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ABSTRACTS

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ABSTRACTS

Accardi, *Luigi*:

Unitary Representations of *-Lie Algebras and Quantum Probability

Unitary representations of *-Lie algebras allow to associate these algebras to families of classical stochastic processes. In particular current algebras give rise to additive independent increment processes. Recently it has been discovered that the transition from a Lie algebra $\mathcal{L}$ to its current algebra over a measure space $(S, \mathcal{B}, \mu)$ (e.g. $S = \mathbb{R}, \mu =$ Lebesgue measure) can give rise to obstructions on the existence of certain classes of representations if the measure space $(S, \mathcal{B}, \mu)$ is not purely atomic. The paradigmatic example is the lowest weight (or Fock) representation. These obstructions are strictly related to one aspect of the renormalization problem studied in Physics. The talk describes this problem in some important examples. For further information one can look at the survey paper: L. Accardi, A. Boukas: "Quantum probability, renormalization and infinite dimensional $*$-Lie algebras", to appear in: SIGMA *Symmetry, Integrability and Geometry: Methods and Applications* (2009), or the paper: L. Accardi, A. Boukas: "Central extensions of the Renormalized Higher Powers of White Noise and w_∞ $*$-Lie algebras", *Infinite Dimensional Anal. Quantum Probab. Related Topics* **12** (2) (2009).

Aizawa, *Naruhiko*:

Noncommutative Complex Manifolds *via* Quantum (Super) Group Coherent States

A quantum group extension of Prerelomov's generalized coherent states is considered by taking into account the duality of quantum groups and algebras. The duality is encapsulated in the so-called universal T-matrix which is an q-analogue of the exponential mapping from a Lie algebra to its dual Lie group. Explicit construction for some simple cases such as $SU_q(2)$, $SU_q(1,1)$, $H_q(1)$ and $OSp_q(1/2)$ is carried out. It turns out that the coherent states naturally provide a description of quantum homogeneous spaces (q-sphere, q-hyperboloid and so on) in terms of noncommutative complex variables. This may allow us to develop noncommutative geometry on homogeneous spaces in complex form. Aiming for application of these coherent states for physical models, properties of the coherent states are studied in detail. Especially it is shown that the coherent states for $SU_q(2)$ enjoy a resolution of the unity.

Bakalov, *Bojko*:

W-Constraints for Simple Singularities

Simple, or Kleinian, singularities are classified by Dynkin diagrams of type ADE. Using Picard-Lefschetz periods, we construct a twisted representation of

the lattice vertex algebra V associated to the root lattice of the corresponding finite-dimensional Lie algebra g. By the Frenkel-Kac construction, V is isomorphic to the basic representation of the corresponding affine Kac-Moody algebra, and in particular it admits an action of g by derivations. The kernel of this g-action is a subalgebra of V known as a W algebra. Our main result is that the total descendant potential of the singularity, introduced by Givental, is a highest weight vector for the W algebra. This is a joint work with T. Milanov.

Bouarroudj, *Sofiane*:

Deformations of the Lie Algebra $\mathfrak{o}(5)$ in Characteristics 3 and 2

The finite dimensional simple modular Lie algebras with Cartan matrix are rigid if the characteristic p is equal to 0 or greater than 3. If $p = 3$, the orthogonal Lie algebra $\mathfrak{o}(5)$ is one of the two simple modular Lie algebras with Cartan matrix that have deformations. Kostrikin and Kuznetsov described the orbits (isomorphism classes) under the action of the Chevalley group $O(5)$ of automorphisms of $\mathfrak{o}(5)$ on the space $H^2(\mathfrak{o}(5); \mathfrak{o}(5))$ and produced representatives of the isomorphism classes. Here we explicitly describe global deforms of $\mathfrak{o}(5)$ and consider the deforms of the simple analog of this orthogonal algebra in characteristic 2.

Boukas, *Andreas*:

Central Extensions of the Heisenberg Algebra

We study the non-trivial central extensions $CE(Heis)$ of the Heisenberg algebra $Heis$. We prove that a real form of $CE(Heis)$ is one the fifteen classified real four–dimensional solvable Lie algebras. This algebra and the associated group law have been studied by Feinsilver and Schott. We study the connection of $CE(Heis)$ and the Feinsilver–Schott algebra in detail. We also show that $CE(Heis)$ can be realized (i) as a sub–Lie–algebra of the Schroedinger algebra and (ii) in terms of two independent copies of the canonical commutation relations (CCR). This gives a natural family of unitary representations of $CE(Heis)$ and allows an explicit determination of the associated group by exponentiation. In contrast with $Heis$, the group law for $CE(Heis)$ is given by nonlinear (quadratic) functions of the coordinates. The vacuum characteristic and moment generating functions of the classical random variables canonically associated to $CE(Heis)$ are computed. The second quantization of $CE(Heis)$ is also considered. We show that the Feinsilver-Schott kernel (Leibniz function) for the Schroedinger algebra is shown to be non positive semi-definite. This is a joint work with Prof. L. Accardi.

Cederwall, *Martin*:

Operators on Pure Spinor Spaces

Pure spinors are relevant to the formulation of supersymmetric theories, and provide the only known way to maintain manifest maximal supersymmetry. The (non-linear) pure spinor constraint makes it nontrivial to find well defined operators on pure spinor wave functions. We discuss how such operators are defined. We also discuss some work in progress where the construction is used. One application concerns covariant gauge fixing in maximally supersymmetric Yang-Mills (and string theory). Another issue is the construction of a manifestly supersymmetric action for 11-dimensional supergravity in terms of a scalar superfield.

Cerbu, *Marcela*:

The Excitation of Two Individual Atoms in the Rydberg Blockade

We study the interaction between the module of the microresonator and the atomic flux, which consists from atoms with three energetically levels situated equidistantly. The matrix element of transition are dipole active between the energetically levels in the cascade configuration. This problem is equivalent with the interaction of cavity module with the flux of undistinguished pairs of atoms of two levels. In this case it is necessary that the distance between atoms in one pair to be much smaller then the wavelength of the cavity module.

Cerbu, *Olga*:

Categorial Aspects of the Semireflexivity

In the categorial of the locally convex topological vector spaces we examine the semireflexive subcategories - a categorial generalization of the subcategories of semireflexive spaces. There are studied the properties of this subcategories, the relation of this notion with the right product of two subcategories, with the left exact reflector functor and so on. An important role in the researches of this subcategories is the factorization of reflector functor. As a result is proved that a lot of the properties of semireflexive spaces have a categorial character – it are true for all semireflexive subcategories. There are construct a lot of examples.

Dambroise, *Jennie*:

One Correspondence Used in Reformulating Einstein Equations for Various Scalar Field Cosmologies

Recently we have shown some correspondences between Einstein field equations in a number of cosmological models, with so-called generalized Ermakov-

Milne-Pinney (EMP) or (one-dimensional) nonlinear Schrödinger-type equations. This work has extended the work of a number of authors who originated such reformulations. Since the methodology used in each cosmological model is similar, we will draw ties between them and state an underlying correspondence through which one can prove each of the cases worked out thus far.

De Guise, *Hubert*:

A General Approach to Quasidistributions: the Case of Multiplicity-Free Irreps of $SU(N)$

Wigner pioneered the use of phase space methods in quantum mechanics and his work has been the seed for several successful approaches having the common objective of mapping quantum mechanical operators, defined in an abstract Hilbert space, to complex-valued functions in a classical phase space appropriate for the system under consideration. In this talk I will describe a simple form for the kernel of this mapping, and how this kernel can be used to construct quasidistribution functions for multiplicity-free $SU(N)$ irreps. The problems in extending this approach to irreps with multiplicities will also be discussed. [by H. de Guise and A.B. Klimov]

Dolguntseva, *Irina*:

Extensions of associative Conformal Algebras Cend$_n$ and Cur$_n$

One of the main results of the theory of finite-dimensional algebras is the Wedderburn theorem on the structure of separable algebras. It is known, that this statement is a consequence of the Hochschild theorem on the triviality of the second cohomology group of a matrix algebra over a field. We introduce a notion of Hochschild cohomology of an associative conformal algebra for study of extensions of conformal algebras. It is proved, that there exists one-one correspondence between cohomologies and singular extensions of an associative conformal algebras, and the second cohomology group of an associative conformal algebras with coefficients in any bimodule is trivial. As a result, a segregation of algebras Cend$_n$ and Cur$_n$ is received.

Dragovich, *Branko*:

On p-Adic Sector of Adelic Strings

p-Adic strings play important role in string theory, p-adic mathematical physics and nonlocal cosmology. Adelic strings are composed of the ordinary and p-adic ones. Many properties of p-adic strings are simpler than their analogs of ordinary strings. Starting from exact Lagrangians for p-adic strings, we have constructed a few Lagrangians for p-adic sector of adelic strings, which contain

the Riemann zeta function. We investigate and present various properties of these Lagrangians.

Georgiev, *Lachezar*:

Monodromy Analysis of the Computational Power of the Ising Topological Quantum Computer

We show that all quantum gates that can be implemented by braiding of Ising anyons in the Ising topological quantum computer naturally preserve the n-qubit Pauli group. Analyzing the structure of the Pauli group centralizer, also known as the Clifford group, for $n \geq 3$ qubits we prove that the the image of the braid group is a non-trivial subgroup of the Clifford group and therefore not all Clifford gates could be implemented by braiding. We show explicitly the Clifford gates which cannot be realized by braiding, estimating in this way the ultimate computational power of the Ising topological quantum computer.

Goryuchkina, *Irina*:

Asymptotic forms and expansions of solutions to the Painlevè equations

We consider Painlevè equations [1] which are nonlinear ordinary differential equations of the second order and their solutions determine new special functions (Painlevè transcendents). For these equations we seek their formal solutions, which are represented in asymptotic expansions near any points $x = x_0$ (including zero and infinity) of form

$$y = c_r(x - x_0)^r + \sum_s c_s(x - x_0)^s,\ s \in \mathbf{K}, \qquad (1)$$

of 4 types: power [2, S3], power-logarithmic [2, S3], complicated [3] and exotic [4]. Besides we can calculate exponential asymptotic forms [2, S5] and exponentially small additions [2, S7] to the expansions (1). Many integrable equations of mathematical physics with soliton solutions are reduced to Painlevè equations.

1. Rozov N.H., Painlevè equation, *Math. Encyc.*, Kluwer Acad. Publ., 1995, vol. 8.
2. Bruno, A.D., *Russian Mathematical Surveys*, vol. 59 (2004), no. 3, pp. 429–480.
3. Bruno, A.D., *Doklady Mathematics*, vol. 73 (2006), no.1, pp. 117–120.
4. Bruno, A.D., *Doklady Mathematics*, vol. 76 (2007), no. 2, pp. 714–718.

Horozov, *Ivan*:

Quantum Gravity, Iterated Integrals and Cohomology of $GL_n(C)$

We give models for Quantum Electrodynamics (QED) and Quantum Gravity (QG) in terms of certain iterated integrals. The models for QED and QG are

dual to each other. This theory captures photon, graviton, electron and Dirac sea. Both in QED and in QG partition functions are written in terms of iterated integrals of holomorphic and antiholomorphic differential forms. Key technical tools are higher dimensional iterated integrals and cohomology of topological groups of $GL_n(C)$ and of $U(n)$.

Horozov, *Emil*:

Calogero-Moser Spaces and Representation Theory

We offer a criterion for the reality of irreducible representations of the rational Cherednik algebras. This is shown to imply a criterion for the real loci of the Calogero-Moser spaces Cn in terms of the Etingof-Ginzburg finite maps, recovering a result of Mikhin, Tarasov, and Varchenko. As a consequence we obtain a criterion for the real locus of the Wilson's adelic Grassmannian of rank one bispectral solutions of the KP hierarchy.

Knezevic, *Miljan*:

A Note on the Harmonic Quasi-Isometries

We consider different versions of the Ahlfors-Schwarz lemma for quasiconformal harmonic mappings with respect to the Poincaré metric.

Kojima, *Takeo*:

Wakimoto Realization of the Elliptic Quantum Group $U_{q,p}(\widehat{sl_N})$ and Its Application to Integrals of Motion

We study a free field realization of the elliptic quantum group $U_{q,p}(\widehat{sl_N})$ for arbitrary level k. We construct the free field realization of the elliptic analogue of Drinfeld current. In the limit $p \to 0$, $q \to 1$ this realization becomes Wakimoto realization of affine Lie algebra $\widehat{sl_N}$. As an application of this free field realization, we construct infinitly many commutative operators, which are regarded as level k generalization of the integrals of motion for the deformed W-algebra $W_{q,t}(\widehat{sl_N})$.

1. T. Kojima and J. Shiraishi, The integrals of motion for the deformed W-algebra $W_{q,t}(\widehat{gl_N})$ II, *Commun. Math. Phys.* **283**, 795-851, (2008).
2. T. Kojima, Wakimoto realization of Drinfeld current for the elliptic quantum group, to appear in *Physics of Atomic Nuclei* (Proc. of 27th International Colloquium on Group Theoretical Method in Physics), (2009).

Linshaw, *Andrew*:

Invariant Theory and the $W_{1+\infty}$ Algebra

The vertex algebra $W_{1+\infty,c}$ with central charge c may be defined as a module over the universal central extension of the Lie algebra of differential operators on the circle. For an integer $n \geq 1$, it was conjectured in the physics literature by Blumenhagen-Eholzer-Honecker-Hornfeck-Hubel that $W_{1+\infty,-n}$ should have a minimal strong generating set consisting of n^2+2n elements. Using some ideas from classical invariant theory, we prove this conjecture. As an application, we establish the strong finite generation of a certain family of invariant vertex algebras under reductive group actions.

Malikov, *Fyodor*:

Algebras of Chiral Differential Operators, Twisted and Untwisted

Algebras of differential operators naturally act on functions. To operate on sections of a line bundle, the algebra of differential operators must be twisted, the twist depending on the choice of a line bundle. Usually it is not hard to construct a single universal algebra of twisted differential operators which operates on sections of any line bundle over a given manifold. One can say that a module over such algebra depends on a parameter, a point on the moduli of line bundles. This enrichment of representation theory is important. For example, in case of a flag manifold the algebra of usual differential operators controls, via the Beilinson-Bernstein localization, the representation theory of the corresponding simple Lie algebra with the zero central character only; the universal algebra of twisted differential operators allows to handle an arbitrary central character. Algebras of chiral differential operators, introduced some 10 years ago, are vertex algebra analogues of algebras of differential operators. Algebras of twisted chiral differential operators, a recent invention, are not unlike the universal twisted version of the latter in that they also afford families of modules depending on a number of parameters, but in this case parameters are functional. In case of a flag manifold these parameters become essentially "opers", i.e., central characters of the corresponding affine Lie algebra at the critical level. One can say that the twisted chiral differential operator construction suggests a notion of an oper for an arbitrary manifold. Upon reviewing algebras of chiral differential operators, twisted and untwisted, we shall focus on the case of a flag manifold. Our main result is an explicit computation of the cohomology of modules over the algebra of twisted chiral differential operators. We shall explain that this result implies a version of the Beilinson-Bernstein localization over flag manifolds of g-integrable affine Lie algebra modules at the critical level. Applications to character formulas and elliptic genus will also be discussed. The physics interpretation of this story starts with the assertion, due to Witten and (in a slightly

different situation) to Kapustin , that the cohomology of algebras of chiral differential operators equals, perturbatively, Witten's half-twisted algebra of a certain (0,2)-superconformal field theory, also introduced by Witten. This is joint work with Arakawa and Chebotarov.

Nahm, *Werner*:

Integrable deformations of CFTs and the discrete Hirota equations

TBA

Nikolov, *Nikolay*:

Anomalies in Quantum Field Theory and Cohomologies of Configuration Spaces

In this work we study systematically the Euclidean renormalization in configuration spaces. We investigate also the deviation from commutativity of the renormalization and the action of all linear partial differential operators. This deviation is the source of the anomalies in quantum field theory, including the renormalization group action. It also determines a Hochschild 1-cocycle and the renormalization ambiguity corresponds to a nonlinear subset in the cohomology class of this renormalization cocycle. We show that the related cohomology spaces can be reduced to de Rham cohomologies of the so called "(ordered) configuration spaces". We find cohomological differential equations that determine the renormalization cocycles up to the renormalization freedom. This analysis is a first step towards a new approach for computing renormalization group actions. It can be also naturally extended to manifolds as well as to the case of causal perturbation theory. (preprint: arXiv:0903.0187)

Nissimov, *Emil*:

Wormholes and Non-Singular Black Holes *via* Lightlike Branes

We describe a general scheme for constructing self-consistent spherically symetric or rotating cylindrical wormhole solutions of Einstein equations of bulk Einstein or Einstein-Maxwell system coupled to lightlike branes with well-defined reparametrization invariant world-volume actions, where the lightlike branes automatically occupy the pertinent wormhole throats. Some of these solutions provide a non-trivial realization of Misner-Wheeler effect "electric charge without electric source" or "magnetic charge without magnetic source". Similarly we find non-singular black hole solution where the bulk space-time consist of two regions – an interior de Sitter and an exterior Reissner-Nordstroem matched along common horizon occupied by a charged lightlike brane, which also dynamically generates the non-zero cosmological constant in the interior region.

Obrenovic, *Kristina*:

Some Examples of Slant Surfaces in The Nearly Köhler Six Sphere

We will consider slant surfaces of six-dimensional sphere that are obtained as orbits of two-dimensional subgroup of $H \subset G_2 \subset SO(7)$.It will be shown that those orbits are flat tori and that their slant angle is between $\arccos \frac{1}{3}$ and $\frac{\pi}{2}$. This is a joint work with Dr. Srdjan Vukmirovic.

Poletaeva, *Elena*:

Superconformal Algebras and Related Topics

Superconformal algebras (SCA) are superextensions of the Virasoro algebra. They play an important role in the conformal field theory and mirror symmetry. Well-known examples of SCA are the $N = 2$ and the Big $N = 4$ SCA. They are spanned by 4 and 16 fields. In 1997 V.G. Kac and S.-J. Cheng discovered a new exceptional $N = 6$ SCA spanned by 32 field. A remarkable property of these SCA is that they have realizations as Lie subalgebras of pseudodifferential symbols on the circle extended by 1, 2 and 3 odd variables. This allows to obtain "small" representations of these SCA and also realize them in matrices of size 2, 4 and 8 over a Weyl algebra. These matrix realizations are closely connected with spin representations of the orthogonal Lie algebras. We also obtain realizations of the family of simple finite-dimensional Lie superalgebras $D(2, 1; \alpha)$ related to SCA, in terms of differential operators on the supercircle with two odd variables and matrices over a Weyl algebra.

Popov, *Todor*:

Hopf structures on Standard Young Tableaux

We review the Poirier-Reutenauer Hopf structure on Standard Young Tableaux and show it is a distinguished member of a family of Hopf structures. The family in question is related to deformed parastatistics.

Rakic, *Zoran*:

$F_q[M_n]$, $F_q[GL_n]$ and $F_q[SL_n]$ as Quantized Universal Enveloping Algebras

Within the quantum function algebra $F_q[GL_n]$, we investigate the subset

$$\mathcal{F}_q[GL_n] := \left\{ f \in F_q[GL_n] \middle| \langle f, \mathcal{U}_q(\mathfrak{gl}_n) \rangle \subseteq \mathbb{Z}\left[q, q^{-1}\right] \right\},$$

of all elements of $F_q[GL_n]$ which are $\mathbb{Z}\left[q, q^{-1}\right]$–valued when paired with $\mathcal{U}_q(\mathfrak{gl}_n)$, the unrestricted $\mathbb{Z}\left[q, q^{-1}\right]$–integral form of $U_q(\mathfrak{gl}_n)$ introduced by De

Concini, Kac and Procesi. In particular, we obtain a presentation of it by generators and relations, and a PBW-like theorem. A direct proof that $\mathcal{F}_q[GL_n]$ is a Hopf subalgebra of $F_q[GL_n]$, and that $\mathcal{F}_q[GL_n]\Big|_{q=1} \cong U_{\mathbb{Z}}(\mathfrak{gl}_n{}^*)$ is given.

Its specializations at roots of 1, say ε, and the associated quantum Frobenius (epi)morphism from $\mathcal{F}_\varepsilon[GL_n]$ to $\mathcal{F}_1[GL_n] \cong U_{\mathbb{Z}}(\mathfrak{gl}_n{}^*)$, are described explicitly. The same analysis is done for $\mathcal{F}_q[SL_n]$ and (as key step) for $\mathcal{F}_q[M_n]$.

Randjbar-Daemi, *Seifallah*:

Infrared Modified Gravity with Dynamical Torsion

We continue the recent study of the possibility of constructing a consistent infrared modification of gravity by treating the vierbein and connection as independent dynamical fields. We present the generalized Fierz–Pauli equation that governs the propagation of a massive spin-2 mode in a model of this sort in the backgrounds of arbitrary torsionless Einstein manifolds. We show explicitly that the number of propagating degrees of freedom in these backgrounds remains the same as in flat space-time. This generalizes the recent result that the Boulware–Deser phenomenon does not occur in de Sitter and anti-de Sitter backgrounds. We find that, at least for weakly curved backgrounds, there are no ghosts in the model. We also briefly discuss the interaction of sources in flat background.

Rashkov, *Radoslav*:

GStrings on $T^{1,1}$ and Reducion to an Integrable System

We consider string theory on $T^{1,1}$. Using a certain ansatz for the the string embedding we find solitonic a type system. We find "magnon" and "spiky" string solutions and the dispersion relations for the theory under consideration. The implications for the AdS/CFT correspondence are discussed.

Rausch De Traubenberg, *Michel*:

Parafermions, Ternary Extension of the Poincaré Algebra and Its Associated Superspace

Lie algebras of order F (or F-Lie algebras) are possible generalisations of Lie algebras ($F = 1$) and Lie superalgebras ($F = 2$). An $F-$Lie algebra admits a $\mathbb{Z}_F$-gradation, the zero-graded part being a Lie algebra. An F-fold symmetric product (playing the role of the anticommutator in the case $F = 2$) expresses the zero graded part in terms of the non-zero graded part. These structures have been used to implement new non-trivial extensions of the Poincaré algebra and a group associated to these types of algebras was defined. In this talk we construct explicitly a differential realisation of a given cubic extension of the Poincaré algebra by means of parafermions of order two. This means in particular that

parafermionic variables enable us to define an associated superspace together with corresponding superfields.

Regniers, *Gilles*:

Wigner Quantization of $H = xp$

The quantization of the simple one-dimensional Hamiltonian $H = xp$ is of interest for its mathematical properties rather than for its physical relevance. In fact, the Berry-Keating conjecture speculates that a "proper quantization" of $H = xp$ could yield a relation with the Riemann hypothesis. Motivated by this, we study the so-called Wigner quantization of $H = xp$. As far as we can see, this does not lead to a relation with the conjecture, but it leads to some interesting aspects of representation theory. The Wigner quantization relates the problem to representations of the Lie superalgebra $osp(1|2)$, and all relevant operators act in positive discrete series representations of $osp(1|2)$ as Hilbert spaces. The spectrum of $hatH$ is determined, and its formal eigenvectors are expressed in terms of the standard basis involving Meixner-Pollaczek polynomials as coefficients. The formal eigenvectors of $\hat{x}$ are also determined, and involve generalized Laguerre polynomials as coefficients. An interesting problem is the determination of the wave functions in the coordinate representation when the system is in a stationary state with energy E.

Salom, *Igor*:

Applicability of the Gell-Mann Formula to $sl(n, R)$ Algebras

The Gell-Mann formula is proposed as an algebraic expression inverse to the Inönü-Wigner Lie algebra contraction. As such, it has a limited applicability in the case of the $sl(n, R)$ algebras which are contracted w.r.t. their $so(n)$ subalgebras. A thorough analysis of the Gell-Mann formula in the $sl(n, R)$ representation spaces given as sums of representation spaces of the Spin(n) groups, generated by the maximal compact subalgebras $so(n)$, is carried out. A list of symmetric spaces, which furniture the $sl(n, R)$ representations spaces for which this formula holds, is presented.

Sasakura, *Naoki*:

Tensor Models as Theory of Dynamical Fuzzy Spaces and General Relativity

The tensor model is discussed as theory of dynamical fuzzy spaces and as a way to formulate gravity on fuzzy spaces. It is shown that the low-lying fluctuation spectra around the Gaussian background solutions in the tensor model are in correct agreement with the metric fluctuations on the flat spaces with general

dimensions in the general relativity. Furthermore, to see whether the local translation symmetry is also emergent around these backgrounds, the BRS gauge fixing is carried out for the orthogonal group symmetry in the tensor model. It is shown that the low-lying ghost modes are in correct agreement with the ghost fields in the corresponding BRS gauge fixing of the general relativity.

Scheithauer, *Nils*:

Moonshine for Conway's Group

The physical states of a bosonic string moving on a 26-dimensional torus form an infinite dimensional Lie algebra called the fake monster algebra. This Lie algebra is a generalized Kac-Moody algebra. Its real simple roots correspond to the Leech lattice. The automorphism group of the Leech lattice acts by diagram automorphisms on the fake monster algebra. Borcherds conjectured that the corresponding twisted denominator identities are automorphic forms of singular weight on orthogonal groups. We describe a proof of this conjecture for elements whose order is equal to their level.

Schomerus, *Volker*:

Principal Chiral Model on Superspheres

We investigate the spectrum of the principal chiral model (PCM) on odd-dimensional superspheres as a function of the curvature radius R. For volume-filling branes on $S^{3|2}$, we compute the exact boundary spectrum as a function of R. The extension to higher dimensional superspheres is discussed, but not carried out in detail. Our results provide very convincing evidence in favor of the strong-weak coupling duality between supersphere PCMs and OSP(2S+2—2S) Gross-Neveu models that was recently conjectured by Candu and Saleur in arXiv:0801.0444.

Suchanek, *Paulina*:

4-Point Conformal Blocks in 2D SuperConformal Field Theory

In two dimensional conformal and superconformal field theories any 4-point correlation function can be expressed through 3-point coupling constants and the 4-point conformal blocks. Even if the latter are universal functions completely determined by the symmetry, their analytic form is (save fore some specific cases) not known. In the non supersymmetric case the recursive methods of an approximate, analytic determination of the conformal blocks were proposed by Al. Zamolodchikov. I will remind the essential points of this derivation and show how to generalize it in the case of superconformal blocks corresponding to the correlation functions of Neveu-Schwarz and Ramond fields.

Sugino, *Fumihiko*:

Ginsparg-Wilson Formulation of 2D $\mathcal{N} = (2, 2)$ SQCD with Exact Supersymmetry

In this talk, I will discuss on a lattice formulation of 2D $\mathcal{N} = (2, 2)$ SQCD preservng one of the supercharges. In particular, the overlap Dirac operator, which satisfies the Ginsparg-Wilson relation, is introduced to the matter sector of the theory. It realizes the exact chiral flavor symmetry on the lattice, to make possible to define the lattice action for general number of the flavors of fundamental and anti-fundamental matter multiplets and for general twisted masses. Furthermore, superpotential terms can be introduced with exact holomorphic or anti-holomorphic structure on the lattice. I will also discuss the lattice formulation of matter multiplets charged only under the central $U(1)$ (the overall $U(1)$) of the gauge group $G = U(N)$, and then construct lattice models for gauged linear sigma models with exactly preserving one supercharge and their chiral flavor symmetry.

Todorov, *Ivan*:

Minimal Representations and Dual Pairs

A minimal representation of a (non-compact) Lie group is obtained by quantizing the smallest co-adjoint orbit of its Lie algebra. Triggered by the physicists' excitement with spectrum generating algebras, introduced in the mid 1970's by A. Joseph, the concept keeps attracting the interest of mathematicians and (mathematical) physicists – see e.g. [1-4]. One objective of the present recreational survey is to convince physicists that they actually know a substantial part of it and hence stand a chance to understand the rest and to profit from it. Another, is to provide a context for Roger Howe's notion of a reductive dual pair and its applications.

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Van Der Jeugt, *Joris*:

New Analytically Solvable Hamiltonians: Canonical Quantization and Wigner Quantization

Quantum systems consisting of a linear chain of n harmonic oscillators coupled by a quadratic nearest neighbour interaction are considered. Such systems are always solvable and involve the numerical eigenvalues of the interaction matrix. We investigate when such a system is analytically solvable, in the sense that the eigenvalues and eigenvectors of the interaction matrix have analytically closed expressions. This leads to a relation with Jacobi matrices of systems of discrete orthogonal polynomials. Our study leads to three new analytically solvable Hamiltonians, related to Krawtchouck, Hahn and q-Krawtchouk polynomials. All these results hold in the case of canonical quantization, but we show that these systems can also be treated in the case of Wigner quantization.

Yakimov, *Milen*:

Quantized Nilpotent Algebras

De Concini, Kac and Procesi defined a family of subalgebras U_+^w of a quantized universal enveloping algebra $U_q(\mathfrak{g})$, associated to the elements of the corresponding Weyl group W. The algebras of quantum matrices arise as special cases. Based on results of Gorelik and Joseph, we construct explicitly the H invariant prime ideals of each U_+^w and show that the corresponding poset is isomorphic to $W^{\leq w}$, where H is the group of group-like elements of $U_q(\mathfrak{g})$. Moreover, for each H-prime of U_+^w we construct a generating set in terms of Demazure modules related to fundamental representations.

Zhang, *Ruibin*:

Quantum Group Actions on Noncommutative Algebras and Equivariant K-Theory

We study module algebras over quantum groups and their categories of equivariant modules. An equivariant algebraic K-theory of quantum group actions is introduced, and properties of this K-theory are developed. The equivariant K-groups for quantum homogeneous spaces and quantum symmetric algebras are computed. This is joint work with Gus Lehrer and Ngau Lam.

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