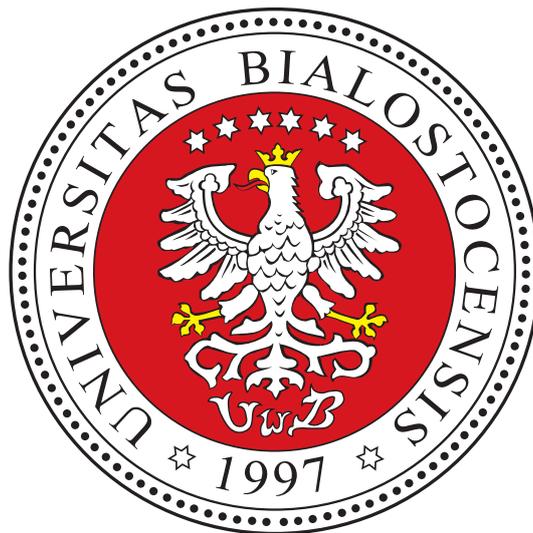


XXXV WORKSHOP ON GEOMETRIC METHODS IN PHYSICS

Białowieża, Poland, June 26 – July 2, 2016



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LIST OF ABSTRACTS

Plenary lectures

1. **Dorothea BAHNS** – *Universität Göttingen, Germany*

An infinite dimensional Lie algebra and conserved charges in String theory

2. **Ivan CHELTSOV** – *University of Edinburgh, UK*

Stable and unstable del Pezzo surfaces

Yau–Tian–Donaldson conjecture, recently proved by Chen, Donaldson and Sun, says that a Fano manifold is Kahler–Einstein if and only if it is K -stable. Its stronger form, still open, says that a polarized manifold (M, L) is K -stable if and only if M admits a constant scalar curvature with Kahler class in L . In this talk, I will describe K -stability of ample line bundles on smooth del Pezzo surfaces (two-dimensional Fano manifolds). I will show how to apply recent result of Dervan to prove K -stability and how to use flop-version of Ross and Thomas’s obstruction to prove instability.

The talk is based on my joint work with Jesus Martinez-Garcia (Johns Hopkins University, Baltimore, USA).

3. **Maxim GRIGORIEV** – *Lebedev Physical Institute, Russia*

Supergeometry of gauge PDE and AKSZ sigma models

AKSZ sigma models were originally proposed to describe topological systems. In fact, an AKSZ model with finite number of fields and space-time dimension higher than 1 is necessarily topological. These models are quite distinguished in the sense that the geometry of the target space manifold encodes not only its Lagrangian/equations of motion but also the complete BV-BRST differential. Moreover, the Hamiltonian BRST formulation (also known as BFV-BRST) is also naturally contained in the AKSZ one. In this sense it naturally unifies both the Lagrangian and the Hamiltonian formalism of gauge systems. I will explain how this extends to the case of non-topological PDE. It turns out that any gauge PDE can be equivalently reformulated as an AKSZ sigma-model whose target-space is the respective equation manifold (stationary surface, seen as a submanifold of the associated jet-space) extended by the relevant ghost variables. In particular, a gauge PDE is fully determined by a graded supermanifold equipped with a pair of commuting homological vector fields of degree 1. In the case of Lagrangian PDE extra structures are present. Just like the Hamiltonian formalism is contained in the AKSZ formulation one can employ AKSZ to describe (asymptotic) boundary values of the fields. This technique appears promising in the context of AdS/CFT correspondence for higher-spin models.

4. **Sergei MERKULOV** – *University of Luxembourg, Luxembourg*

Props of ribbon graphs, involutive Lie bialgebras and moduli spaces of curves

We discuss a new and surprisingly strong link between two previously unrelated theories: the theory of moduli spaces of curves (which, according to Penner, is

controlled by the ribbon graph complex) and the homotopy theory of operads (controlled by ordinary graph complexes with no ribbon structure, introduced first by Kontsevich). The talk is based on a joint work with Thomas Willwacher.

5. **Ruben MKRTCHYAN** – *Yerevan Physics Institute, Armenia*

Universality in simple Lie algebras and Chern–Simons theory

We review the notion of Vogel’s universality in simple Lie algebras and their applications.

We present universal functions for: the (quantum) dimensions of adjoint and some other (series of) representations; generating function of eigenvalues of higher Casimir operators on adjoint representation; invariant volume of the compact simple Lie groups; the central charge and partition function of Chern–Simons theory on 3d sphere; colored (adjoint) knots polynomials for torus knots, etc. Universal Chern–Simons partition function is presented in terms of multiple Barnes’ gamma functions and multiple sine functions with universal arguments. In particular case of $SU(N)$ gauge group this representation establishes an exact nonperturbative Chern–Simons / topological string duality. An anomaly of Vogel’s symmetry is calculated. When restricted to the $SU(N)$ line it is shown to coincide with Kinkelin’s relation on Barnes’ G -function.

Universality naturally leads to classification of simple Lie algebras in terms of solutions of certain cubic Diophantine equations on three variables. One of these equations establishes the connection with McKay correspondence and equivelar maps. We discuss Deligne’s hypothesis on universal characters and Vogel’s conjectures on Lambda-algebra and their implications for universality.

6. **Michael PEVZNER** – *Université de Reims, France*

Symmetry breaking operators for infinite-dimensional representations

Sometimes the intertwining operators appearing in branching laws of infinite-dimensional representations of reductive Lie groups turn out to be realized by differential operators. An example of this phenomenon is given by the celebrated Rankin–Cohen brackets. We will explain the algebraic and geometric nature of these operators and present a general method for their effective construction. We will illustrate these ideas with concrete examples in six different complex parabolic geometries focusing on the fundamental role of the Gauss hypergeometric equation and will also outline some applications.

7. **Emma PREVIATO** – *Boston University, USA*

Elliptic and Hyperelliptic Fibrations in Integrability

The integrability version of E. Wigner’s famous pronouncement, “The Unreasonable Effectiveness of Mathematics in the Natural Sciences” could be “the unreasonable effectiveness of the addition law in achieving integration by quadratures”. Behind it is a powerful geometric structure of the parameter space of the equations of motion, namely an elliptic or hyperelliptic fibration. This talk will focus on a hyperelliptic model (Toda Lattice) and on an elliptic surface (difference-equation systems), highlighting a new link and proposing a bridge to mirror symmetry.

8. **Claude ROGER** – *Université Claude-Bernard Lyon 1, France*

An algebraic background for hierarchies of PDE in dimension (2|1)

In $d = 2$ with variables (x, t) the superalgebraic trick of adding a supplementary odd variable allows the construction of a "square root of time", an operator D satisfying $D^2 = \partial/\partial t$ in dimension (2|1). We used it to obtain a Miura transform in dimension (2|1) for a non stationary Schrödinger type operators. I will discuss here the construction of an algebra of pseudodifferential symbols in dimension (2|1).

9. **Craig TRACY** – *University of California, Davis, USA*

Integrable Probability and the Role of Painlevé Functions

This lecture gives an overview of recent work in stochastic growth processes in the KPZ universality class. The connection with integrable systems (in particular the asymmetric simple exclusion process) will be explained.

10. **Milen YAKIMOV** – *Louisiana State University, USA*

Generalized Gelfand–Tsetlin integrable systems and cluster algebras

In the first part of the talk we will review the definition of Cluster Algebras, introduced by Fomin and Zelevinsky, and some of their applications including those to Poisson geometry. We will also discuss the notion of maximal green sequences of mutations which are used in the study of Donaldson–Thomas invariants and spectra of BPS states. In the second part of the talk we will introduce a generalization of the Gelfand–Tsetlin construction of integrable systems, where the recursive use of Casimirs is replaced by subalgebras generated by Poisson normal elements. We will then describe a classification of those using Poisson Unique Factorization Domains. These techniques will be applied to settle several open problems on cluster algebras, including the problem of whether the Berenstein–Fomin–Zelevinsky cluster algebras coincide with the coordinate rings of double Bruhat cells and the problem for existence of maximal green sequences for them. Similar results will be proved in the quantum situation. Part of the results in the talk are joint work with Ken Goodearl (UC Santa Barbara).

11. **Vladimir ZAKHAROV** – *University of Arizona, USA*

Schrödinger operator with continuous spectrum and turbulence in integrable systems

We study one-dimensional stationary Schrödinger operator with bounded on the line non-periodic and non-quasiperiodic potentials. We address the following question: Could the Schrödinger operator have a spectrum similar to the spectrum of an operator with periodic potential, pure continuous spectrum of band type? The answer is positive. We developed an algorithm for construction of such potentials based on solution of certain non-local Riemann–Hilbert problem on the plane of complex wave numbers. The wave function of such operator is an analytic function on this plane with exception of symmetry posed cuts. In a general case the constructed potentials are random, they describe random bounded solutions of the Korteweg–de Vries (KdV) equation. Temporal evolution of such potentials can be interpreted as integrable turbulence in framework of the KdV equation. Analytic results are supported by numerical experiments.

Contributed lectures

12. **Azar AHMADOV** – *Baku State University, Azerbaijan*

Higher-Twist Mechanism and Inclusive pion pairs Production in Proton-Antiproton Collisions

We calculate the contribution of the higher-twist Feynman diagrams to the large- p_T inclusive pion pairs production cross section in proton-antiproton collisions $p\bar{p} \rightarrow \pi^+\pi^-X$ with the two pions emitted back to back at 90° in case of the running coupling and frozen coupling approaches within perturbative and holographic QCD. The structure of infrared renormalon singularities of the higher-twist subprocess cross section are obtained and the resummed higher-twist cross sections (Borel sum) with the ones obtained in the framework of the frozen coupling approach and leading-twist cross section are compared and analyzed. Infrared renormalon induced divergence is regularized by means of the principal value prescription. The contributions of the renormalon effects in this process are essential.

Joint work with C. Aydin, O. Uzun, M. Demirci.

13. **Anatolij ANTOŃEVICH** – *Uniwersytet w Białymstoku, Poland*

Quasi-periodic algebras and their automorphisms

Let $CB(\mathbb{R}^m)$ be the space of bounded continuous functions on \mathbb{R}^m . A closed subalgebra $\mathcal{A} \subset CB(\mathbb{R}^m)$ is called a *quasi-periodic algebra*, if it is generated by a finite number of exponents

$$e^{i2\pi\langle \pm h_j, x \rangle}, \quad h_j \in \mathbb{R}^m, j = 1, 2, \dots, N.$$

Quasi-periodic algebras and quasi-periodic functions arise in the theory of quasi-crystals and other problems.

14. **Daniel BELTIȚĂ** – *Institute of Mathematics "Simion Stoilow" of the Romanian Academy, Romania*

Coadjoint dynamical systems and group C^* -algebras

We approach some basic topological properties of unitary dual spaces of solvable Lie groups using suitable dynamical systems defined by the coadjoint action. For any exponential solvable Lie group the method of coadjoint orbits still works and we use it for computing some noncommutative dimensions (the real and stable rank) of the group C^* -algebra in terms of the Lie algebra of the group under consideration. Beyond that class of groups, we construct an example of solvable Lie group whose unitary dual space contains a dense singleton subset. This talk is based on joint work with Ingrid Beltiță.

15. **Volodymyr BEREZOVSKI** – *Uman National University of Horticulture, Ukraine*

Almost geodesic mappings

We and J. Mikeš give some conditions for preservation of Riemannian curvature tensor with respect to almost geodesic mappings of affinely connected spaces. It is noteworthy that these conditions are valid for other types of mappings. For the almost geodesic mappings of first type, when the Riemannian curvature tensor

is invariant, the authors deduce a differential equations system of Cauchy type. In addition the authors investigate almost geodesic mappings of first type, where the Weyl tensor of projective curvature is invariant and Riemannian tensor is not invariant.

16. **Marek BOŻEJKO** – *Uniwersytet Wrocławski, Poland*

Generalized Fock spaces and second quantization as examples of hypercontractive semigroups

In my talk we will consider the following topics:

- (a) Generalized Fock spaces $F(T, H)$ for real contraction T on a real Hilbert space H .
- (b) Anyonic Fock spaces and q -CCR relations for $|q| = 1$ and connections with type B-Fock spaces.
- (c) Second quantization $\Gamma(T, S)$ from the von Neumann algebra $G(T, H)$ generalized by T -Gaussian operators $G(f) = a(f) + a^+(f)$, where f is in a real Hilbert space H .
- (d) If $S = \exp(-t)Id$, we get so called generalized Ornstein–Uhlenbeck semigroup $U_t = \Gamma(T, S)$ and in many cases of T we have ultracontractivity, i.e. U_t maps L^2 into L^∞ , where here L^2 =the Fock space $F(T, H)$ and $L^\infty = G(T, H)$.

The subject of the talk is taken from the main results of the papers together with W. Ejsmont, T. Hasebe, E. Lytvynov, I. Rodionova, Q. Xu and J. Wysoczański.

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17. **Tomasz BRZEZIŃSKI** – *Uniwersytet w Białymstoku / Swansea University, Poland / UK*

Noncommutative gauge theory of generalized (quantum) Weyl algebras

Generalized (quantum) Weyl algebras (over a polynomial ring in one variable) can be understood as models for non-commutative surfaces. We describe quantum principal bundles over such algebras, and demonstrate how this algebraic approach to non-commutative gauge theory leads to introduction of differential and spin geometry (Dirac operators) of these algebras.

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

The Shmushkevich method for higher symmetry groups

The basic idea of Shmushkevich is "isotopic non-polarization" of the states before the interaction and after it. Hence his underlying Lie group was $SU(2)$. We extend this idea to any simple Lie group. This paper determines the relative probabilities of various channels of scattering and decay processes following from the invariance of the interactions with respect to a compact simple a Lie group. Aiming at the probabilities rather than at the Clebsch–Gordan coefficients makes the task easier, and simultaneous consideration of all possible channels for given multiplets involved in the process, makes the task possible. The probability of states with multiplicities greater than 1 is averaged over. Examples with symmetry groups $O(5)$, $F(4)$, and $E(8)$ are shown.

The talk is based on joint work with M. Bodner, J. Patera, A. Tereszkievicz.

19. **Marián FECKO** – *Univerzita Komenského v Bratislave, Slovakia*

On symmetries and conserved quantities in Nambu mechanics

In Hamiltonian mechanics, a (continuous) symmetry leads to conserved quantity, which is a function on (extended) phase space. In Nambu mechanics, a straightforward consequence of symmetry is just a relative integral invariant, a differential form which only upon integration over a cycle provides a conserved real number. The origin of the difference may be traced back to a shift in degrees of relevant forms present in equations of motion, or alternatively, to a corresponding shift in degrees of relevant objects in action integral for Nambu mechanics.

20. **Dmitry GITMAN** – *P.N. Lebedev Physical Institute, Russia*

QED with strong external backgrounds

QED with strong external backgrounds that can create particles from the vacuum is well developed for the so-called t-electric potential steps, which are time-dependent external electric fields that are switched on and off at some time instants. However, there exist many physically interesting situations where external backgrounds do not switch off at the time infinity. E.g., these are time-independent non-uniform electric fields that are concentrated in restricted space areas. The latter backgrounds represent a kind of spatial x-electric potential steps for charged particles. They can also create particles from the vacuum, the Klein paradox being closely related to this process. Approaches elaborated for treating quantum effects in the t-electric potential steps are not directly applicable to the x-electric potential steps and their generalization for x-electric potential steps was not sufficiently developed. We present a consistent solution of the latter problem. We consider a canonical quantization of the Dirac and scalar fields with x-electric potential step

and have found in- and out-creation and annihilation operators that allow one to have particle interpretation of the physical system under consideration. To identify in- and out-operators we have performed a detailed mathematical and physical analysis of solutions of the relativistic wave equations with an x-electric potential step with subsequent QFT analysis of correctness of such an identification. We elaborated a nonperturbative (in the external field) techniques that allows one to calculate all characteristics of zero-order processes, such as, for example, scattering, reflection, and electron-positron pair creation, without radiation corrections, and also to calculate Feynman diagrams that describe all characteristics of processes with interaction between the in-, out-particles and photons. These diagrams have formally the usual form, but contain special propagators. Expressions for these propagators in terms of in- and out-solutions are presented. We apply the elaborated approach to two popular exactly solvable cases of x-electric potential steps, namely, to the Sauter potential and to the Klein step.

21. **Gerald GOLDIN** – *Rutgers University, USA*

Conformal symmetry and nonlinear Maxwell fields

In connection with our continuing study of the class of nonlinear Maxwell field theories respecting conformal symmetry (with V. Shtelen and S. Duplij), I shall offer some interesting findings in a self-contained way.

22. **Cristi GUEVARA** – *Louisiana State University, USA*

Behavior of solutions for the Exciton-Polariton system

23. **Ivan HOROZOV** – *Bronx Community College / City University of New York, USA*

Iterated Integrals and Periods over Totally Real Number Rings

Riemann zeta values and multiple zeta values were defined by Euler. Kontsevich expressed each of them via iterated integrals, which led to many algebra-geometric properties of Riemann zeta values and of multiple zeta values. Deligne showed that multiple zeta values are (mixed Tate) period over the integers. More recently F. Brown showed that essentially they are all mixed Tate periods over the integers.

Dedekind zeta values are a number theoretic analogue of Riemann zeta values. They are (mixed Tate) periods over a number ring (Borel, Beilinson). In 2014, I defined a number theoretic analogue of multiple zeta values, which I called multiple Dedekind zeta values. These objects are again defined via iterated integrals. They will be the central object of the talk together with a recent result (2016): multiple Dedekind zeta values give examples of mixed Tate periods over totally real number rings.

24. **Mahouton Norbert HOUNKONNOU** – *University of Abomey-Calavi, Republic of Benin*

On construction of the recursion operator in the Minkowski metric using a modified Poisson bracket

A recursion operator for a geodesic flow in a noncommutative phase space endowed with the Minkowski metric is constructed and discussed.

25. **Plamen ILIEV** – *Georgia Institute of Technology, USA*

A quantum integrable system on the sphere and bispectrality

I will discuss hypergeometric functions in several variables orthogonal with respect to the multivariate beta distribution within the context of the Lie algebra \mathfrak{t}_{d+1} . This interpretation naturally leads to the construction of bispectral commutative algebras of partial difference operators related to a quantum (super)integrable system on the sphere.

26. **Steven JACKSON** – *University of Massachusetts, USA*

An exactly solvable quantum four-body problem associated with the symmetries of an octacube

In this talk we discuss the application of the theory of discrete reflection groups to integrable systems via the Bethe ansatz.

As an example, we show that eigenenergies and eigenstates of a system consisting of four one-dimensional hard-core particles with masses $6m$, $2m$, m , and $3m$ in a hard-wall box can be found exactly using a Bethe ansatz based on the exceptional affine reflection group F_4 associated with the symmetries of the 24 -cell. We also relate conserved quantities to the invariant theory of the reflection group: the four integrals of motion in involution are identified as invariant polynomials of the finite reflection group F_4 , taken as functions of the components of momenta.

27. **Michał JÓŹWIKOWSKI** – *Instytut Matematyczny Polskiej Akademii Nauk, Poland*

Local optimality of sub-Riemannian geodesics

It is well-known that normal extremals in sub-Riemannian geometry are curves which locally minimize the energy functional. However, the known proofs of this fact are computational and the relation of the local optimality with the geometry of the problem remains unclear. In the talk I will provide a new proof of this result, which gives insight into the geometric reasons of local optimality. Also the relation of the regularity of normal extremals with their optimality become apparent in our approach. The talk is based on a joint work with professor Witold Respondek.

28. **Alexander KARABEGOV** – *Abilene Christian University, USA*

Deformation quantization with separation of variables on a split supermanifold

Given a holomorphic vector bundle E on a complex manifold M and a star product with separation of variables \star on M , we lift the product \star to a star product with separation of variables \star on the split supermanifold ΠE . A trace density of the star product \star is lifted to a trace density of the product \star on ΠE , which is explicitly described.

29. **Hovhannes KHUDAVERDIAN** – *University of Manchester, UK*

Higher Koszul brackets

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

Wigner function for a qubit

Geometric structures which are necessary for quantization are thoroughly analyzed. A new approach to quantization of compact phase spaces is presented. As an application the Wigner function for a qubit is presented.

31. **Rodrigo LUNA** – *State University of Londrina, Brazil*

Planar Composite String, S-functions and Quantum Affine Algebras

The string consists of $2N$ pieces of equal length, of alternating type 1 and type 2 materials, endowed with two different tensions T_1, T_2 , and mass densities p_1, p_2 but adjusted in a way that the velocity of sound is equal the velocity of light. Then we consider replicated S-functions and calculate Vertex Operator Traces useful to Quantum Affine Algebras.

32. **Wen-Xiu MA** – *University of South Florida, USA*

Soliton hierarchies and matrix loop algebras

We will talk about the zero curvature formulation for soliton hierarchies associated with matrix spectral problems. Liouville integrability will be shown by establishing Hamiltonian structures through either the trace identity or the variational identity over matrix loop algebras. Illustrative examples are generated from matrix spectral problems formulated using the two real three dimensional Lie algebras, $sl(2, \mathbb{R})$ and $so(3, \mathbb{R})$.

33. **Innocenti MARESIN** – *Steklov Mathematical Institute, Russia*

Celestial geometry of Lorentzian manifolds

Mostly based on arXiv:1605.07070; more at <http://course.irccity.ru/celestial/>.

34. **Ian MARSHALL** – *High School of Economics, Russia*

Hamiltonian reduction and Duality for the BC_n Ruijsenaars model

It has been shown that the hyperbolic BC_n Ruijsenaars model emerges from Hamiltonian reduction applied to the Heisenberg double of the group $SU(n, n)$. I will show how its dual model can be found. I will also discuss Lax representations for these systems.

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

Radon transform on a hyperboloid related to isotropic lines

Let \mathcal{H} be a hyperboloid in \mathbb{R}^n . Isotropic lines on \mathcal{H} are lines completely contained in \mathcal{H} . We consider a Radon transform R that to functions on \mathcal{H} assigns their integrals over isotropic lines. We determine the kernel and the image of R .

36. **Ratbay MYRZAKULOV** – *Eurasian National University, Kazakhstan*

Motion of curves and surfaces and nonlinear evolution equations

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37. **Anatol ODZIJEWICZ** – *Uniwersytet w Białymstoku, Poland*

Geometric structures canonically related to a W^* -algebra

Concepts of Lie groupoids, Lie algebroids and Poisson manifolds are of great importance in the contemporary differential geometry as well as in mathematical physics. They also give the mathematics framework for the classical physical systems theory. No less important is the theory of W^* -algebras (von Neumann algebras) for the description of the quantum systems.

In this presentation we show that for any W^* -algebra one can canonically assign the complex Banach–Lie groupoids and algebroids. We also investigate the fibre-wise linear complex Banach sub Poisson structures defined by the structure of a W^* -algebra and indicate their usefulness in the theory of infinite dimensional integrable systems.

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38. **Aleksander ORLOV** – *Institute of Oceanology / High School of Economics, Russia*

Hurwitz numbers for RP^2 and CP^1 cases, matrix integrals and integrable systems

39. **Fernand PELLETIER** – *Université de Savoie, France*

Partial Poisson structure

40. **Anatolij PRYKARPATSKI** – *Akademia Górniczo-Hutnicza, Poland*

Hamilton Operators and Related Integrable Differential-Algebraic Novikov–Leibniz Structures

There is devised a general differential-algebraic approach to constructing multi-component Hamiltonian operators as differentiations on suitably constructed loop Lie algebras. The related Novikov–Leibniz type algebraic structures are presented, a new nonassociative "Riemann" algebra is constructed, deeply related with infinite multi-component Riemann type integrable hierarchies. A close relationship to the standard symplectic analysis techniques is also discussed.

41. **Alexei RYBKIN** – *University of Alaska Fairbanks, USA*

The Cauchy problem for the KdV equation with no decay at minus infinity

Using techniques of Hankel operators we prove that the KdV equation is well-posed for initial data which have nearly unrestricted behavior at minus infinity and short range decay at plus infinity. We also develop the inverse scattering transform for such initial profiles in term of the Hankel operator which symbol is conveniently represented in terms of the scattering data for the Schrödinger operator in the Lax pair. The spectral properties of this Schrödinger operator can be directly translated into the spectral properties of the Hankel operator. The latter then yield properties of the solutions to the KdV equation through explicit formulas. This allows us to recover and improve on many already known results as well as a variety of new ones. We can effortlessly include into our picture low regularity that is far beyond what standard harmonic analytic techniques can handle. Main results discussed in the talk are optimal.

42. **Axel SAENZ** – *University of California, Davis, USA*

Geometry and Topology on the Bethe Ansatz for the Periodic ASEP model

The periodic ASEP model is an interacting particle model on a lattice ring with the particles jumping (continuously) one position to the left and right with probability p and q , respectively, and obeying an exclusion rule. Recently, along with collaborators Eric Brattain (SUNY: New Paltz) and Norman Do (Monash Uni.), we showed that the Bethe ansatz gives you a complete basis to the Hamiltonian of such model. In doing so, we used techniques from algebraic topology and algebraic geometry, and this is what I will introduce in this talk.

43. **Andrei SHAFAREVICH** – *Moscow State University, Russia*

Lagrangian manifolds and Maslov indices corresponding to the spectral series of the Schrödinger operators with delta-potentials.

We study spectral series of the Schrödinger operator with delta-type potential on 2D or 3D Riemannian spherically symmetric manifold. Lagrangian manifolds, corresponding to these series, do not coincide with the standard Liouville tori. We describe topological structure of these manifolds as well as Maslov indices, entering quantization conditions. In particular, we study the effect of the jump of the Maslov index via passing through the critical values of the multipliers of the delta-functions.

44. **Ekaterina SHEMYAKOVA** – *State University of New York at New Paltz, USA*

Darboux transformations of differential operators on the superline

In this talk we describe Darboux transformations (DTs) of differential operators on a superline. Sometime ago we obtained a full classification of them (for non-degenerate operators). We shall also present analogues of classical formulas for DTs in super case. Such formulas are given in terms of Berezinians.

45. **Jan SMOTLACHA** – *Joint Institute of Nuclear Research, Russia*

Electronic properties of carbon nanostructures

The carbon nanostructures are in central point of view of todays physics. They have extraordinary electronic properties and it makes them possible candidates

for future materials. The basic structure is graphene - the hexagonal plane lattice from which other kinds are derived by placing the topological defects or by cutting isolated parts from graphene. Among others, we can in this way get not only fullerene, but also nanocones, nanoribbons etc. We introduce the electronic properties of nanoribbon structures with reconstructed edges and under the influence of magnetic field.

46. **Ewa STRÓŻYNA** – *Politechnika Warszawska, Poland*

The complete list of normal forms for germs of vector fields with quadratic leading part

I'm going to present a complete list of formal non-orbital normal forms for vector fields with quadratic leading terms and show how to obtain normal forms avoiding complicated calculations.

47. **Jacek SZMIGIELSKI** – *University of Saskatchewan, Canada*

On isospectral deformations of classical inhomogeneous strings

This talk is about a class of isospectral deformations of the inhomogeneous string boundary value problem. The deformations considered are generalizations of the isospectral deformation that has arisen in connection with the Camassa–Holm equation but are of independent interest. I will discuss how these new isospectral deformations result in evolution equations on the mass density whose form depends on how the string is tied at the endpoints. Also, if time permits, I will discuss why the evolution equations in this class linearize on the spectral side and hence can be solved by the inverse spectral method. As an example, I will discuss the problem involving a mass density given by a discrete finite measure and arbitrary boundary conditions which, as it turns out, can be solved by Stieltjes' continued fractions.

This is joint work with D. Gomez (University of British Columbia, Canada) and K. Colville (McGill University, Montreal, Canada).

48. **Jaromir TOSIEK** – *Politechnika Łódzka, Poland*

An adaptation of the WKB approximation to deformation quantisation

An adaptation of the WKB method in the deformation quantisation formalism is presented with the aim to obtain an approximate technique of solving the eigenvalue problem for energy in the phase space quantum approach. A relationship between the phase $\sigma(\vec{r})$ of a wave function $\exp\left(\frac{i}{\hbar}\sigma(\vec{r})\right)$ and its respective Wigner function is discussed. Formulas to calculate the Wigner function of a product and of a superposition of wave functions are proposed. Properties of a Wigner function of interfering states are investigated. Examples of the semiclassical approximation in deformation quantisation are analysed.

49. **Alice Barbara TUMPACH** – *Laboratoire Painlevé, France*

Banach Poisson Lie groups and the restricted Grassmannian

50. **Theodore VORONOV** – *University of Manchester, UK*
Thickening and quantization of the category of (super)manifolds
51. **Wojciech WOJTYŃSKI** – *Uniwersytet w Białymstoku, Poland*
String Lie theory and diffeomorphism groups
52. **Henryk ŻOŁĄDEK** – *Uniwersytet Warszawski, Poland*
Painleve equations, elliptic integrals and elementary functions
 The six Painlevé equations can be written in the Hamiltonian form, with time dependent Hamilton functions. We present a rather new approach to this result, leading to rational Hamilton functions. By a natural extension of the phase space one gets corresponding autonomous Hamiltonian systems with two degrees of freedom. We realize the Bäcklund transformations of the Painlevé equations as symplectic birational transformations in \mathbb{C}^4 and we interpret the cases with classical solutions as the cases of partial integrability of the extended Hamiltonian systems. We prove that the extended Hamiltonian systems do not have any additional algebraic first integral besides the known special cases of the third and fifth Painlevé equations. We also show that the original Painlevé equations admit the first integrals expressed in terms of the elementary functions only in the special cases mentioned above. In the proofs we use equations in variations with respect to a parameter and Liouville's theory of elementary functions.
 Joint work with G. Filipuk.

Poster session

53. **Hesham Abdelbagi Ali ABDELBAĞI** – *University of Pretoria, South Africa*
Influence of grain size of different fission products
 The Pebble Bed Modular Reactor is a relatively new design in nuclear power plants and could be the first successful Generation IV power plant, A key feature of the Pebble Bed Modular Reactor is the fuel used in the reactor, it called TRISO Particle, consists of a small round UO₂ kernel of approximately 0.5 mm diameter. This kernel is surrounded by four layers making the final diameter of the TRISO particle approximately 0.92 mm. Three of the layers are carbon allotropes with the other one composed of SiC.
 The main function of these layers is to act as diffusion barriers for the nuclides produced by the fission process. Thus, these fission products are kept within the fuel particles, even under accident conditions.
 The most important coating layer in the TRISO particle is composed of polycrystalline 6H-SiC, it work like a diffusion barrier for the radioactive fission products. But there is problem, Some fission product it release from SiC coated, like Silver 110 , so now there a lot of studies try to explain the main reason that let Ag going through SiC .

The grain boundaries diffusion, it a good theory to explain this problem.

In my work, I studied the influence of grain size of different fission products, After Annealing and Implanted by different fission products.

first sample is Sic implanted by Ag 107, Under 350 c , and after that is annealed to 1900 c for 2 hour and 10 min , this sample it investigated by XRD to determine the grain sizes using Sherre equation , and also investigated by Scanning electron microscopy (SEM) , This Sample it Shown on the SEM device , a lot of cracks and this crack it happened under high temperature , and also shown the Ag 107 on the Surface of Sample. And also compared Ag release from TRISO particles with different SiC grain size, samples containing small equiaxed grains showing a lower diffusion rate than the ones containing larger columnar grains.

54. **Pierre-Henry COLLIN** – *Université de Lorraine, France*

C^* -algebras of Penrose type hyperbolic tilings

One can construct an euclidian tilings using substitutions. I will explain how you use substitutions to construct tilings on Poincaré half-plane. Using canonical actions on tilings, one can then introduce C^* -algebras of tilings space. I will then explain how the hyperbolic situation is related to the euclidian one.

55. **Alina DOBROGOWSKA** – *Uniwersytet w Białymstoku, Poland*

R -matrix, Lax pair, and multiparameter decompositions of Lie algebras

We construct R operators on the Lie algebra $\mathfrak{gl}(n, \mathbb{R})$ or more generally Hilbert–Schmidt operators \mathcal{L}^2 in Hilbert space. These operators are related to a multiparameter deformation given by a sequence of parameters $\alpha = \{\alpha_1, \alpha_2, \dots\}$. We determine for which choices of parameters R operators are R -matrices. We also construct the Lax pair for the corresponding Hamilton equations.

56. **Daniel GROMADA** – *České Vysoké Učení Technické v Praze, Czech Republic*

Construction of Lie algebra realizations

The problem of realization of a Lie algebra structure by vector fields is widely applicable in group analysis of differential equations. One of the natural problems arising is classification of all realizations of a given Lie algebra. It is known, that classification of so called transitive realizations is equivalent to classification of subalgebras of the Lie algebra. In the presentation we briefly introduce one of possible ways of constructing transitive realizations proposed by A.A. Magazev, V.V. Mikheyev and I.V. Shirokov. Then we shall discuss possible ways of construction of non-transitive realizations.

57. **Jiří HRIVNÁK** – *České Vysoké Učení Technické v Praze, Czech Republic*

Weight- and Coweight-Lattice Discretization of Weyl-Orbit Functions

It is standard to perform the discrete Fourier analysis with Weyl-orbit functions on the coweight-lattice fragment contained in the fundamental region of the affine Weyl group. Here we compare the standard treatment to the recently-developed analysis on the fragment of the weight lattice. The weight-lattice discretization possesses symmetry between the labels and the arguments of the Weyl-orbit functions. This property allows the construction of unitary, symmetric matrices with Weyl-orbit-valued elements. For antisymmetric orbit functions, these matrices coincide

with the Kac–Peterson modular S matrices. Consequences of the weight lattice discretization for the corresponding orthogonal polynomials are also discussed. This is a joint work with Mark Walton.

58. **Simon LI** – *State University of New York at New Paltz, USA*

Super Darboux Transformations and Super Wronskians

Darboux transformations are an important tool in solving differential equations such as the Sturm–Liouville and KdV. The study of supersymmetry has introduced “super” versions of these familiar problems. Using what we know of the classical Darboux and Crum theorem and its extension in supersymmetry and using the properties of the Berezinian, we study the super-Wronskian, an analogue of the classical Wronskian determinant, to classify and express Darboux transformations of non-degenerate supersymmetric differential operator in terms of its solutions.

59. **Dmitry MALININ** – *University of the West Indies, Jamaica*

On representations of finite groups and some applications to geometry and physics

Representation theory of groups is an intensively developing branch of algebra which is extremely useful in chemistry and physics. Integral representations of groups and their characters are used in crystallography, numerous applications of representations of groups can be found in nuclear physics, quantum mechanics and relativity, classical mechanics, quantum electronics, particle physics, electrodynamics, and arithmetic subgroups of GL_n play a special role in these applications.

We consider the arithmetic background of integral representations of finite groups over the maximal orders of local and algebraic number fields. Some infinite series of integral pairwise inequivalent absolutely irreducible representations of finite p -groups with the extra congruence conditions are constructed. Certain problems concerning integral two-dimensional representations over number rings are discussed.

In his recent publication J.-P. Serre emphasized remarkable connections between integral irreducible representations of the group of quaternions and genus theory of Gauss and Hilbert, and the theory of Hilbert’s symbol. This was also considered in our recent paper with F. Van Oystaeyen as an application to the description of globally irreducible representations over arithmetic rings which has been earlier introduced by F. Van Oystaeyen and A.E. Zalesskii. This is also motivated by the question concerning realizability of K -representations over rings R having the quotient field K considered by J.-P. Serre, W. Feit and other mathematicians. Another approach to generalization of integral representations of finite groups was proposed by D.K. Faddeev as a generalization of the theory of Steinitz and Chevalley (in particular, for classification of Fedorov’s groups).

60. **Lenka MOTLOCHOVA** – *České Vysoké Učení Technické v Praze, Czech Republic*

Dual Root-Lattice Discretization of Weyl-Orbit Functions

The discrete properties of Weyl-orbit functions are crucial in processing of multidimensional digital data and related Fourier methods. The Weyl-orbit functions sampled on finite fragments of the dual weight lattice are recently studied in several papers and the results are used in deriving numerical integration formulas, interpolation methods and others. Among the Weyl group invariant lattices, the

second most prominent lattice is the dual root lattice. In this talk, the explicit formulas of the discrete orthogonality relations of the Weyl-orbit functions sampled on fragments of the scaled dual root lattice are presented. Examples of the corresponding discrete transforms are shown. Possible applications to other related methods and applications of this discretization are discussed.

This is a joint work with J. Hrivnák.

61. **Petr NOVOTNY** – *České Vysoké Učení Technické v Praze, Czech Republic*
Gradings of Matrix Algebras

We describe several methods for construction of gradings of matrix algebras. MAD-group method which yields group gradings and a method based on the tensor product which yields non-group grading are presented. Explicit examples in low dimension are given.

62. **Matt PEDDIE** – *University of Manchester, UK*
A Modular Class for Odd Poisson Manifolds

63. **Elwira WAWRENIUK** – *Uniwersytet w Białymstoku, Poland*
Classical and quantum Kummer shape algebras

64. **Tomasz Łukasz ŻYNDĄ** – *Politechnika Warszawska, Poland*
Weighted Szego Kernels

XXXV WORKSHOP ON GEOMETRIC METHODS IN PHYSICS

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