XXXII WORKSHOP ON GEOMETRIC METHODS IN PHYSICS

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Białowieża, POLAND, 1 June – 6 June 2013

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LIST OF ABSTRACTS

Plenary lectures

1. **Leonid CHEKHOV** — *Loughbourough University, United Kingdom*

   Solving quantum Liouville theory using topological recursion

   We solve the quantum Liouville theory in the strong coupling limit using the technique of quantum Riemann surfaces and the related topological recursion procedure. Postulating the Seiberg–Witten relations, we find the correspondence with known exact results. Based on joint paper(s) with B. Eynard and S. Ribault.

2. **Giulio CHIRIBELLA** — *Tsinghua University, China*

   Amplifying quantum information

   Quantum teleportation enables one to perfectly simulate the direct transfer of a quantum state form a sender to a receiver though the transfer of a finite amount of classical bits and the consumption of a finite amount of quantum entanglement. In this context, it is usually assumed that the sender and receiver receiver share the same reference frame, e.g. that their clocks are synchronized or that Cartesian axes x, y, z point in the same directions in space. However, this assumption may not be taken for granted in many situations, for example in satellite communication where the clocks of the sender and the receiver may not be synchronized. In this talk I will address the task of teleportation in the absence of a shared reference frame, showing a connection with the problem of optimal estimation of a unitary group action using quantum entanglement.

3. **Manuel GADELLA** — *University of Valladolid, Spain*

   Quantum resonances: theory and models

   Resonances in non relativistic quantum mechanics. Separation of the exponentially decaying part. Gamow states, definition and properties. Mathematical definition of Gamow states. Time asymmetric quantum mechanics. The Friedrichs model. One dimensional models. Relativistic resonances.

4. **William KIRWIN** — *Universität zu Köln, Germany*

   Complex-time flows in geometric quantization

   Using ideas of Thiemann, the adapted complex structure on a tubular neighborhood of a real-analytic Riemannian manifold in its tangent bundle can be understood as the "time-i" geodesic flow. On the tangent bundle of a compact Lie group, the geometric quantization of this flow composed with the Schrödinger quantization of the associated Hamiltonian is Hall's coherent state transform (CST), a unitary isomorphism relating square-integrable functions on the group to certain holomorphic functions on the complexification. In this talk, I will explain these ideas, and how they may be generalized to yield an infinite-dimensional family of "complex-time" flows, each of which generates a generalized CST.

5. **Yuri KORDYUKOV** — *Institute of Mathematics, Ufa Scientific Center of RAS, Russia*

   Semiclassical spectral asymptotics for magnetic Schrödinger operators

   We describe recent results on semiclassical asymptotics for the spectrum of a magnetic Schrödinger operator on a Riemannian manifold in the case when the

magnetic field does not vanish at each point. We give geometric interpretations of our results and discuss some related problems in differential geometry and integrable systems. This is joint work with B. Helffer.

6. **Giovanni LANDI** — *Università di Trieste, Italy*

   The Weil algebra of a general Hopf algebra

   We generalize the notion, due to H. Cartan, of an operation of a Lie algebra in a graded differential algebra. Firstly, for such an operation we give a natural extension to the universal enveloping algebra of the Lie algebra and analyze all of its properties. Building on this we define the notion of an H-operation, that is the operation of a general Hopf algebra H in a graded differential algebra. We then introduce for such an operation the notion of algebraic connection. Finally we discuss the corresponding noncommutative version of the Weil algebra as the universal initial object of the category of H operations with connections.

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

   Complex hulls of the one-sheeted hyperboloid, analytic continuation of spherical functions, and Plancherel formula

   For the one-sheeted hyperboloid in $\mathbb{R}^3$, we construct four complex hulls and continue analytically to them spherical functions of different series: continuous (twice), holomorphic and antiholomorphic. For these series, we write explicitly projection operators and Cauchy–Szegö kernels.

8. **Sergey NATANZON** — *Higher School of Economics, Russia*

   A Hurwitz theory avatar of open-closed strings

   Will be represent the statement about coincidence the algebraic structure of open - closed topological string theories and the algebras, generated by Hurwitz numbers of foams. The talk is based on works joint with A. Alekseevskii, A. Mironov and A. Morosov.

9. **Radu PURICE** — *"Simion Stoilow" Institute of Mathematics of the Romanian Academy, Romania*

   Magnetic coherent states

   We introduce magnetic coherent states for a particle in a variable magnetic field. They provide a pure state quantization of the phase space $\mathbb{R}^{2N}$ endowed with a magnetic symplectic form.

10. **Vladimir ROUBTSOV** — *Université d'Angers, France*

    Title to be announced

11. **Sergey SHADRIN** — *Universiteit van Amsterdam, The Netherlands*

    Matrix models, topological recursion and Givental theory

    Topological recursion for matrix models has appeared in the papers of Chekhov, Eynard, and Orantin, and it serves both as a very powerful computational tool and as a way to defines the correlation forms of a matrix model in a mathematically rigorous way.

    We explain a version of the topological recursion procedure for a collection of isolated local germs of the spectral curve. Under some conditions we can identify

the n-point functions computed from spectral curve with the Givental formula for the ancestor formal Gromov–Witten potential.

Using this identification one can deduce various relations of combinatorial problems to the intersection theory of the moduli spaces of curves. Examples include the Norbury-Scott conjecture on a particular spectral curve for the Gromov–Witten theory of CP^1, a new way to derive the ELSV formula for Hurwitz numbers, and a mathematical physics proof of the 2006 conjecture of Zvonkine that relates Hurwitz numbers with completed cycles to the intersection theory of the moduli spaces of r-spin structure.

The talk will follow my recent works with Dunin-Barkowski, Orantin, Spitz, and Zvonkine.

12. **Daniel STERNHEIMER** — *Rikkyo University (Tokyo) & Université de Bourgogne, France*

Altneuland in mathematical particle physics: back to the drawing board??

We describe work in progress and outline a "scheme for conjectural frameworks" based on Flato's deformation philosophy, on joint works with or by Flato and coworkers (especially Fronsdal) since the 60's, and on discussions with many mathematicians and physicists in the past years. Namely we return to the old problem of connection between external (Poincaré group) and internal (unitary) symmetries of elementary particles but with a (Drinfeld) twist, suggesting that the internal symmetries might emerge from deforming to Anti de Sitter $SO(2,3)$ and quantizing that (possibly in a new generalized manner) at root of unity. That raises challenging problems, both on the mathematical part and for particle physics. See the longer pdf abstract:

`http://monge.u-bourgogne.fr/d.sternh/papers/DSaltneulandWGMP32LongAbstract.pdf`

and for an earlier text, see:

`http://wwwen.uni.lu/content/download/56018/661547/file/sternheimer.pdf`

13. **Piotr SUŁKOWSKI** — *Uniwersytet Warszawski & Caltech, Poland/USA*

On knots, super-A-polynomial, and BPS states

In the last two decades it has been realized that intricate relations between knot theory, quantum field theory and string theory may be very fruitful, and taking advantage of them has led to several remarkable discoveries. In this talk, after a brief review of these relations, I will focus on topics currently studied. In particular I will introduce the notion of super-A-polynomial — a new knot invariant, which takes form of an algebraic curve. From mathematics viewpoint the super-A-polynomial encodes information about homological knot invariants. Physically it plays an important role in a large class of three-dimensional, supersymmetric gauge theories, which are dual to Chern–Simons theory. These topics are at the forefront of current research and lead to surprising new insights.

14. **Mikhail ZELIKIN** — *Moscow State University, Russia*

Stochastic dynamics of the Lie algebra of Poisson brackets in the vicinity of discontinuity points of Hamiltonian systems

The structure of solutions to Hamiltonian systems with continuous but non-smooth Hamiltonian H is explored. It is considered solutions passing through a point x_0, which belongs to the junction of three domains of smoothness Ω_i, $(i = 1,2,3)$

of the Hamiltonian H. Let H_i be the restriction of the Hamiltonian H to the smoothness domain Ω_i. The Lie algebra $\mathfrak{L}$ of Poisson brackets with generators H_i is a graded, homogeneous algebra with a scale group $\mathfrak{g}$. The dynamics $\mathfrak{A}$ of $\mathfrak{L}$ along the Hamiltonian system is explored. The system $\mathfrak{A}$ coincides with that of Pontryagin Maximum Principle for a problem P of minimization the mean square deviation from the point x_0 of solutions to the system $\ddot{x} = u$ where $x, u \in \mathbb{R}^2$ and the control $u \subset U$ belongs to the equilateral triangle U. We factories this dynamics by the scale group $\mathfrak{g}$. After the resolution of singularity of the Poincaré map of the break surface at the point x_0 (blow up procedure), one obtains a dynamical system that has a stochastic dynamics defined by the Bernoulli shift on a topological Markov chain. The synthesis of optimal trajectories of the problem P is designed. The set of non-wandering points (NW) has the structure of a Cantor set similar to that of the Smale horseshoe. The Hausdorff dimension and the entropy of NW are calculated.

Contributed lectures

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

Right-sided hyperbolic operators

16. **Constantin ARCUS** — *Secondary School "Cornelius Radu", Romania*

Mechanical systems in the generalized Lie algebroids framework

Mechanical systems called by use, mechanical $(\rho;\eta)$-systems, Lagrange mechanical $(\rho;\eta)$-systems or Finsler mechanical $(\rho;\eta)$-systems are presented. The canonical $(\rho;\eta)$-semi(spray) associated to a mechanical $(\rho;\eta)$-system is obtained. New and important results are obtained in the particular case of Lie algebroids. The Lagrange mechanical $(\rho;\eta)$-systems are the spaces necessary to develop a new Lagrangian formalism. We obtain the $(\rho;\eta)$-semispray associated to a regular Lagrangian L and external force F_e and we derive the equations of Euler–Lagrange type. So, a new solution for the Weinstein's Problem in the general framework of generalized Lie algebroids is presented.

17. **Marat AUKHADIEV** — *Kazan State Power Engineering University, Russia*

Classical compact quantum semigroups as deformations of abelian groups

The algebra of continuous functions $C(G)$ of a compact abelian group G can be deformed using its Pontryagin dual discrete group Γ. In fact, this new C^*-algebra is generated by an inverse semigroup, and is called a reduced semigroup C^*-algebra. We show that this C^*-algebra can be regarded as an algebra of functions on a compact quantum semigroup QS, which posesses different interesting properties. Thus, QS is a "deformation" of the group G. The quantum semigroup QS is endowed with a natural coaction of G, given by a C^*-dynamical system. Such compact quantum semigroups form a tensor category, dual to a category of some abelian semigroups.

18. **Elena Mirela BABALIC** — *"Horia Hulubei" National Institute of Physics and Nuclear Engineering, Romania*

Geometric algebra, Fierz identities and supergravity

I discuss applications of geometric algebra techniques to the theory of spinors on curved spacetime. In particular, I outline a systematic and unified approach to

Fierz identities in arbitrary dimensions and signatures, illustrating this briefly with a few examples from supergravity compactifications.

19. **Alexander BELAVIN** — *Landau Institute for Theoretical Physics RAS, Russia*

    Frobenius algebras, KdV hierarchies and minimal Liouville gravity

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

    Quantum mechanics and geometry on Siegel–Jacobi disk

    The Jacobi group is the semidirect product of the real symplectic group with appropiate Heisenberg group. The Sigel–Jacobi domains are homogenous Kähler manifolds attached to the Jacobi groups. We have introduced generalized coherent states based on the the Siegel–Jacobi manifolds. Using a holomorphic representation of the Jacobi algebra by first order differential operators, we describe the dyamics of a process generated by a linear Hamiltonian in the generators of the Jacobi group. The Berezin kernel, Calabi's diastasis, the Kobayashi embedding, and the Cauchy formula for the Sigel–Jacobi disk are presented.

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

    On deformation quantisation

    We will present some recent and less recent features of deformation quantisation.

22. **Goce CHADZITASKOS** — *České Vysoké Učení Technické v Praze, Czech Republic*

    C-orbit function and image filtering

    We use C-orbit function for image procesing. C-orbit function is a generalization of cosine function, its discretization is defined on simplexes. The function is connected with Weyl group of roots of simple Lie algebras. We use A_2 C-orbit function for image processing and we present application of several filters on the image.

23. **Ioana-Alexandra COMAN** — *"Horia Hulubei" National Institute of Physics and Nuclear Engineering, Romania*

    Geometric algebra study of $N = 2$ M-theory compactifications to AdS_3

    We present techniques of geometric algebra and their application to the study of supergravity compactifications. We then investigate, using these techniques, the most general warped compactifications of eleven-dimensional supergravity on eight-manifolds to AdS_3 spaces, which preserve $N = 2$ supersymmetry in three dimensions. In this study we consider a non-vanishing four-form flux and do not impose any restrictions on the chirality of the internal part of the supersymmetry generators.

24. **Alina DOBROGOWSKA** — *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

    Integrable systems related to deformed $\mathfrak{so}_{\lambda,\alpha}(5)$

    We investigate a family of integrable Hamiltonian systems on Lie–Poisson spaces dual to Lie algebras $\mathfrak{so}_{\lambda,\alpha}(5)$ being two-parameter deformations of $\mathfrak{so}(5)$. We integrate corresponding Hamiltonian equations in quadratures as well as discuss their possible physical interpretation.

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

Nonlinear conformal-invariant electrodynamics in $(4+2)$-dimensional spacetime

The conformal compactification of $(3+1)$-dimensional Minkowski spacetime, as is well-known, can be identified with the projective light cone in $(4+2)$-dimensional spacetime. In this space the conformal group acts linearly via rotations, and fields satisfying conformal-invariant linear Maxwell equations can be defined. Here we consider nonlinear, conformal-invariant equations for the higher-dimensional Maxwell fields. Nonlinear constitutive equations are expressed in terms of a pair of invariant functionals. We write their transformation properties under conformal inversion in some different coordinate systems. We then explore them in relation to the class of nonlinear constitutive equations for classical electromagnetism in $3+1$ dimensions respecting conformal symmetry (including Lagrangian and non-Lagrangian systems). The talk is based on continuing joint work by the presenter with Steven Duplij (Kharkov National University, Ukraine) and Vladimir Shtelen (Rutgers University, USA).

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

Geodesic mappings of (pseudo-)Riemannian manifolds preserve class of differentiability

We prove that geodesic mappings of (pseudo-)Riemannian manifolds preserve the class of differentiability. Joint work with J. Mikeš.

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

***N* points star product: construction and integral representation**

This talk addresses a new star product, called N points star product, of a finite set of Schwartz class functions, built on the property of cyclic permutation of points. Relevant algebraic properties and integral representation of such a product are established and discussed.

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

Fourier transforms of E-functions of $O(5)$ and $G(2)$

We discuss the properties of six types of special functions related to the Weyl groups of $O(5)$ and $G(2)$. These functions of two real variables, known as $E-$functions, are generalization of the common exponential functions for each group. The Fourier transforms of these function are described. We focus on discrete transforms on lattices — the symmetries of these lattices are inherited from the groups $O(5)$ and $G(2)$. Examples of application to interpolation are presented.

29. **Michał JÓŹWIKOWSKI** — *Instytut Matematyczny Polskiej Akademii Nauk, Poland*

On geometry of higher-order Euler–Lagrange equations

We construct a geometric framework to study variational problems on higher tangent bundles. As a result we obtain a geometric construction of higher-order Euler–Lagrange equations together with the corresponding momenta.

My talk is based on a joint work with Mikołaj Rotkiewicz.

30. **Igor KANATCHIKOV** — *Center of Quantum Physics, State Open University, Moscow & KCIK, Sopot, Russia, Poland*

Quantum gravity and quantum cosmology from precanonical approach to quantization

Precanonical quantization based on the mathematical structures of the De Donder–Weyl (polysimplectic) covariant Hamiltonian formalism can be applied to general relativity and leads to a new nonperturbative, background independent and covariant formulation of quantum gravity and quantum geometry described in term of the wave functions or transition amplitudes on the bundle of connections over space-time. We formulate the analogue of the Schrödinger equation in this approach and discuss some of its consequences in simple cases, including a simplified quantum cosmology model. Refs: see the forthcoming papers in Arxiv.

31. **Hovhannes KHUDAVERDIAN** — *University of Manchester, United Kingdom*

Operator pencils on densities

Let Δ be a linear differential operator acting on the space of densities of a given weight t_0 on a manifold M. One can consider lifting of this operator, a pencil of operators Δ_t passing through the operator Δ such that any Δ_t is a linear differential operator acting on densities of weight t. We study liftings which are equivariant with respect to group of diffeomorphisms of M, and some of its subgroups. Our analysis is essentially based on the simple but very important facts that a pencil of operators can be identified with a linear differential operator $\hat{\Delta}$ acting on the algebra of densities of all weights, and this algebra possesses a canonical scalar product.

32. **Stéphane KORVERS** — *Université Catholique de Louvain, Belgium*

The deformation quantizations of the Hermitian symmetric space $SU(1,n)/U(n)$

In "The Deformation Quantizations of the Hyperbolic Plane" (Bieliavsky, Detournay, Spindel, Commun. Math. Phys. 2008), the authors show that a curvature contraction on the hyperbolic plane produces a symplectic symmetric surface whose transvection group is isomorphic to the Poincaré group in dimension 2. They also prove that from this contraction process emerges a differential operator of order two whose certain solutions of its evolution equation define convolution operators that intertwine the deformation theory (star-products) at the contracted level with that of the hyperbolic plane. This talk will be devoted to the study of a generalization of this construction in the case of the Hermitian symmetric space $SU(1,n)/U(n)$.

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

Aspects of the quantum separation of variables for the Toda chain

The quantum separation of variables method consists in mapping the original Hilbert space where a spectral problem is formulated onto one where the spectral problem takes a simpler "separated" form. In order to realise such a program, one should first construct the so-called SoV map explicitly and then show that it is unitary. Second, one should "translate" the local operators on the original Hilbert onto operators on the "separated" space, ie solve the so-called quantum inverse scattering problem. In the present talk, we shall discuss several progress that we have made in respect to the two point points mentioned previously. Namely, in

the case of the quantum Toda chain, we shall describe a technique which allows one to prove the unitarity of the SoV map. Then we shall discuss the progress we have made in the resolution of the quantum inverse scattering problem for this model. Our approach to the proof of unitarity solely builds on objects and relations naturally arising in the framework of the so-called quantum inverse scattering method. Hence, with minor modifications, it appears readily transposable to other quantum integrable models solvable by the quantum separation of variables method. As such, it provides an important alternative, in what concerns studying unitarity of the SoV map, in respect to results obtained previously within the group theoretical interpretation of the model, which is absent for more complex quantum integrable models.

34. **Sergey KTITOROV** — *Ioffe Institute & Polytechynic University & Electrotechnical University, Russia*

Electronic states in curved graphene

The effective action for Dirac electrons in the curved graphene sheet is derived. Autolocalized states are considered. Effect of 2d fluctuations is analyzed.

35. **Kirill MACKENZIE** — *University of Sheffield, United Kingdom*

Actions of Poisson groups and Lie bialgebras

A smooth action of a Lie group on a manifold gives rise to a Lie groupoid, the Lie algebroid of which arises from the infinitesimal action of the Lie algebra by a corresponding construction. This basic observation allows the integrability of infinitesimal actions to be treated as part of the general integrability question for Lie algebroids.

The construction however does not extend in a direct way to Poisson actions of Poisson Lie groups: the action groupoid constructed from a Poisson action is not a Poisson groupoid. We will show how this can be resolved by use of the cotangent structures associated to Lie groups and Poisson manifolds; one must construct the action structure on the level of doubles. The construction extends to Poisson actions of general Poisson groupoids and Lie bialgebroids.

36. **Dmitry MALININ** — *United Arab Emirates University, United Arab Emirates*

Elliptic curves and Abelian varieties: some links to group representations, geometry and number theory

We study some geometric and arithmetic properties of Abelian varieties, related group representations, Hopf algebras and quantum groups. In particular, representations attached to torsion points on supersingular elliptic curves give an infinite number of solutions of the tame inverse Galois problem, and the properties of formal groups and the action of the inertia group on the Tate module of the associated representations, can be generalized for Abelian varieties and supersingular Abelian surfaces with some extra conditions. We study Galois cohomology of related arithmetic groups. There is a connection between the study of special classes of coherent sheaves on elliptic curves and their degenerations with solutions of the classical Yang–Baxter equation; in particular, this theory contributes to classification of indecomposable vector bundles on elliptic curves, certain matrix problems and Frobenius Lie algebras.

37. **Bogdan MIELNIK** — *CINVESTAV, Mexico*

Icecream and parasites

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

On geodesic and holomorphically projective mappings

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

Planar motion of charged particles in a magnetic dipole field

We consider the system of Newton–Lorentz equations describing the planar non-relativistic motion of a charged particle of unit mass in a transverse magnetic dipole field. Actually, this system belongs to the class of dynamical systems of two degrees of freedom whose integrability in the Liouville–Arnold sense is studied in [1]. The magnitude of magnetic dipole field depends only on the distance from the origin and therefore (see [2]), the corresponding Newton–Lorentz system is integrable by quadratures since it possesses two functionally independent integrals of motion. In the present work, the techniques developed by the authors in [1, 2] are used to represent the trajectories of the particles in explicit analytic form in terms of Jacobian elliptic functions.

[1] Vassilev V., Djondjorov P. and Mladenov I., Integrable Dynamical Systems of the Frenet–Seret Type. In: Proc. 9th International Workshop on Complex Structures, Integrability and Vector Fields, World Scientific, Singapore 2009, pp. 234-245.

[2] Mladenov I., Hadzhilazova M., Djondjorov P. and Vassilev V., On the Plane Curves whose Curvature Depends on the Distance from the Origin, AIP Conf. Proc. vol. 1307, American Institute of Physics, New York 2010, pp. 112-118.

40. **Yurii NERETIN** — *Institute for Theoretical and Experimental Physics, Russia*

Difference Sturm–Liouville operators in imaginary direction

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

A simple construction of integrable Whitham type hierarchies

A simple construction of Whitham type hierarchies in all genera is suggested. Potentials of these hierarchies are written as integrals of hypergeometric type.

42. **Sergei PARKHOMENKO** — *L.D. Landau Institute for Theoretical Physics, Russia*

Line bundle twisted chiral de Rham complex and bound states of D-branes on toric manifolds.

We calculate elliptic genus in various examples of twisted chiral de Rham complex on two dimensional toric compact manifolds and Calabi–Yau hypersurfaces in toric manifolds. At first the elliptic genus is calculated for the line bundle twisted chiral de Rham complex on a compact smooth toric manifold and $K3$ hypersurface in $\mathbb{P}^3$. then we twist chiral de Rham complex by sheaves localized on positive codimension submanifolds in $\mathbb{P}^2$ and calculate in each case the elliptic genus. In the last example the elliptic genus of chiral de Rham complex on $\mathbb{P}^2$ twisted by $SU(N)$ vector bundle with instanton number k is calculated. In all the examples considered we find the infinite tower of open string oscillator contributions of the corresponding bound state of D-branes identifying thereby directly the open string boundary conditions and D-brane charges.

43. **Mikołaj ROTKIEWICZ** — *Instytut Matematyczny Polskiej Akademii Nauk, Poland*

Higher algebroids and reductions of higher tangent bundles

I will show how to define objects called *higher (Lie) algebroids* which generalize higher tangent bundles T^kM in the same way as (Lie) algebroids generalize the tangent bundle TM. I will study the reductions of higher tangent bundles of a Lie groupoid which provide a natural example of such objects. Then I will give an abstract definition of higher algebroids taking an arbitrary almost Lie algebroid as a starting point.

This higher version of algebroids is suitable for geometric framework for variational problems in which Lagrangian depends on higher derivatives and has some inner symmetries.

My talk is based on a joint paper with Michał Jóźwikowski.

44. **Serguei SAMBORSKI** — *Université de Caen Basse-Normandie, France*

The equation $H(x, y, grad\ y) = f$

Extensions of PD operators from the set of smooth functions in some appropriate functional spaces lead to solutions of corresponding equations which may be discontinuous but physically justified (f.e. shock waves). General existence results that are new even in the case of Ordinary DE are obtained. We study also "superstability" of these solutions i.e. stability under "singular perturbations" that raise the order of PDE. In some results the only condition for H is its continuity.

45. **Martin SCHLICHENMAIER** — *Université du Luxembourg, Luxemburg*

Some naturally defined star products for Kähler manifolds

We give for the Kähler manifold case an overview of the constructions of some naturally defined star products. In particular, the Berezin–Toeplitz, Berezin, Geometric Quantization, Bordemann–Waldmann, and Karabegov standard star product are introduced. With the exception of the Geometric Quantization case they are of separation of variables type. The classifying Karabegov forms and the Deligne–Fedosov classes are given. Besides the Bordemann–Waldmann star product they are all equivalent.

46. **Alexander SCHMEDING** — *Universität Paderborn, Germany*

Diffeomorphism groups of non-compact orbifolds

Orbifolds are a generalization of manifolds. They arise naturally in different areas of mathematics and physics, e.g.:

- Spaces of symplectic reduction are orbifolds,
- Orbifolds may be used to construct a conformal field theory model (cf. [1]).

We consider the diffeomorphism group of a paracompact, non-compact smooth reduced orbifold. Our main result is the construction of an infinite dimensional Lie-group structure on the diffeomorphism group and several interesting subgroups (our exposition follows [3]). Here orbifold morphisms are understood as maps in the sense of [2]. In the talk we sketch the construction and its main ingredients.

[1] Dixon, L.J., Harvey, J.A., Vafa, C. and Witten, E.: Strings on orbifolds

Nuclear Phys. B 261:4 (1985), 678-686

[2] Pohl, A.D.: Convenient categories of reduced orbifolds

arXiv:1001.0668v4 [math.GT] (2010) http://arxiv.org/abs/1001.0668

[3] Schmeding, A.: The diffeomorphism group of a non-compact orbifold

arXiv:1301.5551 [math.GR] (2013) http://arxiv.org/abs/1301.5551

47. **Ekaterina SHEMYAKOVA** — *State University of New York at New Paltz, USA*

Factorization of Darboux transformations of arbitrary order for two-dimensional Schrödinger operator

We prove that a Darboux transformation of arbitrary order d for two-dimensional Schrödinger operator can be factored into Darboux transformations of order 1.

Even for the special case of Darboux transformations of order 2 this problem is hard. For this case we have found earlier a rather beautiful proof based on the invariantization (we used regularized moving frames due to Olver and Pohjanpelto).

The analogous statement for one-dimensional Schrödinger operator was proved in four steps (Shabat, Veselov and Bagrov, Samsonov). In this case the factorization is not unique, and different factorizations imply discrete symmetries related to the Yang–Baxter maps (Adler and Veselov).

48. **Aneta SLIŻEWSKA** — *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

Groupoids related to W*-algebra

In this talk we will investigate the groupoid $\mathcal{U}(\mathcal{M})$ of partial isometries and the groupoid $\mathcal{G}(\mathcal{M})$ of partially invertible elements of the W*-algebra $\mathcal{M}$.

49. **Stanislav STEPIN** — *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

Bound states and scattering for nonselfadjoint Schrödinger operator

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

Toeplitz quantization with non-commuting symbols

Results will be presented on Toeplitz operators whose symbols are elements in a paragrassmann algebra or in the complex quantum plane, each of which is a non-commutative algebra. Special cases of these Toeplitz operators are creation and annihilation operators, whose commutation relations will also be discussed. I am not aware of any other Toeplitz quantization scheme which employs non-commuting symbols.

51. **Jaromir TOSIEK** — *Politechnika Łódzka, Poland*

States in the phase space formulation of quantum mechanics

We propose several practical criteria how to recognise functionals representing states in the phase space formulation of quantum mechanics. After minor modifications these criteria can be applied to check positivity of any functions from an algebra with the Weyl type $*$-product.

52. **Gijs TUYNMAN** — *Université de Lille I, France*

The Hamiltonian?

53. **Elizaveta VISHNYAKOVA** — *Université du Luxembourg, Luxemburg*

About classification of complex supermanifolds

A supermanifold is called homogeneous (even-homogeneous) if it possesses a transitive action of a Lie supergroup (an even-transitive action of a Lie group). We will present the most resent results about the classification of even-homogeneous and homogeneous complex supermanifolds whose reduction is a given flag manifold obtained by A. Onishchik, M. Bashkin and myself.

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

Algebra of densities

The talk is devoted to differential-geometric constructions on the **algebra of densities** $\mathrm{Den}(M)$, which is a commutative algebra canonically associated with a given manifold or supermanifold M. The algebra $\mathrm{Den}(M)$ is graded by real numbers and possesses a natural invariant scalar product. This leads to important geometric consequences and applications to geometric constructions on the original manifold. The talk is based on joint works with H.M. Khudaverdian and includes a recent result of our student A. Biggs.

55. **Wojciech WOJTYŃSKI** — *Uniwersytet Warszawski, Poland*

Towards Lie theory of diffeomorphism groups

The "string approach" to Lie group theory is introduced. Instead of assuming that the treated group G is equipped with a differentiable manifold structure we impose the condition that G is a topological group having "rich" family of continuous one-parameter subgroups.

56. **Stanisław Lech WORONOWICZ** — *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

Categories of C*-algebras with crossed product

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

Star products, star exponentials and applications

In this short talk, we give an introduction to star produts parametrized by complex symmetric matrices.

We extend the typical star product such as Moyal product and we define a family of star products depending on complex symmetric matrices. We give a geometric picutre for a family of star prdoucts.

In troducing a topology into star product algebras, we consider exponential elements for the extended complete algebra. We show exaples of star exponentials and disscuss their application.

Poster session

58. **Danail BREZOV** — *University of Architecture Civil Engineering and Geodesy, Bulgaria*

Euler Decomposition in a Non-Orthogonal Basis

We obtain covariant expressions for the generalized Euler decomposition of three-dimensional rotations based on the vector parametrization construction, proposed

by Rodrigues. On the condition that the axes of rotations in the decomposition form a non-orthogonal basis, the solution may be written explicitly, with the help of the metric, in terms of the coordinates of the compound vector parameter in this basis. These results can be naturally generalized to the case of coplanar axes, which is the classical Euler decomposition and some specific details are added concerning the cases of half turns and one-parameter degenerate solutions (gimbal lock). The problem can also be related to a coordinate frame, attached to the rotating object as far as physical applications are concerned.

59. **Małgorzata BURZYŃSKA** — *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

Differential groupoids

In the poster basic properties and examples of the differential groupoids have been studied.

60. **Smail CHEMIKH** — *Preparatory School in Science and Technic Alger, Algiers*

Almost contact manifolds

61. **Satish Kumar DIXIT** — *ICFAI University Raipur, India*

Studies on deformation theory of algebraic structures

The aim of this paper is to develop a deformation theory which classifies infinitesimal deformations of multi-categories. In order to achieve this, methods from homological algebra will be used: a cochain complex will be constructed such that infinitesimal deformations up to equivalence correspond to elements of the second cohomology group. The thesis starts with presenting the classical result of deformations of associative algebras. On the way we also encounter deformations of Lie algebras and of categories. Gerstenhaber describes in a method to construct a cochain complex bringing us into the arena of homological algebra. The idea of homological algebra is to assign to an object a cochain complex, i.e. a sequence of modules such that the composition of any two consecutive maps is zero.

62. **Lenka HÁKOVÁ** — *Ceské Vysoké Učení Technické v Praze, Czech Republic*

Interpolation of multidimensional digital data using Weyl group orbit functions

Orbit functions are families of special functions related to the Weyl group of semisimple Lie algebras. They are complex functions depending on n variables where n is the rank of the underlying Lie algebra. They possess several remarkable properties, among them a discrete orthogonality when sampled on a lattice fragment of a domain in $\mathbb{R}^n$. This allows applications of orbit functions in processing of digital data. We present a method for an interpolation of discrete functions using the family of so-called S^l-function defined by the Weyl group of the Lie algebra B_3.

63. **Robert JANKOWSKI** — *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

On the stability Nash equilibrium in the model of replicator dynamics with asymmetric delays

In this poster, the model of replicator dynamics with asymmetric delays is investigated. The Nash equilibrium is stable strategy in such contest under certain

circumstances. Those conditions are shown and proved.

64. **Radhakrishnan NAIR** — *University College Trivandrum, India*

Geometry of stochastic matrices and the underlying symmetries

Singly stochastic, doubly stochastic and magic doubly stochastic matrices are presented with the geometries associated with them and the consequent symmetries.

65. **Urszula OSTASZEWSKA** — *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

Spectral exponent of moment-generating functions of weighted composition operators

66. **Barbara PIETRUCZUK** — *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

Asymptotic integration of third-order differential equations

There will be presented asymptotic formulas for solutions of the equation

$$u''' - (1 + \varphi(t))u = 0,$$

where the function φ is small in a certain sense for large values of the argument. Usage of two methods of asymptotic integration, the method based on a reduction to the Poincaré–Lyapunov equation and the method of L-diagonal system, allowes to obtain various forms of solutions depending on the properties of function φ.

67. **Dana SMETANOVÁ** — *Vysoá Škola Technická a Ekonomická v Českých Budějovicích, Czech Republic*

On regularization procedure for Lagrangians in field theories

68. **Joanna ZONENBERG** — *Instytut Matematyki, Uniwersytet w Białymstoku, Poland*

Title to be announced

II School on Geometry and Physics

8 July — 13 July 2013

ABSTRACTS OF COURSES

1. **Alexey BOLSINOV** — *Loughborough University, United Kingdom*

   Holonomy groups and special geometries

2. **Alexander GAYFULLIN** — *Steklov Mathematical Institute, Russia*

   Coxeter groups, permutahedra, and realisation of cycles

   The following classical question is due to Steenrod (1940s) and is usually called the problem on realisation of cycles:

   Given a topological space and an integral homology class of it, can we realise this homology class as a continuous image of the fundamental class of an oriented closed smooth manifold?

   Originally, this question is purely topological, and certainly it was attacked in 1950s–1960s by methods of algebraic topology. Important results were obtained by Thom, Milnor, Novikov, Buchstaber, and Sullivan.

   Recently a new approach has been found by a lecturer. This approach deals nothing with algebraic topology. Instead, it uses direct geometric and combinatorial constructions involving right-angular Coxeter groups and special convex polytopes called permutahedra. A key role in this approach is played by the isospectral manifold of real symmetric tridiagonal matrices, which is important in mathematical physics, since it carries the famous Toda flow.

   The minicourse will be devoted to this new approach to the problem on realisation of cycles, and its connections to other interesting objects such as small covers of simple polytopes, hyperbolic manifolds, domination relation for oriented manifolds, and simplicial volume.

3. **Hovhannes KHUDAVERDIAN** — *University of Manchester, United Kingdom*

   Operator pencils, densities and equivariant geometry

   We consider pencil lifting maps from operators on densities of given weight to operator pencils defined on densities of all weights. In general, such a map can be defined and it can be defined uniquely, only on operators of order ≤ 2, if we impose a natural condition that the lifting is equivariant with respect to the group of all diffeomorphisms of the base manifold. We explain the geometrical meaning of such a map. Then we analyze the existence and uniqueness of lifting maps defined on operators of all orders in the case if lifting map is equivariant with respect to a smaller group, such as the group of diffeomorphisms preserving volume form, or the group of diffeomorphisms preserving a projective structure.

4. **Kirill MACKENZIE** — *University of Sheffield, United Kingdom*

   Approaches to the integrability of Lie algebroids

   Given a principal bundle $P(M, G)$, the G-invariant vector fields on P are sections of a vector bundle on M which is the central term of a short exact sequence, the **Atiyah sequence of** $P(M, G)$. This is a transitive Lie algebroid and by extending the classical geometric prequantization technique one can find, for any transitive Lie algebroid, a Cech class which determines whether the Lie algebroid is the Atiyah sequence of a principal bundle. We will describe this construction in the first lecture.

   For general Lie algebroids the problem of integrability is very much more difficult. In the second lecture we will outline the approach of Cattaneo–Felder–Crainic–Fernandes which starts from Duistermaat's correspondence between paths in a Lie group and paths in its Lie algebra.

5. **Yuri NERETIN** — *Institute for Theoretical and Experimental Physics, Russia*

   Geometry of double coset spaces and infinite-dimensional groups

6. **Alexei PENSKOI** — *Moscow State University & Independent University of Moscow, Russia*

   Spectral Geometry and Mathematical Physics

   In 1966, Mark Kac formulated a celebrated question "Can one hear the shape of a drum?" It illustrates very well one of the central problems in spectral geometry: namely, to understand the relations between the geometry of a domain (or a manifold) and the spectrum of the Laplace operator with suitable boundary conditions. Nowadays, spectral geometry is a very active area of mathematics with numerous links to analysis, mathematical physics, differential geometry an other fields. In this three lecture mini-course, I will present a brief introduction to spectral geometry and discuss its connections to mathematical physics.

7. **Alexander VESELOV** — *Loughborough University, United Kingdom*

   Universal formulae in Lie group theory

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

   On integration over compact supermanifolds

   I will discuss concrete examples of calculating integrals over compact supermanifolds such as projective superspaces. There are some interesting phenomena here that do not occur in the ordinary case. For example, there may occur the situation of the zero total volume or when the volume becomes a topological quantity (not depending on characteristic parameters). Also some standard methods of calculating integrals over compact manifolds unexpectedly fail in the supercase. I will try to make the exposition elementary.