XXXVII WORKSHOP ON GEOMETRIC METHODS IN PHYSICS

Białowieża, Poland, July 1 – July 7, 2018

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XXXVII Workshop on Geometric Methods in Physics organized by Institute of Mathematics, University of Białystok, Ciołkowskiego 1M, 15-245 Białystok, Poland, e-mail: wgmp@uwb.edu.pl

LIST OF ABSTRACTS

Plenary lectures

1. **Miguel ABREU** — *University of Lisbon, Portugal*

   Applications of symplectic/contact invariants to conservative dynamics

   I will survey recent joint work with Leonardo Macarini, on applications of symplectic/contact invariants to multiplicity and dynamical properties of periodic orbits in conservative dynamics.

2. **Mikhail BABICH** — *St. Petersburg Department of the Steklov Mathematical Institute, Russia*

   On canonical parametrization of phase spaces of Isomonodromic Deformation Equations

   Phase spaces of the equations of the Isomonodromic Deformations are rational symplectic manifolds glued from several coadjoint orbits of the general linear group. Even in the simplest case of the Painlevé VI equation it is non-trivial problem to introduce proper coordinates and write down the equation. I will explain several ways to do it for P VI-equation and demonstrate how the methods work for more complicated cases.

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

   Special geometry on the 101 dimesional Moduli space of the Quintic threefold

   A new method for explicit computation of the Calabi–Yau moduli space metric was proposed by the author recently. The method makes use of the connection of the moduli space with a certain Frobenius algebra. I will present this approach and demonstrate its efficiency by computing the Special geometry of the 101-dimensional moduli space of the Quintic threefold.

4. **Michael BIALY** — *Tel Aviv University, Israel*

   Around Birkhoff's conjecture for convex and other billiards

   Birkhoff's conjecture states that the only integrable billiards in the plane are ellipses. I am going to give a survey of recent progress in this conjecture and to discuss geometric results and questions around it. No prior knowledge of the subject will be assumed.

5. **Giuseppe DITO** — *Université de Bourgogne, France*

   Wheels in deformation quantization

   In this talk, we will discuss the appearance of directed cycles (graphs with wheels) in Kontsevich's deformation quantization formula for a Poisson structure, and show that any universal formula necessarily involves wheels. We will conclude by sketching how the wheels can be absorbed in a deformation of the Poisson structure.

6. **Misha FEIGIN** — *University of Glasgow, United Kingdom*

Dunkl angular momenta algebra

Universal enveloping algebra of Lie algebra $so(N)$ has a standard representation by differential operators in N-dimensional space, where generators are mapped to the operators of infinitesimal rotations. Elements of Dunkl angular momenta algebra are obtained by replacing partial derivatives with Dunkl operators associated with a Coxeter group W. The resulting algebra is a special subalgebra of the rational Cherednik algebra and it has good properties. Thus it is a PBW quadratic algebra, which may be thought of as a non-commutative deformation of the algebra of functions on the cone over Grassmanian of two-dimensional planes.

The central generator of the Dunkl angular momenta algebra can be identified with the non-local angular Calogero–Moser Hamiltonian associated with W. There is a version of Laplace–Runge–Lenz vector for the non-local Calogero–Moser Hamiltonian, which leads to an algebra isomorphic to the central quotient of Dunkl angular momenta algebra. The central quotient can also be obtained as the algebra of global sections of the sheaf of Cherednik algebras on the quadric of isotropic vectors.

The talk is based on joint works with Hakobyan, Nersessian and Thompson.

7. **Yasuyuki KAWAHIGASHI** — *University of Tokyo, Japan*

Conformal field theory, operator algebras and vertex operator algebras

We have two mathematical axiomatizations of a chiral conformal field theory. One is a local conformal net, which is based on theory of operator algebras and the other is a vertex operator algebra, which is purely algebraic. We compare two theories and give a direct relation between them. We emphasize representation theoretic aspects.

8. **Ulrich KRAEHMER** — *Technische Universität Dresden, Germany*

How homogeneous is a quantum homogeneous space

I will discuss the definition of a quantum homogeneous space and then focus on examples of coordinate rings of singular plane curves which are quantum homogeneous spaces. Based on joint work with Angela Tabiri and Manuel Martins.

9. **Yoshiaki MAEDA** — *Yokohama, Japan*

Fundamental groups of the group of diffeomorphisms

In this talk, I would like to discuss on the fundamental groups of the diffeomorphism groups. We prove that the fundamental group of the group of the diffeomorphisms of the total space of circle bundles associated to high multiples of the Kaehler class over integral surface. I will generalize this result to the higher dimensional cases.

10. **Georgy SHARYGIN** — *Moscow State University, Russia*

The commuting elements in deformation of Poisson manifolds

Let M be a Poisson manifold. As one knows according to Kontsevich's result there always exists a deformation quantization of the algebra of smooth functions on M. Suppose now that $f_1, \dots, f_n$ are Poisson commuting functions on M. In my talk I shall discuss the question, whether it is possible to extend these functions to commuting elements in the deformed algebra. I will describe few old and new

cohomological obstructions for this and discuss relations between them; I will also give few examples of such systems and their quantizations.

11. **Wojciech SZYMAŃSKI** — *University of Southern Denmark, Denmark*

Quantum lens and weighted projective spaces

Contributed lectures

12. **Daniel BELTIȚĂ** — *Institute of Mathematics "Simion Stoilow" of the Romanian Academy, Romania*

On the inverse problem in representation theory of nilpotent Lie groups

We show that every Heisenberg group is uniquely determined by its unitary dual space, within the class of exponential Lie groups. We also announce further progress on the inverse problem in representation theory of nilpotent Lie groups, that is, the open problem of establishing to what extent nilpotent Lie groups can be recovered from their representation theory. The presentation is based on recent joint work with Ingrid Beltiță.

13. **Petr BLASCHKE** — *Silesian University in Opava, Czech Republic*

Pedal coordinate, dark Kepler and other force problems

We will make the case that pedal coordinates (instead of polar or Cartesian coordinates) are more natural settings in which to study force problems of classical mechanics in the plane. We will show that the trajectory of a test particle under the influence of central and Lorentz-like forces can be translated into pedal coordinates at once without the need of solving any differential equation. This will allow us to generalize Newton theorem of revolving orbits to include non-local transforms of curves. Finally, we apply developed methods to solve the "dark Kepler problem", i.e. central force problem where in addition to the central body, gravitational influences of dark matter and dark energy are assumed.

14. **Goce CHADZITASKOS** — *Czech Technical University in Prague, Czech Republic*

The Shmushkevich method for collisions of particles for higher symmetry groups

We propose a way how to use Shmushkevich method to calculate the probabilities of creation of resonances when particle beams are collided. The calculation of probabilities of particle production of resonances decay is the crucial point of our approach. The inelastic scattering process is done as a combination of resonance creation and resonance decay.

15. **Eduardo CHIUMIENTO** — *Universidad Nacional de La Plata, Argentina*

Essentially commuting projections

Let $\mathcal{H} = \mathcal{H}_+ \oplus \mathcal{H}_-$ be a fixed orthogonal decomposition of a Hilbert space, with both subspaces of infinite dimension, and let E_+, E_- be the projections onto $\mathcal{H}_+$ and $\mathcal{H}_-$. We study the set $\mathcal{P}_{cc}$ of orthogonal projections P in $\mathcal{H}$ which *essentially commute* with E_+, i.e.

$$[P, E_+] = PE_+ - E_+P \quad \text{is compact.}$$

Using the projection π onto the Calkin algebra, one sees that these projections $P \in \mathcal{P}_{cc}$ fall into nine classes. Indeed, $\pi(P)$ can be represented as a 2×2 diagonal projection, where the diagonal elements can be 0, 1 or a proper projection. We define the *discrete classes*, when the diagonal elements are 0 or 1, which corresponds to finite rank projections, finite co-rank projections, the restricted Grassmannian of $\mathcal{H}_+$ and the restricted Grassmannian of $\mathcal{H}_-$. The connected components of each of these classes are parametrized by the integers. The five remaining classes are called *essential classes*, and they are connected. We show that the Hopf–Rinow Theorem holds in the discrete classes, but not in the essential classes. This is joint work with Esteban Andruchow and María Eugenia Di Iorio.

16. **Nicola CICCOLI** — *University of Perugia, Italy*

Quantum homogeneous spaces at roots of unity

17. **Diego Julio CIRILO-LOMBARDO** — *CONICET / Bogoliubov Laboratory of Theoretical Physics, Argentina*

Dynamical symmetries, coherent states and noncommutative structures: geometrical quantization analysis

The relation between fundamental spacetime structures and dynamical symmetries are treated from the geometrical and topological viewpoint. To this end analyze, taking into account the concept of categories and quasi hamiltonian structures, a recent research [Int. J. Geom. Meth. Mod. Phys. 15 (2017) no. 01, 1850005], where one linear and one quadratic in curvature models were constructed and where a dynamical breaking of the $SO(4,2)$ group symmetry arises. We explain there how and why coherent states of the Klauder–Perelomov type are defined for both cases taking into account the coset geometry and some hints on the possibility to extend they to the categorical (functorial) status are given. The new spontaneous compactification mechanism that was defined in the subspace invariant under the stability subgroup. The physical implications of the symmetry rupture as the introduction of a noncommutative structure in the context of non-linear realizations and direct gauging are analyzed and briefly discussed.

18. **Ziemowit DOMAŃSKI** — *Poznań University of Technology, Poland*

Deformation quantization with minimal length

We present a complete theory of non-formal deformation quantization exhibiting a nonzero minimal uncertainty in position. An appropriate integral formula for the star-product is introduced together with a suitable space of functions on which the star-product is well defined. The construction relies on a generalized arithmetic on $\mathbb{R}$, which we also present. Basic properties of the star-product are

showed and the extension of the star-product to a certain Hilbert space and an algebra of distributions is given. A C^*-algebra of observables and a space of states are constructed. Moreover, an operator representation in momentum space is presented. Finally, examples of position eigenvectors and states of maximal localization are given.

19. **David FERNANDEZ** — *CINVESTAV, Mexico*

A simple generation of Painlevé V transcendents

An algorithm for generating solutions to the Painlevé V equation, the so-called Painlevé V transcendents, is presented. One arrives to such a recipe as follows: first one looks for the general one-dimensional Schrödinger Hamiltonians ruled by third degree polynomial Heisenberg algebras (PHA), which have fourth order differential ladder operators; then one realizes that there is a key function that must satisfy the Painlevé V equation. Conversely, by identifying a system ruled by such a PHA, in particular its four extremal states, one can build this key function in a simple way. The simplest Painlevé V transcendents will be as well generated through such an algorithm.

20. **Jean Pierre GAZEAU** — *University Paris-Diderot, France*

Quantum Localisation on the Circle

Covariant integral quantisation using coherent states for semi-direct product groups is implemented for the motion of a particle on the circle. In this case the phase space is the cylinder, which is viewed as a left coset of the Euclidean group $E(2)$. Coherent states issued from fiducial vectors are labelled by points in the cylinder and depend also on extra parameters. Corresponding quantisations and lower symbols of basic classical observables are implemented. The quantum localisation on the circle is examined through the properties of the angle operator yielded by this procedure, its spectrum and lower symbol, its commutator with the quantum angular momentum, and the resulting Heisenberg inequality.

This is a work with R. Fresneda and D. Noguera, J. Math. Phys. 59, 052105 (2018) `https://doi.org/10.1063/1.5001178`.

21. **Anthony GIAQUINTO** — *Loyola University Chicago, USA*

Deformations, Twists, Frobenius and Lie Algebras

In this talk we will explore universal deformation formulas ("twists") and their relation to Frobenius Lie algebras. Interesting algebraic results and conjectures about such algebras will be formulated. We will see, in particular, that there is a canonical quantization formula associated to each positive rational number.

22. **Tomasz GOLIŃSKI** — *Uniwersytet w Białymstoku, Poland*

Queer Poisson brackets on Banach manifolds

It turns out that Poisson brackets on Banach manifolds M defined as a bilinear antisymmetric maps from $C^\infty(M)\times C^\infty(M)$ to $C^\infty(M)$ satisfying Leibniz and Jacobi conditions may not be given by Poisson tensors. Their value at some point may depend on higher order derivatives of functions. We present a specific example of such Poisson bracket on l^p spaces related to the operational (queer) vector fields. From physical point of view these brackets are pathological, as the Hamiltonian vector fields don't lead to flows on M.

The talk is based on joint work with D. Beltiţă and A.B. Tumpach: `arxiv:1710.03057`, to appear in J. Geom. Phys.

23. **Leszek HADASZ** — *Uniwersytet Jagielloński, Poland*

Quantum curves and conformal field theory

Using the formalism of matrix and eigenvalue models one can associate to a given classical algebraic curve an infinite family of quantum curves, which are in one-to-one correspondence with singular vectors of a certain (e.g. Virasoro or super-Virasoro) underlying algebra. In my presentation I will discuss how this problem can be reformulated in the language of conformal field theory what leads to a more efficient identification of quantum curves, proves in full generality that they indeed have the structure of singular vectors, enables identification of corresponding eigenvalue models and can be easily generalized to other underlying algebras.

24. **Yuji HIROTA** — *Azabu University, Japan*

On formal deformation quantization for super Calabi–Yau twistor spaces

Deformation quantization is one approach ot the process of obtaining a quantum system from a given classical system, whose origin goes back to the work of Weyl's. In the talk, we focus on some super Calabi–Yau twistor spaces and discuss deformation quantization for graded Poisson algebras associated to them. This is a joint work with Prof. Naoya Miyazaki and Prof. Tadashi Taniguchi.

25. **Jeong Hee HONG** — *Korea Maritime and Ocean University, South Korea*

Maximal Abelian Subalgebras of Graph C^*-algebras

We discuss the problem of classification of MASAs in C^*-algebras. Contrary to the significant advances of the analogous classification of MASAs in von Neumann algebras, in the C^*-algebraic setting much less is known. I would like to present a possible approach to the problem of classifying MASAs in purely infinite simple C^*-algebras using a device borrowed from theory of von Neumann algebras. Examples involve MASAs in graph C^*-algebras.

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

Hamiltonian dynamics of the Kepler problem in a deformed phase space

This work addresses the Hamiltonian dynamics of the Kepler problem in a deformed phase space, by considering the equatorial orbit. The recursion operators are constructed and used to compute the integrals of motion. The same investigation is performed with the introduction of the Laplace–Runge–Lenz vector. The existence of quasi-bi-Hamiltonian structures is also elucidated. Related properties are studied.

27. **Grzegorz JAKIMOWICZ** — *Uniwersytet w Białymstoku, Poland*

Tangent lifts of Poisson structures and their infinitesimal deformations

We construct several Poisson structures on the tangent bundle TM to a Poisson manifold M using the Lie algebroid structure on the cotangent bundle T^*M. We describe some infinitesimal deformation of Poisson tensor π_{TM} using the

information from the basis M. We also show that bi-Hamiltonian structure from M can be transferred to its tangent bundle TM. Moreover, we present how to find Casimir functions for those Poisson structures and we discuss some particular examples.

28. **Jerzy KIJOWSKI** — *Center for Theoretical Physics, Poland*

Energy carried by gravitational waves

Andrzej Trautman showed in 1958 how to measure the amount of energy carried by gravitational field (the "Trautman–Bondi energy"). I prove that this construction is a particular example of an universal phenomenon, existing in any classical field theory, also special relativistic like, e.g., classical electrodynamics. The existence of such a phenomenon is an entirely new observation.

29. **Zhanna KUZNETSOVA** — *Federal University of ABC, Brazil*

Observational consequences of light-like deformations of the Poincaré algebra from (extended) jordanian twist

In the talk I discuss the observational consequences of the light-like deformations of the Poincaré algebra induced by the jordanian and the extended jordanian classes of Drinfel'd twists. We consider four type of deformations, obtained from the twists and their "flipped" versions. In two of the cases the set of the deformed operators include a subalgebra of pseudo-hermitian operators, conserving (pseudo) hermiticity in the positive light-cone direction but not for all negative light-cone operators. Twist-deformed generators belonging to a universal enveloping algebra close non-linear W-algebras. In one of the cases the W-algebra is responsible for the existence of bounded domains of the deformed momenta. The Hopf algebra coproduct implies associative non-linear additivity of the multi-particle states. One can observe a parallel with the limit on velocity and additive velocity formula in special relativity. A subalgebra of twist-deformed observables is recovered whenever the twist-deformed generators are either hermitian or pseudo-hermitian with respect to a common invertible hermitian operator.

30. **Bartosz KWAŚNIEWSKI** — *Uniwersytet w Białymstoku, Poland*

Cuntz–Krieger uniqueness theorem for Cuntz–Pimsner algebras

Cuntz–Pimsner algebras model various universal C^*-algebras defined in terms of generators and relations of dynamical or combinatorial type. Examples include crossed products, graph C^*-algebras or Cuntz–Krieger algebras. We will discuss a general theorem that identifies a condition under which every set of generators satisfying prescribed relations generates a copy of the universal algebra.

This talk is based on a joint work with Toke Carlsen and Eduard Ortega.

31. **Radosław KYCIA** — *Masaryk University, Czech Republic*

Topological analysis of nuclear pasta phases

"The heavens contain a variety of materials that range from conventional to extraordinary and extreme" [1]. It will be shown how to use algebraic topology to describe topological invariants of the pasta phases that were identified recently [1] in neutron stars. The talk is based on the article [2].

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Bibliography:

[1] M. E. Caplan, C. J. Horowitz, *Astromaterial Science and Nuclear Pasta*, arXiv:1606.03646 [astro-ph.HE]

[2] R. A. Kycia, S. Kubis, W. Wójcik *Topological analysis of nuclear pasta phases*, Phys. Rev. C 96, 025803 (2017); arXiv:1709.07521 [astro-ph.HE]

32. **Gabriel LAROTONDA** — *Consejo Nacional de Investigaciones Cientificas y Técnicas (CONICET), Argentina*

Short geodesics for Ad invariant metrics in locally exponential Lie groups

Let K be a locally exponential (possibly infinite dimensional) Lie group, provided with a continuous tangent Finsler metric, which is invariant for the adjoint action of the group itself. We show that the one-parameter groups are minimizing for the Length functional of the Finsler metric. Relevant applications are given by examining groups of isometries of Banach spaces.

33. **Andrey MIRONOV** — *Laboratory of Topology and Dynamics of Novosibirsk State University, Russia*

Commuting difference operators

We consider one-point commuting difference operators of rank one. The coefficients of these operators depend on a functional parameter, shift operators being included only with positive degrees. We study these operators in the case of hyperelliptic spectral curve when the marked point coincides with the branch point. We construct examples of operators with polynomial and trigonometric coefficients. Moreover, difference operators with polynomial coefficients can be embedded in the differential ones with polynomial coefficients. This construction provides a new way of constructing commutative subalgebras in the first Weyl algebra. Results were obtained with G. Mauleshova.

34. **Yury NERETIN** — *University of Vienna, Austria*

Operational calculus for Fourier transform for the group $GL(2,\mathbb{R})$

We show that for Fourier transform on $GL(2,\mathbb{R})$ images of polynomial differential operators are differential diference operators including shift in imaginary direction. We also evaluate explicitely formulas for generators of the algebra of differential operators.

35. **Aleksandr ORLOV** — *Institute of Oceanology / High School of Economics, Russia*

Chord diagrams, random matrices and Hurwitz numbers

We shall consider the product of complex random matrices from the independent Jinibre ensembles. The product includes complex matrices $Z_i, Z_i^\dagger$, $i = 1, \dots, n$ and n sources (complex matrices A_i). Any such product can be represented by a chord diagram that encodes the order of the matrices in the product. We introduce the "genus" g of the chord diagram and show that the spectral correlation functions of the product generate Hurwitz numbers that enumerate nonequivalent branched coverings of Riemann surfaces of genus g. The role of sources is the generation of ramification profiles.

36. **Pinaki PATRA** — *Brahmananda Keshab Chandra College, India*

Co-adjoint orbit for Some New Nonlinear Equations

The formalism of Adler–Kostant–Symes is used along with some new Lie algebras to generate some new integrable nonlinear equations, where the usual space and time variables are interchanged. Their recursion operator and Bi-Hamiltonian structure are deduced. In the next part, an extension of the same Lie Algebra is utilized to construct an integrable coupling of this set with another. Incidentally, this new system also turns out to be Bi-Hamiltonian.

37. **Anatolij PRYKARPATSKI** — *Politechnika Krakowska, Poland*

On the geometric structure of the WDVV associativity equations and their solutions

In this Letter I devise an algebraically feasible approach to investigating solutions to the oriented associativity equations, related with commutative and isoassociative algebras, interesting for applications in the quantum deformation theory and in some other fields of mathematics. The construction is based on a version of the Adler–Kostant–Symes scheme, applied to the Lie algebra of the loop diffeomorphism group of a torus and modified for the case of the Gauss–Manin displacement equations, depending on a spectral parameter. Their interpretation as charactersitic equatiuons for some system of the Lax–Sato type vector fieldeld equations made it possible to derive the determining separated Hamiltonian evolution equations for the related structure matrices, generating commutative and isoassociative algebras under regard.

38. **Jakub REMBIELIŃSKI** — *Uniwersytet Łódzki, Poland*

Photon and Preferred Frame Scenario

I discuss structure of the space of photonic states under working hypothesis of existence of a preferred frame for photons. Polarization experiments are proposed to test the preferred frame scenario.

39. **Andrzej SITARZ** — *Uniwersytet Jagielloński, Poland*

The hidden features of the Standard Model from NCG

The construction of the Standard Model in the noncommutative geometry allows to demonstrate its surprising new features. First of all the mixing between the mass eigenstates for different flavors could be interpreted as Hodge duality, the nonexistence of leptoquarks appears to be linked to its Lorentzian structure and last, not least, the spectral action sheds light on why the neutrino masses are small.

40. **Stephen SONTZ** — *Centro de Investigacion en Matematicas, Mexico*

Co-Toeplitz Operators and the Corresponding Quantization

Dual to the theory of Toeplitz operators with symbols in an algebra we introduce a theory of co-Toeplitz operators with symbols in a co-algebra. This gives a corresponding quantization scheme, including creation and annihilation operators. An example will be presented.

41. **Piotr STACHURA** — *Warsaw University of Life Sciences, Poland*

κ-Poincaré Group on a C^*-level

I will present a $C*$-algebra underlying κ-Poincaré Group. It turns out it is the same as "κ-Euclidean" Group but the comultiplication is twisted.

42. **Francesco TOPPAN** — *Centro Brasileiro de Pesquisas Fisicas, Brazil*

Quasi-nonassociativity from an exceptional spectrum-generating superalgebra

Exceptional Lie (super)algebras are derived from octonions. I present the Calogero-deformed quantum oscillator derived from the spectrum generating superalgebra $F(4)$. Its spectrum is a direct sum of $F(4)$ lowest weight representations. This system is a unique example of "quasi-nonassociativity". This means, in particular, that the Calogero coupling constants are determined in terms of the octonionic structure constants. The Hilbert space is a 16-ple of square integrable functions.

This talk is based on the paper `arXiv:1711.02923[math-ph]`, published in J. Math. Phys. 59, 022101 (2018) in collaboration with N. Aizawa and Z. Kuznetsova.

43. **Gijs TUYNMAN** — *Universite de Lille, France*

Regular representations of super Lie groups

The regular representation of a large number of super Lie groups is not super unitary when one applies the standard definition of a super unitary representation. I will argue that weakening the definition of a super Hilbert space and adapting the definition of super unitary accordingly, one can show that the regular representation of any connected super Lie group is super unitary.

44. **Ilya VYUGIN** — *Institute for Information Transmission Problems RAS, Russia*

On the Riemann–Hilbert Problem for difference and q-difference equations

We study an analogue of the classical Riemann–Hilbert problem stated for the classes of difference and q-difference systems. A generalization of Birkhoff's existence theorem is presented. We prove that for any admissible set of characteristic constants there exists a system

$$Y(z+1) = A(z)Y(z) \text{ or } Y(qz) = Q(z)Y(z),$$

which has the given constants.

45. **Henryk ŻOŁĄDEK** — *Uniwersytet Warszawski, Poland*

Perturbations of the Hess–Appelrot and the Lagrange cases in the rigid body dynamics

The Lagrange case in the rigid body dynamics is completely integrable, with a family of invariant tori supporting periodic or quasi-periodic motion. We study perturbations of this case. In the non-periodic case the KAM theory predicts no changes in the evolution. In the periodic cases one expects existence of isolated limit cycles, which can be studied using Melnikov functions. We find these cycles in the case when the invariant torus is close to so-called critical circle. The presented approach is analogous to our previous analysis of the Hess–Appelrot case. In particular, we show that the number of created limit cycles in the latter case is uniformly bounded.

46. **Tomasz Łukasz ŻYNDA** — *Warsaw University of Technology, Poland*

Weighted generalization of the Szegö kernel and its dependence on the weight of integration

A concept of reproducing kernel is connected with a Hilbert space. Not for every Hilbert space, however, there exists a reproducing kernel of it. An example of such weighted Bergman space gave Z. Pasternak-Winiarski in [1]. In that paper, he gave a characterization theorem for weights of integration (which he called admissible weights), for which there exists a reproducing kernel of the corresponding weighted Bergman space. The aim of this presentation is to answer the question for which weights of integration there exists a reproducing kernel of the weighted Szegö space and how does the weighted Szegö kernel depend on the weight of integration. The talk will be partially based on [2].

[1] Z. Pasternak-Winiarski, "On weights which admit the reproducing kernel of Bergman type", Internation Journal of Mathematics and Mathematical Sciences, Volume 15, Issue 1, p. 1-14 (1992).

[2] Z. Pasternak-Winiarski, T. Ł. Żynda, "Weighted Szegö Kernels", Geometric Methods in Physics XXXV, p. 151-157 (2018).

Poster session

47. **Jiří HRIVNÁK** — *Czech Technical University in Prague, Czech Republic*

Generating functions of two-variable Chebyshev polynomials

Fourteen classes of generalized Chebyshev polynomials related to rank two Lie algebras are introduced. The variables of the polynomials are given via the classical characters of the Lie algebras. There exist two, four and eight classes for the algebras A_2, C_2 and G_2, respectively. The admissible weight shift, which permits the constructions of the eight classes of C_2, directly generalizes the four classical kinds of Chebyshev polynomials. Generating functions of all fourteen classes are constructed in the form of rational polynomial functions of four variables. Explicit evaluating formulas, which calculate any given polynomial using addition and multiplication only, are derived and linked to the incomplete exponential Bell polynomials. This is a joint work with Tomasz Czyżycki and Jiří Patera.

48. **Tomoyo KANAZAWA** — *Tokyo University of Science, Japan*

A direct proof for an eigenvalue problem by counting Lagrangian submanifolds

Here we consider a kind of Schrödinger operators called the Bochner–Laplacian. Using Jensen's Formula and Vandermonde convolution, we show directly that for each $k = 0, 1, 2, \ldots$, the number of Lagrangian submanifolds which satisfy the Maslov quantization condition is just equal to the multiplicity of the kth eigenvalue of the operator.

49. **Patrick MOYLAN** — *Pennsylvania State University, United States*

Heisenberg–Weyl Algebras and Representations of Poincaré Groups

We give a novel description of unitary irreducible representations of the Poincaré groups in 2, 3 and 4 space-time dimensions as unitary operators on the representation spaces of the Schrödinger representation of the Heisenberg–Weyl

algebra $\mathbf{W}_n(\mathbb{R})$ of index n = 1, 2, and 3, respectively. We relate this approach to the usual method of describing the representations of Poincaré groups, i.e. the Wigner–Mackey construction.

50. **Petr NOVOTNÝ** — *Czech Technical University in Prague, Czech Republic*

Generalized derivations of Jordan algebras

The definition of derivations of Jordan algebras is generalized by considering complex multiples of original terms. Dimensions of obtained spaces of linear operators are new invariant characteristics of Jordan algebras. These invariant characteristics form a complete set of invariants for indecomposable Jordan algebras up to dimension four. Values of these invariants for all semisimple Jordan algebras are obtained.

51. **Gulgassyl NUGMANOVA** — *Eurasian National University, Kazakhstan*

About the integrable two-layer spin systems with self-consistent potential

Integrable nonlinear differential equations admit soliton and other exact solutions. Study of soliton solutions and related solutions become on of the most active areas of research in the field of physics and mathematics. In this paper we present two-layer spin systems, which are generalization of the Landau–Lifshitz equation with self-consistent potential. We consider relations between two layers of spin, impact of self-consistent potential on these layers and their interactions on basic of differential geometry of curves.

52. **Bakyt SHALABAYEVA** — *Eurasian National University, Kazakhstan*

Simulation of the dynamics of a single drop of a viscous liquid

Theoretical and experimental study of the behavior of individual drops of one viscous liquid in another under the action of various physical fields (thermal, acoustic, electromagnetic) is of great importance in solving technological problems in various industries. In general, the shape of the drop is non-spherical and is formed as a result of the complex interaction of a whole set of factors. Such as viscosity of liquids, interfacial tension forces, gravity, acoustic and electromagnetic fields, etc. Therefore, for an adequate description of the nonlinear dynamics of a single drop, it is necessary to use modern numerical simulation methods that allow one to determine border position of section between phases.

53. **Aneta SLIŻEWSKA** — *Uniwersytet w Białymstoku, Poland*

Symmetries of the space of connections on a principal G-bundle and related symplectic structures

We investigate G-invariant symplectic structures on the cotangent bundle T^*P of a principal G-bundle $P(M,G)$ which are canonically related to automorphisms of the tangent bundle TP covering the identity map of P and commuting with the action of TG on TP. The symplectic structures corresponding to connections on $P(M,G)$ are also investigated.

54. **Marzena SZAJEWSKA** — *Uniwersytet w Białymstoku, Poland*

The orthogonal systems of functions on lattices of $SU(n+1)$, $n < \infty$

We recall the definitions of the orbit functions, their orthogonality relations, congruence classes and decomposition matrices. The orthogonality of the symmetric

and antisymmetric orbit functions, namely $C-$ and $S-$functions, which are given on the fundamental region F_M of the weight lattice for the simple Lie groups $SU(n+1)$ of any rank n is defined. The splitting of the weight lattice of A_n into congruence classes is shown. The description of the structure of the decomposition matrices for the Fourier transforms is presented.

55. **Karolina WOJCIECHOWICZ** — *Uniwersytet w Białymstoku, Poland*

Deformation of algebroid bracket of differential forms and Poisson manifold

We construct the family of algebroid brackets on the tangent bundle T^*M to a Poisson manifold (M, π) starting from an algebroid bracket of differential forms. We use these brackets to generate Poisson structures on the tangent bundle TM. Next, in the case when M is equipped with a bi-Hamiltonian structure (M, π_1, π_2) we show how to construct another family of Poisson structures. Moreover we present how to find Casimir functions for those structures and we discuss some particular examples.

56. **Naoko YOSHIMI** — *Tokyo University of Science, Japan*

2+1-Moulton Configuration

We pose a new problem of collinear central configurations in Newtonian n-body problem based *Moulton configuration*, that is, can we add a new body on the straight line of initial two bodies without changing the move of the initial two bodies and the configuration of the three bodies is central, too? Then we find there exist three solutions which the positions are outside of initial bodies or between their, and the mass of new body is zero. But when we allow the motion and the center of mass of three bodies are free, the mass of added body is positive.

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