XXX WORKSHOP ON GEOMETRIC METHODS IN PHYSICS

Białowieża, Poland, June 26 – July 2, 2011

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LIST OF ABSTRACTS

Plenary lectures

1. **Ingemar BENGTSSON** — *Stockholm University, Sweden*

   Complex Hadamard matrices: Introduction

   The study of the shape of the body of density matrices was pioneered by Mielnik. Recently it has become clear that this shape depends in critical ways on the prime number decomposition of the dimension of Hilbert space. As an example of this phenomenon we study pairs of unbiased bases, which leads up to the problem of classifying complex Hadamard matrices. After reviewing some other ways in which this problem arises, I will begin to explain some recent work on it (with Barros e Sa).

2. **Iwo BIAŁYNICKI-BIRULA** — *Centum Fizyki Teoretycznej, PAN, Poland*

   Dynamic Casimir effect: A global view

   The dynamical Casimir effect will be fully described by analogy with the harmonic oscillator. This description exhibits in a direct way a close relation of this effect to the notion of squeezed states. This description is particularly useful in the study of the time evolution of the states. A global view that emerges from this description does not require any mode decompositions of the electromagnetic field.

3. **Marek BOŻEJKO** — *Instytut Matematyczny, Uniwersytet Wrocławski, Poland*

   Generalized Gaussian processes, second quantization of Yang–Baxter type with applications to von Neumann algebras and free probability

   We will present the following topics:

   1) q-Gaussian processes: non-commutative and classical aspects, Comm. Math. Phys. (1997)
   2) Interpolations between bosonic and fermionic relations given by generalized Brownian motions, Math. Z. (1996)
   3) Bessis–Moussa–Villani conjecture for generalized Gaussian random variables, Infin. Dimens. Anal. Quantum Probab. Relat. Top. 11 (2008)
   4) Free infinite divisibility for q-Gaussian and normal law- N(0,1), Adv. Math. (2011)
   5) Functors of white noise associated to characters of the infinite symmetric group, Comm. Math. Phys. (2002)
   6) Remarks on q-CCR relations for $|q| > 1$ and new von Neumann algebras generated by generalized Gaussian processes, Banach Center Publ., vol. 78, Polish Acad. Sci., Warsaw, 2007.

4. **Vasily DOLGUSHEV** — *Temple University, USA*

On stable formality quasi-isomorphisms for Hochschild cochains

I will introduce stable formality quasi-isomorphisms for Hochschild cochains of a polynomial algebra. This notion formalizes quasi-isomorphisms which admit "graphical expansion". The zeroth cohomology $H^0(GC)$ of Kontsevich's graph complex GC acts naturally on homotopy classes of stable formality quasi-isomorphisms. In my talk I will prove that this action turns the set of homotopy classes of stable formality quasi-isomorphisms into a torsor over the group $\exp(H^0(GC))$. If time permits, I will mention various interesting consequences of this result.

5. **David J. FERNÁNDEZ C.** — *Departamento de Física, Cinvestav, Mexico*

Mielnik's achievements on quantum control in Mexico

In this talk two main aspects of quantum control, which require of mathematical techniques basically different, will be addressed: in the first place the systems are characterized by stationary Hamiltonians, while in the second they are ruled by time-dependent ones. These trends were initiated in Mexico by Bogdan Mielnik, who has played a central role in forming a research group on quantum control at Cinvestav.

6. **Rais ISMAGILOV** — *Bauman Moscow State Technical University, Russia*

Racah operators for representations of groups

We define the Racah operators for any triple of representations of locally compact group with the "nice" dual space. To calculate them explicitely some analytical and geometrical considerations are needed.

7. **Alexander KARABEGOV** — *Abilene Christian University, USA*

Infinitesimal deformations of a formal symplectic groupoid

Given a formal symplectic groupoid G over a Poisson manifold (M, π_0), we define a new object, an infinitesimal deformation of G, which can be thought of as a formal symplectic groupoid over the manifold M equipped with an infinitesimal deformation $\pi_0 + \varepsilon\pi_1$ of the Poisson bivector field π_0. The source and target mappings of a deformation of G are deformations of the source and target mappings of G. To any pair of natural star products $(*, \tilde{*})$ having the same formal symplectic groupoid G we relate an infinitesimal deformation of G. We call it the deformation groupoid of the pair $(*, \tilde{*})$. We give explicit formulas for the source and target mappings of the deformation groupoid of a pair of star products with separation of variables on a Kähler–Poisson manifold. Finally, we give an algorithm for calculating the principal symbols of the components of the logarithm of a formal Berezin transform of a star product with separation of variables. This algorithm is based upon some deformation groupoid.

8. **Hovhannes KHUDAVERDIAN** – *University of Manchester, United Kingdom*

Berezin integral and Berezinian: from identities in the Grothendieck ring of the general linear supergroup to the geometry of Batalin–Vilkovisky quantisation

In the talk we consider applications of Berezin integral and Berezinian with examples ranging from identities for traces of the exterior powers of linear operators on superspaces to odd symplectic geometry and Batalin–Vilkovisky formalism.

9. **Petr KULISH** – *St. Petersburg Department of the Steklov Mathematical Institute, Russia*

Twisting adjoint module algebras and non-commutative geometry

Transformation of operator algebras under Hopf algebra twist is discussed. It is pointed out that if the Hopf algebra acts on module algebra by adjoint action the twisted module algebra is isomorphic to the original one. The isomorphism transformation is given. Different applications to vector fields on non-commutative space-time and quantum field theories are considered.

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

Multivariate characteristic functions and double coset spaces for infinite-dimensional groups

11. **Victor PALAMODOV** – *Tel Aviv University, Israel*

Singular simplectic reduction and quantization

12. **Wiesław PUSZ** – *Katedra Metod Matematycznych Fizyki, Uniwersytet Warszawski, Poland*

On Woronowicz approach to quantum group theory

13. **Vera SERGANOVA** — *University of California at Berkeley, USA*

Geometric methods in representation theory of Lie supergroups

We will discuss two geometric approaches for representation theory of classical Lie supergroups: associated variety and Borel-Weil-Bott theory. The results include superdimension and character formula for irreducible finite-dimensional representations.

14. **Dmitry TAMARKIN** — *Northwestern University, USA*

Action of $Sp(2n)$ on sheaves

Let X be a smooth manifold. One can define a certain full sub-category $D_{>0}(X\times\Re)$ in the derived category of sheaves of vector spaces on $X\times\Re$; this sub-category has close ties with the symplectic manifold $T^{*}X$. One can define the notion of microsupport for objects of this category as a closed subset of $T^{*}X$, each hamiltonian symplectomorphism F of $T^{*}X$ can be 'quantized: there exists an endofunctor QF of $D_{>0}(X\times\Re)$ which transforms microsupports of objects according to F. I will discuss the quantization of the symplectic action of $Sp(2n)$ on $T^{*}\Re^{n}$. It turns out that it is naturally defined on the universal cover G of $Sp(2n)$. The kernel of the covering map $G\to Sp(2n)$ acts by homological shifts; the restriction to the sub-group $GL(n)$ difffers from the action by coordinate changes by a twist via a local system.

15. **Arkady VAINTROB** — *University of Oregon, USA*

Generalized complex geometry and supermanifolds

We will discuss several applications of the supermanifold theory to the study of generalized complex and Kähler structures.

16. **Alexander VASILIEV** — *University of Bergen, Norway*

Loewner–Kufarev evolution in the universal Grassmannian

We discuss complex and Cauchy–Riemann structures of the Virasoro algebra and of the Virasoro–Bott group in relation with the Loewner–Kufarev evolution. Based on the Hamiltonian formulation of this evolution we obtain an infinite number of conserved quantities and provide embedding of the Loewner–Kufarev evolution into Sato's Grassmannian. The tau-function is constructed.

17. **Karol ŻYCZKOWSKI** — *Instytut Fizyki, Uniwersytet Jagielloński, Poland*

The set of quantum states and its shadow

The totality of normalised density matrices of order N forms a convex set $\mathbb{Q}_N$ in $\mathbb{R}^{N^2-1}$. In the one–qubit case the set $\mathbb{Q}_2$ forms a Bloch ball, while $\mathbb{Q}_N$ for $N\geq 3$ it is neither a ball nor a polytope.

Working with the flat geometry induced by the Hilbert–Schmidt distance we consider images of orthogonal projections of $\mathbb{Q}_N$ onto a two–plane and show that they are similar to the numerical ranges of matrices of order N. For a matrix A of a order N one defines its numerical shadow as a probability distribution supported on its numerical range $W(A)$, induced by the unitarily invariant Fubini–Study measure on the complex projective manifold $\mathbb{C}P^{N-1}$. We define generalized, mixed–states shadows of A and demonstrate their usefulness to analyse the structure of the set of quantum states and unitary dynamics therein.

The notions of numerical range and numerical shadow can be extended for operators acting on a Hilbert space with a tensor product structure. Restricting the set of pure states to the set of product states or maximally entangled states we introduce restricted numerical range and restricted numerical shadow of an operator. Analyzing restricted shadows of operators of a fixed size $N = N_A \times N_B$ we analyze the geometry of sets of separable and maximally entangled states of the $N_A \times N_B$ composite quantum system.

(in collaboration with C. Dunkl, J. Holbrook, P. Gawron, J. Miszczak, Z. Puchała, and Ł. Skowronek)

Contributed lectures

18. **Musavvir ALI** — *Aligarh Muslim University, India*

Vector fields associated to Ricci solitons, representing symmetries of spacetime manifold in general relativity

The symmetry assumtions on a spacetime manifold are known as collineation, these collineations are defined on the basis of Lie derivation of certain tensor with respect to a vector. The aim of this paper is to study the vector fields associated with Ricci solitons in Riemann manifold. We study the correspondence between these vector fields and symmetries of spacetime manifold in general relativity.

19. **Syed Twareque ALI** — *Department of Mathematics and Statistics, Concordia University, Canada*

Some non-standard aspects of coherent state quantization

We look at certain non-standard constructions of coherent states, viz., over matrix domains, on quaternionic Hilbert spaces and C^*-Hilbert modules and their possible use in quantization. In particular, we look at a family of coherent states built over Cuntz algebras and their application to non-commutative spaces.

20. **Jean-Pierre ANTOINE** — *Université Catholique de Louvain, Belgium*

Partial inner product spaces, a unifying language for quantum mechanics

It is common wisdom that Hilbert space is too "small" for quantum mechanics, in that it fails to contain useful objects such as a plane wave or a δ function. Thus it cannot cope with the familiar Dirac bra- and ket formalism. A first way out is to use instead a Rigged Hilbert Space, e.g. Schwartz's tempered distributions $\mathcal{S} \subset L^2 \subset \mathcal{S}'$. The price to pay is to introduce sophisticated locally convex spaces. However, the triplet may be advantageously replaced by a scale of Hilbert spaces interpolating between $\mathcal{S}$ and $\mathcal{S}'$ (the Hermite representation).

In fact, many such families of function spaces play a central role in analysis, such as L^p spaces, Besov spaces, amalgam spaces or modulation spaces. In all such cases, the parameter indexing the family measures the behavior (regularity, decay properties) of particular functions or operators. Actually all these space families are, or contain, scales or lattices of Banach spaces, which are special cases of *partial inner product spaces*. So are also a single Hilbert space and a Rigged Hilbert Space. Thus partial inner product spaces offer a unifying language for quantum mechanics.

In this lecture, we shall give an overview of partial inner product spaces and operators on them, defined globally on the whole family, instead of individual spaces. We will discuss a number of operator classes, such as morphisms, projections or group representations and quote a number of applications in quantum mechanics.

21. **Gustavo ARCINIEGA** – *Facultad de Ciencias, UNAM, Mexico*

Topological quantization of free massive bosonic field

We present the formalism of topological quantization applied to free massive bosonic fields. We show that the harmonic maps are the adecuate mappings to construct a principal fiber bundle over this physical system and found its topological spectrum in the particular case where we have two free massive bosonic fields with two non-zero modes when the background space is a PPwave space and the origin space is a two dimensional space like a closed string configuration. We found that the Euler invariant integral is non-commutative respect to the integration order of its parameters and as a consequence we formulate the general expresion of this Euler invariant wich give the topological spectrum in this formalism.

22. **Hellmut BAUMGÄRTEL** – *University of Potsdam, Germany*

Canonical association of decay semigroups with quantum mechanical scattering systems

Construction of decay semigroups canonically associated to quantum mechanical scattering systems and characterization of the spectrum of their generators by the set of all resonances by adaption of methods of the Lax-Phillips scattering theory (JMP 51, 113508, 2010).

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

Classical and quantum evolution on Siegel–Jacobi domains

The Jacobi group is the semidirect product of the Heisenberg group with the real symplectic group. Coherent states, based on the Siegel–Jacobi domains, are attached to the Jacobi group. Following Berezin, we investigate the equations of motion on the Siegel–Jacobi domains generated by linear Hamiltonians in the generators of Jacobi group. This is a matrix Riccati equation of motion on the Siegel ball or the Siegel upper half-plane, coupled with a linear equation on the n-dimensional complex plane, which contains a term with the product of both variables.

24. **David BERMÚDEZ** — *Departamento de Física, Cinvestav, Mexico*

Complex solutions to Painlevé IV equation through SUSY QM

We use higher-order supersymmetric quantum mechanics (SUSY QM) to obtain several sets of complex one-parameter solutions to Painlevé IV equation with real or complex parameters a,b. We also study the algebras, the wave functions and the energy spectrum of the complex SUSY transformed systems.

25. **Adam BIGGS** — *University of Manchester, United Kingdom*

The commutative algebra of densities and operators on the line

By considering operators acting on the space of densities we can get interesting results about the structures of such operators. In particular on the real line we recover classical results about differential operators in a different framework.

26. **Arno BOHM** — *Department of Physics, University of Texas at Austin, USA*

Groups and semigroups in quantum mechanics

27. **Catherine BUELL** — *North Carolina State University, USA*

On maximal R-split tori invariant under an involution

Semisimple symmetric spaces are the homogeneous spaces G/H, where G is a real semisimple Lie group and H the fixed point group of an involution σ.

The conjugacy classes of maximal $\mathbb{R}$-split tori invariant under σ are essential to determine the orbit decomposition of minimal parabolic subgroups acting on the symmetric space. The classification of the conjugacy classes of these tori under the fixed point group of the involution σ can be reduced to a classification of conjugacy classes of certain involution in the Weyl group under the action of a subgroup of the Weyl group. The classification can be simplified by considering dual and associated pairs for σ.

28. **Elena BUNKOVA** — *Steklov Mathematical Institute, Russia*

Polynomial dynamical systems and elliptic curves

The problem of effectivization of the algebro-geometric method in soliton theory is well known. The talk is devoted to recent results obtained in this direction in collaboration with V.M. Buchstaber.

We shall present polynomial dynamical systems on the n-dimensional complex linear space for $n = 3$ and 4. The construction of these systems uses the classical theorem on the rationality of the space of Jacobians of elliptic curves. Solutions of these systems describe the polynomial groupoids corresponding to addition theorems for the elliptic functions and the Baker–Akhiezer function.

We shall describe explicitly solutions and integrals of these systems in terms of the sigma function for $n = 3$ and the Baker–Akhiezer function for $n = 4$. The direct application of the rationality theorem to the space of elliptic curves with marked points leads to a rational dynamical system (case $n = 4$). The polynomial dynamical systems were obtained using properties of the Baker–Akhiezer function. The dependence of solutions on the initial data is expressed in both cases by explicit formulas for the corresponding gradients.

29. **Dariusz CHRUŚCIŃSKI** — *Uniwersytet Mikołaja Kopernika, Poland*

Non-Markovian evolution of quantum systems

We analyze a general approach to non-Markovian quantum evolution and discuss two recently proposed measures of non-Markovianity: one based on the concept of divisibility of the dynamical map and the other one based on distinguishability of quantum states. We show that these two measures need not agree. In addition, we discuss possible generalizations and intricate relations between these measures.

D. Chruściński, A. Kossakowski and S. Pascazio, PRA 81 032101 (2010)

D. Chruściński and A. Kossakowski, PRL 104 070406 (2010)

D. Chruściński, A. Kossakowski and A. Rivas, PRA (in print)

30. **Ruben CORDERO** — *Escuela Superior de Física y Matemáticas del Instituto Politécnico Nacional, Mexico*

Quantum charged rigid Dirac bubble

The early Dirac proposal to model the electron as a charged membrane is reviewed. A rigidity term, instead of the natural membrane tension, involving linearly the extrinsic curvature of the worldvolume swept out by the membrane is considered in the action modelling the bubble in the presence of an electromagnetic field. We set up this model as a genuine second-order derivative theory by considering a nontrivial boundary term which plays a relevant part in our formulation. The Lagrangian is linear in the bubble acceleration and by means of the Ostrogradski–Hamiltonian approach we observed that the theory comprises the management of both first- and second-class constraints. We show thus that our second-order approach is robust allowing for a proper quantization. We found an effective quantum potential which permits to compute bounded states for the system.

31. **Sara CRUZ Y CRUZ** — *UPIITA, Instituto Politécnico Nacional, Mexico*

Position-dependent mass systems and coherent states

The Schrödinger equation for diverse position-dependent mass systems is solved in terms of the factorization method and point canonical transformations. Ladder operators and the corresponding Barut-Girardello and Perelomov coherent states are constructed.

32. **Tomasz CZYŻYCKI** — *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

Title to be announced

33. **Aleksander DENISIUK** — *Uniwersytet Warmińsko–Mazurski, Poland*

Inversion of the X-ray transform of symmetric tensor fields

The X-ray transform I associated with a covariant symmetric tensor field $f(x)$ of order m, $x \in \mathbb{R}^n$, the function $If(l)$ by integration over the line l. This transform and its generalization to Riemannian manifolds have various applications in pure as well as in applied mathematics: the boundary rigidity problem, inverse problem for kinetic equation, photoelastisity, plasma physics, recovering the blood flow in the human body from ultrasound signal Doppler measurements.

It is well-known that I has non-trivial kernel (for $m > 0$). So, the inverse problem is posed to recover some projection of $f(x)$, e.g. the solenoidal part or the Saint–Venant operator of f. On other hand, the inverse problem is overdetermined (for $n > 2$). Thus the reconstruction problem from incomplete, i.e. known only for n-dimensional family of lines, data arises.

In this talk I will present exact inversion formulas for both, complete and incomplete data cases. I will also show how this results can be transferred to the X-ray transform of symmetric tensor fields in spaces of constant curvature and discuss some geometrical structures that appear in this context.

34. **Joseph DONGHO** — *University of Angers/University of Maroua, France/Cameroon*

Logarithmic Poisson cohomology and applications

We introduce the logarithmic Poisson structures and background, on a commutative ring $\mathcal{A}$ with singularities along an ideal $\mathcal{I}$ of $\mathcal{A}$, and we prove that such structure generalized Poisson structure induced by logsymplectic. We also prove that each logarithmic principal Poisson structure along $\mathcal{I}$ induce Lie-Rinehart structure on $\Omega_{\mathcal{A}}(\log \mathcal{I})$ with image in the module of logarithmic principal derivations. We define the notion of logarithmic Poisson cohomology and used it to prove Vaisman condition of prequantization of such Poisson structures.

35. **Vladimir DRAGOVIĆ** — *University of Lisbon/Math. Institute SANU Belgrade, Portugal/Serbia*

Discriminant separability and quad-graph integrability

We present a classification of discriminantly separable polynomials of degree two in each of three variables. To a given such discriminantly separable polynomial, we associate an integrable system on quad-graphs. We make a comparison with recent classification of integrable quad graphs of Adler, Bobenko and Suris. Results are joint with Katarina Kukic.

36. **Michał ECKSTEIN** – *Instytut Matematyki, Uniwersytet Jagielloński, Poland*

Quantum anomalies on noncommutative spaces

Anomalies in quantum field theories have many intriguing geometrical aspects touching the BRST cohomology and index theorems. It is interesting to see how many of these features resist when one trades the base manifold for a spectral triple. I will comment on the general method derived by Denis Perrot and present some results concering the noncommutative 2-torus and Podleś sphere.

37. **Sean FITZPATRICK** – *University of California, Berkeley, USA*

CR geometry and quantization of contact manifolds

We propose two ways of 'quantizing' a contact manifold. One is index-theoretic, and the other is analogous to geometric quantization in symplectic geometry. In both cases the results are most interesting when there exists a compatible CR structure. The two approaches are related, but do not give identical results. Moreover, there appear to be connections to the Toeplitz quantization of Boutet de Monvel and Guillemin, although the precise nature of this relationship has yet to be determined. Time permitting, we will mention similar results for manifolds with f-structure.

38. **Valeri FROLOV** – *University of Alberta, Canada*

Hidden symmetries and complete integrability in higher dimensional black holes

This talk is a brief review of applications of hidden symmetries to black hole physics. In physics and mathematics the symmetry allows one to simplify a problem, and often to make it solvable. Besides evident (explicit) spacetime symmetries, responsible for conservation of energy, momentum, and angular momentum of a system, there also exist what is called hidden symmetries, which are connected with higher order in momentum integrals of motion. A remarkable fact is that black holes in four and higher dimensions always possess a set ("tower") of explicit and hidden symmetries which make the equations of motion of particles and light completely integrable. The talk gives a general review of the recently obtained results.

39. **Hugo GARCIA-COMPEAN** – *Departamento de Física, Cinvestav, Mexico*

The Wigner ground state for linearized gravity

The deformation quantization formalism is applied to the linearized gravitational field. Stratonovich–Weyl quantizer, Moyal star product and the ground state Wigner functional are obtained in the field variables.

40. **Stéphane GARNIER** – *University of Metz, France*

Superdifferential geometry

We have a notion of geodesics that is different from Goertsches' but in close analogy to the ungraded case. We show that there exists a geodesic flow on the (co-)tangent bundle of the Riemannian supermanifold with the usual basic properties (notably a bijection between "integral curves" of this flow and geodesics).

41. **Simon GINDIKIN** — *Rutgers University, USA*

Cohomological Laplace transform

Usual (holomorphic) Laplace transform is defined for functions with supports in a convex cone. We discuss how to define a similar transform for non convex cones. The result is a cohomology Cauchy-Riemann at non convex tubes. It has connections with representations (including Speh's representations).

42. **Dmitri GITMAN** — *Institute of Physics, University of São Paulo, Brazil*

Coherent states in magnetic field in the presence of the Aharonov–Bohm solenoid

Coherent states (CS) and semiclassical states (SS) in magnetic-solenoid field are constructed. The main idea is based on the fact that the AB solenoid breaks the translational symmetry in the xy-plane, this has a topological effect such that there appear two types of trajectories which embrace and do not embrace the solenoid. Due to this fact, one has to construct two different kinds of CS/SS, which correspond to such trajectories in the semiclassical limit. Following this idea, we construct CS in two steps, first the instantaneous CS (ICS) and the time dependent CS/SS as an evolution of the ICS. The construction is realized for nonrelativistic and relativistic, spinning and spinless particles both in $(2+1)$- and $(3+1)$-dimensions and gives a non-trivial example of SS/CS for systems with a nonquadratic Hamiltonian. It is stressed that CS depending on their parameters (quantum numbers) describe both pure quantum and semiclassical states.

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

Quantum configuration spaces of extended objects, diffeomorphism group representations, and exotic statistics

A fundamental approach to quantum mechanics is based on the unitary representations of the group of diffeomorphisms of physical space (and correspondingly, self-adjoint representations of a local current algebra). From these, various classes of quantum configuration spaces arise naturally, as well as the usual exchange statistics for spatial dimension $d \geq 3$, induced by representations of the symmetric group; for $d = 2$, the approach led to an early prediction of intermediate or "anyonic" statistics induced by unitary representations of the braid group. I shall discuss briefly some analogous possibilities for infinite-dimensional configuration spaces, including anyonic statistics for extended objects in 3-dimensional space.

44. **Erlend GRONG** — *University of Bergen, Norway*

Sub-Riemannian geometry on the group of diffeomorphisms of the circle

Sub-Riemannian geometry occurs when you have a system with nonholonomic constraints. We will give a brief introduction to the concepts behind this, and its applications for finite dimensional manifolds. Then we present our attempts to study sub-Riemannian geometry on the infinite dimensional Lie-Fréchet group of diffeomorphisms of the circle. We discuss applications of this to obtain information on the space of normalized complex univalent functions and the space of 2D shapes.

45. **Mahouton Norbert HOUNKONNOU** — *University of Abomey-Calavi, Benin*

Deformation quantization of harmonic oscillator in a general noncommutative phase space: Energy spectrum in relevant representations

In this talk, we discuss deformation quantization of a harmonic oscillator in a general noncommutative phase space, with both noncommuting spatial and momentum coordinates. Different representations are considered.

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

Two types of E-discretization of tori of compact semisimple Lie groups

We consider a compact semisimple Lie group and the corresponding affine Weyl group. We distinguish two cases of even affine Weyl subgroups. In the first case, given two positive integers M_1, M_2, we introduce a finite set of lattice points $F^{e}_{M_1,M_2}$. Similar lattice set F^{e}_{M} is also constructed in the second case. Each even affine Weyl group then determines the symmetry of its corresponding lattice set. We describe two types of $E-$functions corresponding to these two cases and determine maximal sets of pairwise orthogonal $E-$functions over the lattice grids. These finite sets allow us to perform Fourier-like discrete expansions of an arbitrary discrete function on both $F^{e}_{M_1,M_2}$ and F^{e}_{M}.

47. **Daria ISANGULOVA** — *Sobolev Institute of Mathematics, Russia*

Rigidity of isometries on complexified Heisenberg group

Complexified Heisenberg group HC is the simplest nilpotent Lie group with a complex structure. We consider HC as H-type Carnot group equipped with sub-Riemannian metric. We described the group of isometries on HC and proved the quantitative rigidity of isometries: every $(1 + e)$-quasi-isometry on John domain of complexified Heisenberg group is close to some isometry with order of closeness $\sqrt{e} + e$ in the uniform norm and with order of closeness e in the Sobolev norm L^1_p for all $p \in [1, \infty)$.

48. **Jacek JURKOWSKI** — *Uniwersytet Mikołaja Kopernika, Poland*

Quantum discord for generalized entropies

49. **Dmitry KANIN** — *Steklov Mathematical Institute, Russia*

Jet approach to superfield quantization

The concept of jet superstructure on a supermanifold is an adequate mathematical tool of the classical superfield formalism, especially in geometric or variational consideration. We determine and construct the quantum jet superstructure that plays a similar role for the quantum superfields. The property of quantizationability is formulated — certain conditions under which quantum jet superstructure can be interpreted as the second quantization of jet superstructure. We get an approach to the quantum superfield formalism on the basis of such "second quantized" quantum jet superstructures.

50. **Dmitry KAPARULIN** – *Physics Faculty, Tomsk State University, Russia*

BRST cohomology and Noether theorem beyond the class of Lagrangian dynamics

Making use of the Lagrange anchor construction introduced earlier to quantize non-Lagrangian field theories, the Noether theorem is extended beyond the class of variational dynamics.

51. **Paweł KASPRZAK** – *Katedra Metod Matematycznych Fizyki, Uniwersytet Warszawski, Poland*

On a certain approach to quantum homogeneous spaces

We propose a definition of a quantum homogeneous space of a locally compact quantum group. We show that classically it reduces to the notion of homogeneous spaces, giving rise to an operator algebraic characterization of the transitive group actions. On the quantum level our definition goes beyond the quotient case providing a framework which, besides the Vaes' quotient of a locally compact quantum group by its closed quantum subgroup (our main motivation) is also compatible with, generically non-quotient, quantum homogeneous spaces of a compact quantum group studiedby P. Podleś as well as the Rieffel deformation of G-homogeneous spaces. Finally, our definition rules out the paradoxical examples of the non-compact quantum homogeneous spaces of a compact quantum group.

52. **Jerzy KIJOWSKI** – *Centrum Fizyki Teoretycznej, PAN, Poland*

Fractional Fourier transform and symplectic quantization

I will present my personal point of view on geometric quantization theory. It is based on two building blocks: the generalized Galilei transformation and the geometrized Fourier transformation. They imply a (non-flat) connection in the bundle of quantum states, with all possible lagrangian foliations of the phase space being the base of the bundle. Physical implications will be presented.

53. **Mikhail KOROBKOV** – *Sobolev Institute of Mathematics, Russia*

Morse-Sard theorem for Sobolev functions and applications in fluid mechanics

Using the recent version of the Morse-Sard theorem for $W^{2,1}$ plane functions (see the joint paper [Bourgain J., Korobkov M.V. and Kristensen J. arXiv:1007.4408v1]), we prove the Bernoully Law under minimal smoothness asumptions (see [Korobkov M.V. Dokl. Math. 2011. V.83, No.1. P.107-110.]). Further, using the last result, we prove the existence of the solutions to steady Navier–Stokes equations for some plane cases and for the spatial case when the flow has an axis of symmetry (see [Korobkov M.V., Pileckas K. and Russo R. arXiv:1009.4024v1]).

54. **Ryszard KOSTECKI** – *Instytut Fizyki Teoretycznej, Uniwersytet Warszawski, Poland*

Quantum entropy and information geometry based on non-commutative integration

I will present new mathematical results based on application of the Falcone–Takesaki theory of non-commutative integration. In particular, I will show how this theory allows to naturally generalise Bregman and Jencova–Ojima families of quantum relative entropies, as well as Wigner–Yanase–Dyson and Bogolyubov–Kubo–Mori families of quantum metrics to the infinite-dimensional state spaces of arbitrary von Neumann algebras.

55. **Irina KUZMINA** – *Kazan State University, Russia*

The projectivization of conformal models of fibrations determined by the algebra of quaternions

Our aim is to study the principal bundles determined by the algebra of quaternions in the projective model. The projectivization of the conformal model of the Hopf fibration is considered as example.

56. **Bartosz KWAŚNIEWSKI** – *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

Cuntz–Krieger uniqueness theorem for C^*-algebras with circle gauge action

We shall present a result that:

(a) generalizes isomorphism theorems for various crossed products;

(b) is equivalent to Cuntz–Krieger uniqueness theorem for graph C^*-algebras;

(c) potentially could be applied to any C^*-algebra defined by relations that admit semisatured circle action.

57. **Sergey LEBLE** – *Politechnika Gdańska, Poland*

Reduction restrictions of Darboux and Laplace transformations for the Goursat equation

Darboux and Laplace transformations of the solutions and potentials of the Goursat equation are investigated. The equation is equivalent to one of the Lax pair equations for the 2D-MKdV hierarchy. The reduction restrictions for these transformations are considered. The derived reduction equations are generalizations of the Liouville and sinh-Gordon equation. The integrability of these equations by the Spectral Transform method is proved. The novel binary Darboux transformation for the Goursat equation is constracted. We find and investigate some classes of exact nonsingular solutions of the 2D-MKdV (Boiti–Martina–Leon–Pempinelli) equations via the Moutard transformation for the Goursat equation.

58. **Simon LYAKHOVICH** – *Tomsk State University, Russia*

BRST complex for general dynamics

The BRST complex and quantization is considered for general not necessarily Lagrangian dynamical system.

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

Double Lie algebroids and their global forms

Double Lie algebroids can be thought of as abstract forms of the double (iterated) tangent bundle. They also arise naturally in Poisson geometry as the cotangent doubles of Lie bialgebroids and as invariants of Poisson actions.

The abstract concept of double Lie algebroid introduced by the speaker depends heavily on the duality of double vector bundles and is not easy to assimilate quickly. Th. Voronov has given a very natural reformulation in super terms in terms of a pair of commuting homological vector fields.

In this talk we do not attempt to give either general definition but instead describe several key examples of double Lie algebroids and corresponding constructions for double Lie groupoids which, under favourable conditions, give global forms.

60. **Teresia MÅNSSON** – *Royal Institute of Technology, Sweden*

Symmetries of the chiral Potts model

61. **Ian MARSHALL** – *Higher School of Economics, Russia*

Poisson reduction on the space of curves in $\mathbf{R}^n$

I will discuss the exchange algebra Poisson bracket and show how the spectral parameter can emerge as a by-product of reduction. This allows us to generate integrable systems such as KdV and Toda. The examples will be simple, but the setting is rather a general one.

62. **Bikashkali MIDYA** – *Indian Statistical Institute, India*

Nonsingular potentials from excited state factorization of a quantum system with position dependent mass

63. **Bogdan MIELNIK** – *Departamento de Física, Cinvestav, Mexico*

World Anti-Bureaucratic

64. **Josef MIKEŠ** – *Univerzita Palackého v Olomouci, Czech Republic*

On geodesic mappings of special Riemannian spaces

65. **Ivaïlo MLADENOV** – *Bulgarian Academy of Sciences, Bulgaria*

Serret's curves, their generalization and explicit parameterizations

Here we apply our original scheme for the reconstruction of plane curves whose curvatures are specified by functions of the radial coordinate to the curves introduced by J.-A. Serret. These curves are associated with the natural numbers and we extend their definition in order to include them into a family of curves depending on two continuous real parameters. The explicit parameterization of this new class of curves is presented as well.

66. **Vladimir MOLCHANOV** – *Derzhavin Tambov State University, Russia*

Berezin quantization on para-Hermitian symmetric spaces

One of the main goals that Berezin had set up for himself was to define a general concept of quantization. To this end he introduced some general notions and constructions, he constructed the quantization for an important class of symplectic manifolds, namely, for Hermitian symmetric spaces G/K, here he obtained deep analytic and algebraic results.

We would like to carry out a program for a quantization in the spirit of Berezin for other classes of symplectic homogeneous manifolds G/H. Such a program is not only an interesting and fascinating task itself but it has to stimulate active investigations in related harmonic analysis on homogeneous spaces G/H as well.

We can consider that the group G is a simple Lie group. Then these manifolds G/H form 4 classes: (a) Hermitian symmetric spaces; (b) semi-Kählerian irreducible symmetric spaces; (c) para-Hermitian symmetric spaces; (d) complexifications of Hermitian symmetric spaces. Spaces of the class (a) are Riemannian, and spaces of the classes (b), (c), (d) are pseudo-Riemannian (not-Riemannian). We can consider that the space G/H is a G-orbit in the Lie algebra $\mathfrak{g}$ of the Lie group G under the adjoint representation. Berezin constructed his quantization for the class (a).

We concentrate our attention on the class (c). For a space G/H of this class, the orthogonal complement $\mathfrak{q}$ (in sense of the Killing form) to the Lie algebra of H splits into the direct sum of Lagrangian subspaces $\mathfrak{q}^-$ and $\mathfrak{q}^+$ of the tangent space to G at the initial point H, so that the space G/H has two linearly independent polarizations. The subspaces $\mathfrak{q}^{\pm}$ are invariant and irreducible with respect to H, they are Abelian subalgebras of $\mathfrak{g}$. The pair $(\mathfrak{q}^+, \mathfrak{q}^-)$ is a Jordan pair. The main constructions of the Berezin quantization are preserved in the main – with some differences (for example, the factor i in the correspondence principle has to be omitted, instead of complex conjugation of functions one has to take some permutation of arguments, finally, we abandon the Hilbert structure in representation spaces). For a supercomplete system, we take the kernel of an intertwinning operator for maximal degenerate series representations π_λ^- and π_λ^+ acting on functions on $\mathfrak{q}^-$ and $\mathfrak{q}^+$ respectively. Spaces of these functions form analogues of the Fock space.

One of variants of quantization is the so-called *polynomial quantization*. Here for the initial algebra of operators, we take the universal enveloping algebra of $\mathfrak{g}$. It acts on functions on $\mathfrak{q}^-$ and $\mathfrak{q}^+$ by representations π_λ^- and π_λ^+ respectively. Co- and contravariant symbols turn out to be polynomials on $G/H \subset \mathfrak{g}$.

Let us formulate main problems in this theory. First we have to decompose the Berezin function on G/H (a H-invariant disribution) into spherical fuctions. It is equivalent to the Plancherel formula for the Berezin form. It allows to express the Berezin transform in terms of Laplacians. From this, we find an asymptotic behaviour of the Berezin transform when the "Planck constant" tends to zero. It allows us to say where (on which series etc.) the correspondence principle is valid.

These problems are solved for rank one spaces and for spaces with the pseudo-orthogonal group $G = \mathrm{SO}_0(p,q)$ (here $\mathrm{rank}\, G/H = 2$).

The main tool for studying of quantization is *canonical representations*. For Hermitian symmetric spaces G/K, in a unitary case they were introduced by Vershik, Gelfand, Graev and Berezin. We define canonical representations in a wide setting (in particular, we give up the condition of unitarity and let these representations act on sufficiently extensive spaces, in particular, on spaces of distributions). Our approach uses the notion of an "overgroup" and consists in the following.

Let $\widetilde{G}$ be an overgroup for G, it means that G is a spherical subgroup of $\widetilde{G}$. Let $\widetilde{P}$ be a maximal parabolic subgroup of $\widetilde{G}$, let $\widetilde{R}_\lambda$, $\lambda \in \mathbb{C}$, be a series of representations of $\widetilde{G}$ induced by characters of $\widetilde{P}$. As a rule, representations $\widetilde{R}_\lambda$ are irreducible. They act on a compact manifold Ω (a flag manifold for $\widetilde{G}$). Restrictions R_λ of $\widetilde{R}_\lambda$ to G are called canonical representations of G. In general, Ω is not a homogeneous space for G, there are several open G-orbits G/H_i on Ω. The series of canonical representations R_λ has an intertwinning operator Q_λ called the Berezin transform.

The notion of an overgroup allows to present the polynomial quantization as a part of representation theory. Namely, co- and contravariant symbols are obtained under the restriction of a representation $\widetilde{R}_\lambda$ of the overgroup $\widetilde{G} = G \times G$ to the component subgroups $G \times e$ and $e \times G$ (here $\widetilde{R}_\lambda(g_1, g_2) = \pi_\lambda^-(g_2) \otimes \pi_\lambda^+(g_1)$). It gives these symbols and the Berezin transform in a natural and transparent way.

One can consider a some different version of canonical representations, namely, the restriction of canonical representations in the first sense to some open orbit G/H_i. Both variants deserve to be investigated. But, the first variant is in some sense more natural. In particular, in this variant the inverse of the Berezin transform Q_λ can be easy written: it is precisely the Berezin transform $Q_{-\lambda-N}$ where N is a number depending on Ω. It allows to write a decomposition (a "Plancherel formula") of the Berezin form for all λ in a transparent form.

Canonical representations give rise to *boundary representations* of two types associated with the union S of singular G-orbits on Ω. The boundary representations of the first type act on distributions concentrated at S, the ones of the second type act on jets transversal to S. Boundary representations "glue" together representations on separate orbits.

At present, explicit computations for canonical representations are carried out for rank one spaces, in particular, for hyperbolic spaces.

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67. **Elena MOSMAN** — *Department of Quantum Field Theory, Physics Faculty, Tomsk State University, Russia*

Charachteristic classes of Q-manifolds

A $Q-$manifold M is a supermanifold endowed with an odd vector field Q squaring to zero. The Lie derivative LQ along Q makes the algebra of smooth tensor fields on M into a differential algebra. In this talk, we define and study the invariants of Q-manifolds called characteristic classes. These take values in the cohomology of the operator LQ and, given an affine symmetric connection with curvature R, can be represented by universal tensor polynomials in the repeated covariant derivatives of Q and R up to some finite order. As usual, the characteristic classes are proved to be independent of the choice of the affine connection used to define them. The main result of the paper is a complete classification of the intrinsic characteristic classes, which, by definition, do not vanish identically on flat Q-manifolds. As an illustration of the general theory we interpret some of the intrinsic characteristic classes as anomalies in the BV and BFV-BRST quantization methods of gauge theories. An application to the theory of (singular) foliations is also discussed.

68. **Petr NOVOTNÝ** — *České Vysoké Učení Technické v Praze, Czech Republic*

Graded contractions of representations of Lie algebras

The concept of graded contractions for representations of Lie algebras will be presented. Explicit example of graded contractions of all irreducible finite-dimensional representations of $sl(2, \mathbb{C})$ to representations of Euclidean algebra $e(2)$ will be described in detail.

69. **Alexandre ODESSKI** — *Brock University, Canada*

Integrable $(2 + 1)$-dimensional systems of hydrodynamic type

We describe the results that have so far been obtained in the classification problem for integrable $(2 + 1)$-dimensional systems of hydrodynamic type. The so-called systems of Gibbons–Tsarev type are the most fundamental here. A whole class of integrable $(2 + 1)$-dimensional models is related to each such system. We present the known GT systems related to algebraic curves of genus $g = 0$ and $g = 1$ and also a new GT system corresponding to algebraic curves of genus $g = 2$. We construct a wide class of integrable models generated by the simplest GT system, which was not considered previously because it is in a sense trivial.

70. **Sergei PARKHOMENKO** — *Landau Institute for Theoretical Physics, RAS, Russia*

Fermionic sreenings and sigma-models on Calabi–Yau manifolds with line bundles

The construction of chiral de Rham complex on toric Calabi–Yau manifold twisted by a line bundle is proposed. It generalize the Borisov's construction of vertex operator algera of mirror symmetry and gives the holomorphic sector space of states of the sigma-model on toric Calabi–Yau manifold with line bundle.

71. **Maciej PRZANOWSKI** – *Instytut Fizyki, Politechnika Łódzka, Poland*

Time operator on a circle

Time-of-arrival operator on a circle with the use of Weyl–Wigner formalism is found. This operator is bounded, self-adjoint and of Hilbert–Schmidt type. Consequently its spectrum is discreet. Quantum arrival time from the point of view of Mielnik's waiting screen is also considered.

72. **Jeffrey RABIN** – *University of California at San Diego, USA*

Geometry of dual pairs of complex supercurves

Supercurves are a generalization to supergeometry of Riemann surfaces or algebraic curves. They naturally occur in pairs related by a duality. The super Riemann surfaces appearing as worldsheets in perturbative superstring theory are precisely the self-dual supercurves. I will review known results and open problems in the geometry of supercurves, with a focus on Abel's Theorem.

73. **Rasoul ROKNIZADEH** – *Department of Physics, University of Isfahan, Iran*

Title to be announced

74. **Oscar ROSAS-ORTIZ** – *Departamento de Física, Cinvestav, Mexico*

Reflection time delay for rectangular potentials in a semi-harmonic background

It is considered a one-dimensional rectangular potential in a background composed by an harmonic interaction to the left and a free particle interaction to the right of the rectangular potential. Analytic expressions for the wave functions, scattering states and resonances are derived. The times involved in the scattering process are analyzed. In particular, the mean time spent by an scattering particle in the interaction zone is shown to coincide with the phase-time of Eisenbud and Wigner, calculated as the derivative of the reflected phase shift with respect to the energy.

75. **Mikołaj ROTKIEWICZ** – *Uniwersytet Warszawski, Poland*

Homogeneity bundles

76. **Sutanu ROY** – *Georg-August-Universität Göttingen, Germany*

Homomorphisms of quantum groups

We introduce some equivalent notions of homomorphisms between quantum groups that behave well with respect to duality of quantum groups. Our equivalent definitions are based on bicharacters, coactions, and universal quantum groups, respectively.

77. **Łukasz RUDNICKI** – *Centum Fizyki Teoretycznej, PAN, Poland*

Collectibility – a new entanglement test based on uncertainty relations

I would like to present a new idea how to quantify entanglement of many-partite, pure qudit systems. The main result is a sensitive entanglement witness, we shall call collectibility, based on uncertainty relations. Our approach generalizes the geometric measure of entanglement.

78. **Nuno SA** – *Universidade dos Acores, Portugal*

Complex Hadamard matrices: A perturbative approach

This talk is the continuation of "Complex Hadamard matrices: Introduction" by Ingemar Bengtsson. Here we use a perturbative method to study the space of complex Hadamard matrices in the neighbourhood of the Fourier matrix. This method can, in principle, be used to study of the space of solutions for any multivariate system of equations in the neighbourhood of a known solution.

79. **Yuriy SAVCHUK** – *Universität Leipzig, Germany*

Unbounded induced $*$-representations

In the first part we introduce conditional expectations of a $*$-algebra A onto a $*$-subalgebra B and use it to define an induction procedure for $*$-representations.

Further we define the category of well-behaved $*$-representations for a class of group graded $*$-algebras and develope the Mackey theory in this category.

The theory applies to a large variety of examples: Weyl algebra, q-deformed enveloping algebras $u_q(su(2))$, $u_q(su(1,1))$, the Virasoro algebra, $*$-algebras generated by dynamical systems etc.

The talk is based on a joint paper with K. Schmuedgen.

80. **Martin SCHLICHENMAIER** – *Université de Luxembourg, Luxembourg*

Berezin's coherent states, symbols and transform revisited

This talk is of review character. Some results obtained by the author, partly in joint work with M. Bordemann, E. Meinrenken and A. Karabegov, on the theory of Berezin's coherent states for arbitrary quantisable compact Kähler manifolds are recalled. Co- and contravariant symbols are discussed and the Berezin transform relating them for compact Kähler manifold is introduced. It is shown that the Berezin transform has an asymptotic expansion and the first two terms are identified.

81. **Armen SERGEEV** – *Steklov Mathematical Institute, Russia*

Harmonic spheres conjecture

Harmonic spheres are given by the smooth maps of the Riemann sphere into Riemannian manifolds which are the extremals of the energy functional defined by Dirichlet integral. They satisfy nonlinear elliptic equations, generalizing Laplace–Beltrami equation. If the targeting Riemannian manifold is Kähler then holomorphic and anti-holomorphic spheres deliver local minima of the energy functional, however, this functional usually have also non-minimal extremals.

On the other hand, Yang–Mills fields are the extremals of a functional given by the Yang–Mills action. Local minima of this functional are given by instantons and anti-instantons. It was believed that they exhaust all critical points of Yang–Mills action on the 4-dimensional Euclidean space $\mathbb{R}^4$, until examples of non-minimal Yang–Mills fields were constructed.

There is an evident formal similarity between Yang–Mills fields and harmonic maps and it became clear after the Atiyah's paper of 1984 that there is a deep reason for such a similarity. In our talk we formulate a harmonic spheres conjecture which asserts that there is a direct correspondence between the moduli space of Yang–Mills G-fields on $\mathbb{R}^4$ and the space of based harmonic spheres in the loop space ΩG where G is a compact Lie group. The talk will be devoted to the discussion of this conjecture and idea of its proof.

82. **Andrei SHAFAREVICH** — *Moscow State University, Russia*

Properties of classical Hamiltonian systems and quantum packets on graphs and singular spaces

83. **Oleg SHEINMAN** — *Steklov Mathematical Institute, Russia*

Lax integrable systems and Knizhnik–Zamolodchikov equation

Given a finite-dimensional (Hitchin-type) Lax integrable system with the spectral parameter on a Riemann surface we construct a projective unitary representation of the Poisson algebra of its observables by Knizhnik-Zamolodchikov operators. This provides a prequantization of the Lax system. The representation operators of Poisson commuting Hamiltonians of the Lax system projectively commute. If Hamiltonians depend only on action variables then the corresponding operators commute.

84. **Łukasz SKOWRONEK** — *Uniwersytet Jagielloński, Poland*

Bound entanglement with general unextendible product bases

While Unextendible Product Bases (UPBs for short) consisting of mutually orthogonal product vectors seem to be well recognized by the Quantum Information community, practically no attention has been given to UPBs with the orthogonality condition dropped. This seems to be little justified, as general UPBs look more natural in a number of respects. In the talk, I will discuss a proof showing that in the 3×3 case, all PPT bound entangled states of minimal rank, i.e. bound entangled PPT states of rank 4, are equivalent, up to a local transformation, to a projection onto the orthogonal complement to an orthogonal UPB. The product vectors in their kernel belong to a nonzero measure subset of general UPBs, and they can be locally transformed to a 3×3 orthogonal UPB. As a part of the proof, we provide a number of general as well as specific results about product vectors in the kernel of a PPT state. For example, it turns out that the intersection between the Segre variety and the kernel of a 3×3 PPT state of rank four is a transverse one. We also add an algebraic geometry flavour to recent results concerning decomposable entanglement witnesses in the $2 \times n$ and $3 \times n$ cases.

85. **Vojtech STEPAN** – *České Vysoké Učení Technické v Praze, Czech Republic*

Poisson Lie T-plurality and supermanifolds

Poisson Lie T-duality (plurality) of two-dimensional sigma-models will be briefly introduced. More or less straightforward generalization to the case of supermanifolds will be presented. Problems of the concept will be discussed.

86. **Anatole M. STEPIN** – *Moscow State University, Russia*

Some words about the Teacher

87. **Stanislav STEPIN** – *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

Short-time asymptotics of the diffusion semigroups and beyond

88. **Jaromir TOSIEK** – *Instytut Fizyki, Politechnika Łódzka, Poland*

Physically acceptable solutions of an eigenvalue equation in deformation quantization

The eigenvalue equation for an observable usually has not only solutions, which can be interpreted as Wigner functions of pure states but also solutions without any physical interpretation. We propose a method of elimination of these unphysical terms. Our considerations ar e illustrated by an example of the harmonic oscillator solved in the coordinates (time, energy).

89. **Francisco J. TURRUBIATES** – *Escuela Superior de Física y Matemáticas del Instituto Politécnico Nacional, Mexico*

Deformation quantization of cosmological models

The Weyl–Wigner–Groenewold–Moyal formalism of deformation quantization is applied to cosmological models in the minisuperspace. The quantization procedure is performed explicitly for quantum cosmology in a flat minisuperspace. The de Sitter cosmological model is studied under this approach and the computation of the Wigner functions for the Hartle–Hawking, Vilenkin and Linde wave functions are done numerically. The Wigner function is analytically calculated for the Kantowski–Sachs model in (non)commutative quantum cosmology.

90. **Andrey TSIGANOV** – *St. Petersburg State University, Russia*

Natural bi-integrable systems on the Riemannian manifolds

Bi-Hamiltonian structures can be seen as a dual formulation of integrability and separability, in the sense that they substitute a hierarchy of compatible Poisson structures to the hierarchy of functions in involution, which may be treated either as integrals of motion or as variables of separation for some dynamical system.

We discuss the concept of natural Poisson bivectors, which allows us to consider the overwhelming majority of known natural integrable systems on the Riemannian manifolds in framework of bi-Hamiltonian geometry.

91. **Victor TURCHIN** – *Kansas State University, USA*

Operad of little cubes and long knots

It turns out that the operad of $(m+1)$ little cubes acts on the space of m-dimensional long embeddings in $\mathbb{R}^n$. This construction is due to R. Budney. I will explain how this construction works and will present a conjecture describing the $(m+1)$-fold delooping of this space of embeddings in terms of morphisms of operads.

92. **Elizaveta VISHNYAKOVA** – *Ruhr-Universität Bochum, Germany*

Locally free sheaves on complex supermanifolds

The main results of our study are the following ones: the classification of locally free sheaves of modules which have a given retract in terms of non-abelian 1-cohomology; the study of such sheaves on projective superspaces, in particular, generalization of the Barth–Van de Ven–Tyurin Theorem for super-case; a spectral sequence connecting the cohomology with values in a locally free sheaf of modules with the cohomology with values in its retract. In the case of split supermanifold the necessary and sufficient conditions for triviality of cohomology class which corresponds to the tangent sheaf are given.

93. **Sergey VODOPYANOV** – *Sobolev Institute of Mathematics, Russia*

Coarea formula for smooth contact mappings of Carnot–Carathéodory spaces

We prove the coarea formula for sufficiently smooth contact mappings of Carnot manifolds. In particular, we investigate level surfaces of such mappings, and compare Riemannian and sub-Riemannian measures on them. The main tool in obtaining this result is theorem on sharp asymptotic behaviour of Riemannian measure of the intersection of a tangent plane to a level surface with a sub-Riemannian ball. One of the consequences of such calculation is the fact that sub-Riemannian measure of characteristic points (i. e., points where the sub-Riemannian differential is degenerate) equals zero on almost every level set.

The talk is based on the joint paper written with Maria Karmanova:

Karmanova M., Vodopyanov S. *Geometry of Carnot–Carathéodory Spaces, Differentiability, Coarea and Area Formulas*, In: Analysis and Mathematical Physics. Birkhäuser, 2009. P. 233–335.

94. **Theodore VORONOV** – *University of Manchester, United Kingdom*

Graded geometry and a new class of algebras arising from "non-linear" Lie algebroids

Graded geometry is an extension of supergeometry where in addition to parity there is an independent $\mathbb{Z}$-grading (called *weight*). Graded manifolds can be thought of as a generalization of vector spaces and vector bundles to the non-linear setting, because the linear transformations are precisely the weight-preserving transformations for variables of equal weight.

Graded geometry arises as a natural language for various classical notions such as, e.g. Lie algebroids. At the same time it provides a framework for their non-linear analogs. We shall consider such "non-linear Lie algebroids" and show that they possess a faithful linear realization by graded vector bundles with a peculiar algebraic structure on sections. In particular, we arrive at an interesting class of algebras, which we call "two-layer Lie algebras". (They are related with the L-infinity algebras, but are different from them.)

95. **Małgorzata ZDANOWICZ** – *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

Title to be announced