59. **Stephen SONTZ** — *Centro de Investigación en Matemáticas, Mexico*

Dunkl operators as covariant derivatives in a quantum principal bundle

Dunkl operators originated in harmonic analysis and have found application in mathematical physics. Quantum principal bundles are objects of interest in non-commutative geometry. We show how to view Dunkl operators as covariant derivatives of a (quantum, of course) connection in a quantum principal bundle. Joint work with Micho Durdevich.

60. **Vojtěch ŠTĚPÁN** — *České Vysoké Učení Technické v Praze, Czech Republic*

Some Aspects of Poisson–Lie T-Duality

Review of PLT-Duality (Plurality) of 2-dimensional sigma-models will be presented. Then some mathematical background (mainly on supermanifolds) will be discussed from the point of view of its suitability for the model and/or beauty.

61. **Łukasz STĘPIEŃ** — *Uniwersytet Pedagogiczny w Krakowie, Poland*

On Bogomolny decomposition and some solutions of some Skyrme-like models

The Bogomolny decomposition (Bogomolny equations) and the conditions of existence of them, for some Skyrme-like models, will be derived. Some solutions of these models will also be presented.

62. **Rafał SUSZEK** — *Katedra Metod Matematycznych Fizyki, Uniwersytet Warszawski, Poland*

The Gauge Principle in Two-Dimensional Conformal Field Theory

The gauging of groupoidal symmetries of a two-dimensional non-linear sigma model of a multi-phase conformal field theory shall be discussed in the framework of the 2-category of bundle gerbes with connection over the covariant configuration bundle of the model, and that of the geometry of the generalised tangent bundle thereover. In particular, a mixed (Lie-)algebroidal and cohomological classification of gauge anomalies shall be given.

63. **Vitaly TARASOV** — *Indiana University–Purdue University Indianapolis, USA*

Cohomology of flag varieties and Bethe algebras

We identify the equivariant cohomology algebra of the cotangent bundle of a partial flag variety with the image of the Gelfand–Zetlin subalgebra of the Yangian $Y(gl_N)$ acting on the space of vector-valued polynomials invariant under an appropriate action of the symmetric group. For the case of the full flag variety, this identification translates the quantum connection on the cohomology into the dynamical (Casimir) connection. We conjecture a description of the small quantum equivariant cohomology algebra of the cotangent bundle of a partial flag variety as the image of the Bethe subalgebra of $Y(gl_N)$ acting on this space of polynomials.

This is a joint work with V. Gorbounov, R. Rimanyi and A. Varchenko.

64. **Agnieszka TERESZKIEWICZ** — *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

Complete Decomposition of Weyl group orbit product of A_2

Orbits of the Weyl reflection group attached to the simple Lie group A_2 are considered. For this group tensor product of any two orbits is decomposed into the union of the orbits.

65. **Sergiu VACARU** — *University Alexandru Ioan Cuza, Romania*

Noncommutative almost Kaehler–Ricci Solitons and Deformation Quantization

We show how the geometric data for commutative and noncommutative models of Einstein spaces and Ricci solitons can be encoded equivalently in terms of almost Kaehler geometries uniquely determined by the metric and/or almost symplectic strucures. There are provided new classes of exact solutions with (non) commutative variables. Such generic off-diagonal configurations are quantized following the Fedosov method.

Refs.: S. Vacaru, J. Geom. Phys. 60 (2010) 1289, arXiv: 0709.3609; J. Math. Phys. 50 (2009) 073503, arXiv: 0806.3814

66. **Saad VARSAIE** — *Institute for Advanced Studies in Basic Sciences, Iran*

Homotopy classification of superline bundles

In this talk, it is shown that the canonical ν-line bundles over ν-projective spaces [1] can be used for homotopy classification of superline bundles over supermanifolds. Thus the first ν-class can be defined for any superline bundle. Indeed, for a superline bundle over supermanifold $(M, \mathcal{A})$ this class is an element of the second cohomology group of M with coefficients in $\mathbb{Z}[\nu]$, with $\nu^2 = 1$. Roughly, construction of ν-projective spaces implies that the ν-class of a superline bundle, say $\mathcal{E}$, indicates the extent to which even and odd elements of $\mathcal{E}$ are associated to each other.

[1] S. Varsaie; ν-Projective spaces, ν-line bundles and Chern classes, Int. J. Geom. Methods Mod. Phys. 8(2011), no. 2

67. **Sergey VODOPYANOV** — *Sobolev Institute of Mathematics, Russia*

On geometry of Carnot–Carathéodory spaces with C^1-smooth vector fields

Let $\mathbb{M}$ be a smooth N-dimensional manifold. The manifold $\mathbb{M}$ is called a *Carnot manifold* if the tangent bundle $T\mathbb{M}$ has a filtration

$$H\mathbb{M} = H_1\mathbb{M} \subsetneq \ldots \subsetneq H_i\mathbb{M} \subsetneq \ldots \subsetneq H_M\mathbb{M} = T\mathbb{M}$$

by subbundles such that every point $g \in \mathbb{M}$ has a neighborhood $U \subset \mathbb{M}$ equipped with a collection of C^1-smooth vector fields $X_1, \ldots, X_N$, constituting a basis of $T_v\mathbb{M}$ at every point $v \in U$ and meeting the following two properties. For every $v \in U$,

(1) $H_i\mathbb{M}(v) = H_i(v) = \operatorname{span}\{X_1(v), \ldots, X_{\dim H_i}(v)\}$ is a subspace of $T_v\mathbb{M}$ of a constant dimension $\dim H_i$, $i = 1, \ldots, M$;

(2) $[H_i, H_j] \subset H_{i+j}$, $i, j = 1, \ldots, M-1$.

Besides of this, if that next condition holds then the Carnot–Carathéodory space is called the *Carnot manifold*:

(2) $H_{j+1} = \operatorname{span}\{H_j, [H_1, H_j], [H_2, H_{j-1}], \ldots, [H_k, H_{j+1-k}]\}$ where $k = \lfloor \frac{j+1}{2} \rfloor$, $j = 1, \ldots, M-1$.

The subbundle $H\mathbb{M}$ is called *horizontal*. The number M is called the *depth* of the manifold $\mathbb{M}$. The *degree* $\deg X_k$ is defined as $\min\{m \mid X_k \in H_m\}$.

A *sub-Riemannian structure* on $\mathbb{M}$ is a pair $(H\mathbb{M}, \langle\cdot,\cdot\rangle)$ where $H\mathbb{M} = \{H_g\mathbb{M}\}_{g\in\mathbb{M}}$ and $\langle\cdot,\cdot\rangle = \{\langle\cdot,\cdot\rangle_g\}_{g\in\mathbb{M}}$ is a C^1-smooth in g family of Euclidean inner products $(X, Y) \mapsto \langle X, Y\rangle_g$, $X, Y \in H_g\mathbb{M}$, defined on $H_g\mathbb{M}$.

An absolutely continuous curve $\gamma : [0, T] \to \mathbb{M}$ is said to be *horizontal* if $\dot\gamma(t) \in H_{\gamma(t)}\mathbb{M}$ for almost all $t \in [0, T]$. The length of the horizontal curve equals

$$\int_0^T |\dot\gamma(t)|\, dt = \int_0^T \sqrt{\langle\dot\gamma(t), \dot\gamma(t)\rangle_{\gamma(t)}}\, dt.$$

In spite of minimal smoothness we are able to prove some new results and derive from them counterparts of the following results known on Carnot-Carathéodory spaces with smooth enough vector:

1) Gromov nilpotentization theorem in convergence of rescale vector fields;

2) Gromov approximation theorem;

3) Gromov-Mitchell Theorem on the structure tangen cone;

On Carnot manifold we prove

4) Rashevsky–Chow theorem on existence of horizontal curve with the given endpoints.

5) Ball–Box-theorem; this is a counterpart of the well-known Mitchell-Gershkovich-Nagel-Stein-Wainger theorem.

In addition we show some applications of the above-mentioned results to related domains.

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68. **Theodore VORONOV** — *University of Manchester, United Kingdom*

Vector fields on map spaces and a remark about the AKSZ construction

The well-known AKSZ construction (after M. Alexandrov, M. Kontsevich, A. Schwarz, and O. Zaboronsky, who suggested it in 1995) gives a solution of a classical master equation $(S, S) = 0$ on a space of smooth maps between supermanifolds endowed with certain geometric structures. (It was found useful, for example, in deformation quantization.

I will discuss this construction in the context of vector fields on map spaces and demonstrate a construction, which is, in a sense, "inverse" to AKSZ. More precisely, I will show how the geometric data on the AKSZ construction naturally pop up if one requires that certain canonical vector field on the space of mapss is "gradient-type".

69. **Akira YOSHIOKA** — *Tokyo University of Science, Japan*

Star products — formal extension and nonformal extension

We give a brief review on star products. Two directions of extension are explained. One is formal deformation quantization, another is convergent star product. Some examples are explained. I would like to dedicate my talk to Prof. Boris Fedosov.