XXIX Max Born Symposium: Super, Quantum & Twistors II

Wroclaw 28-30 June 2011

List of lectures:

G. Amelino-Camelia Quantum Gravity and Relative Locality

Abstract:
Several indipendent arguments suggest that the notion of locality should be revised at the Planck scale. I review a recently proposed scenario for a modification of locality such that events which are established to be coincident by nearby observers may not appear to be coincident in the coordinatization of spacetime by distant observers. This fits within a path to quantum gravity which Max Born proposed in 1938, involving curvature of momentum space. And a valuable example of relative-locality framework can be built around a kappa-Poincare phase space.

K. Andrzejewski Modified Hamiltonian formalism for higher-derivative theories

Abstract:
The alternative version of Hamiltonian formalism for higher-derivative theories is proposed. As compared with the standard Ostrogradski approach it has the following advantageous:
(i) the Lagrangian, when expressed in terms of new variables yields proper equations of motion; no additional Lagrange multipliers are necessary
(ii) the Legendre transformation can be performed in a straightforward way provided the Lagrangian is nonsingular in Ostrogradski sense.

M. Arzano Quantum fields on curved momentum space

Abstract:
Relativistic particles with momentum space described by a group manifold provide a very interesting link between (quantum) gravity, quantum group symmetries and non-commutative field theories. In 4d the only known example of momenta living on a group is encountered in the context of the k-Poincare' algebra introduced by Lukierski et al. twenty years ago. I will discuss the construction of a one-particle Hilbert space from the classical k-deformed phase space and show how the group manifold structure of momentum space leads to an ambiguity in the quantization procedure reminiscent of the ambiguities found when quantizing fields in curved space-times. The tools introduced in the discussion of field quantization lead to a natural definition of deformed two-point function. Moving to the multiparticle sector I will discuss how the quantum group symmetry of the Hilbert space induces additional structure which reflects in a non-trivial, momentum-dependent statistics. The richer structure of the deformed Fock space allows for the possibility of entanglement between the field modes and "planckian" degrees of freedom.

A. Burinskii The Kerr-Newman electron:Twistorial and stringy structures of spinning particles

Abstract:
The Kerr-Newman solution is considered as a model of the consistent with gravity spinning particle [1]. In particular, it has the gyromagnetic ratio g=2 as that of the Dirac electron [2]. We consider the real, complex and twistorial structures of the Kerr geometry, which are based on the principal null congruences determined by the Kerr theorem [3]. We

show that the real Kerr geometry contains a closed string, structure of which is similar to that of the heterotic one. This string has the Compton radius a= hbar /(2m) and is positioned on the border of the Compton area [4]. In the same time, the complex Kerr-Schild geometry contains an open twistor-string structure [5].
References:
[1] A. Burinskii, "Regularized Kerr-Newman Solution as a Gravitating Soliton". J. Phys. A: Math. Theor. 43 (2010) 392001, [arXiv: 1003.2928].
[2] A. Burinskii, "The Dirac-Kerr-Newman electron" Grav. Cosmol. 14, 109 (2008) [arXiv:hep-th/0507109].
[3] A. Burinskii, "Twistorial analyticity and three stringy systems of the Kerr spinning particle" Phys. Rev. D 70, 086006 (2004), [arXiv:hep-th/0406063].
[4] A. Burinskii, "Gravity versus Quantum theory: Is electron really pointlike?", [arXiv:1104.0573].
[5] A. Burinskii, "String-like Structures in Complex Kerr Geometry", In: Relativity Today, Edited by R.P.Kerr and Z.Perj'ez [arXiv:gr-qc/9303003].

L. Dabrowski Quantum Isometries in the Standard Model

S. Doplicher Superselection structure in Local Quantum Theories with (neutral) massless particles

Abstract:
Joint work in progress with Detlev Buchholz and John E. Roberts. We study the superselection structure in theories with massless particles which do not carry superselection quantum numbers. The results valid in the massive case do extend, in particular we have the intrinsic notion of particle statistics of superselection sectors, and the existence of a unique compact group dual to the superselection structure. Problems with covariance and spectrum condition remain in the case of non simple sectors (i.e. obeying a parastatistics).

M. Dunajski A problem of Roger Liouville

Abstract:
Cover a plane with curves, one curve through each point in each direction. How can you tell whether these curves are the geodesics of some metric? This problem gives rise to a certain closed system of partial differential equations and hence to obstructions to finding such a metric. It has been an open problem for at least 120 years. I shall present a twistor inspired solution obtained jointly with Robert Bryant and Mike Eastwood.

R. Durka Constrained BF theory as gravity

Abstract:
In the late 70's MacDowell and Mansouri introduced a new formulation of gravity (with nice extension to N=1 supergravity) based on broken symmetry of the gauge theory. Recently this formalism was generalized to the form of the constrained topological BF theory of the anti-de Sitter (or de Sitter) gauge group.
Presented framework provides the most general form of action for the first order gravity containing Einstein-Cartan action with negative (or positive) cosmological constant, Holst term and topological Euler, Pontryagin and Nieh-Yan invariants, and governed by only three constants (Newton constant, cosmological constant, and Immirzi parameter).

From the black hole thermodynamics perspective such a construction is supported by differentiability of the action incorporated in the model, with the topological terms playing essential role in regularization of the gravitational Noether charges (mass, angular momentum, and entropy).

A. Frydryszak Supersymmetry and entanglement

E. Ivanov Supersymmetric quantum mechanics and harmonics

R. Kerner Space-time emerging from quark algebra

Abstract:
Ternary generalization of the Pauli principle is introduced via cubic relations involving the cubic root of unity instead of (-1) in the usual case. The group of automorphisms of thus introduces quark algebra turns out to be the Spin group of the Minkowskian space. Vector representation also appears naturally. Next we discuss the tenary generalization of Dirac's equation and cubic Clifford algebras, and non-associative ternary algebras appearing in this formalism.

D. Kovacevic kappa-Minkowski space-time and Hermitian covariant realizations

Abstract:
We consider a family of algebras unifying k-Minkowski spacetime and Poincare algebra. Hopf algebra of Poincare algebra is presented in unified and covariant form. Realizations and star product are analyzed in general. Left-right dual realizations and dual algebra are introduced and considered. Hermitian realization and corresponding star product are presented. The correspondence between the involution and inner product is analyzed. Integral identities are presented. Finally, translation invariance of star product is pointed out.

J. Kowalski-Glikman Curved momentum space and relative locality

Abstract:
There are indications that there might exist a limit of (quantum) gravity coupled to matter, in which local degrees of freedom of the gravitational field are switched off and spacetime is locally flat, while the momentum space of matter degrees of freedom becomes curved. In my talk I will discuss the construction of a theory of interacting particles with curved momentum space. It turns out that for such models absolute locality is replaced in the controllable manner with locality relative to an observer.

L. Mason The S-matrix from holomorphic Wilson loops in twistor space

Abstract:
Twistors have provided a powerful technique in the study of four-dimensional theories, most recently in the study of scattering amplitudes. In this talk I explain how some of the ideas may be generalized to higher dimensions. In particular I will discuss how the Penrose transform works in relation to momentum eigenstates and give some higher dimensional twistor formulae for amplitudes.

G. Pogosyan The Kepler-Coulomb problem on 3D hyperboloids

Abstract:
In this note we discuss the Kepler-Coulomb problem on the two spaces with constant negative curvature one-sheeted and SO(2,2) hyperboloids. The work done with D. Petrosyan

Z. Popowicz N=1 Supersymmetric Liouville equation

M. Rausch de Traubenberg Higher order extensions of the Poincar'e Algebra

Abstract:
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 ZF−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. This structure enables us to define various non-trivial extensions of the Poincar´e algebra. These extensions are study more preciselly in two different contexts. The first algebra we are considering is shown to be an (infinite dimensional) extension of the Poincar´e algebra in (1 + 2)−dimensions and turns out to induce a symmetry which connects relativistics anyons. The second extension we are studing is related to a specific finite dimensional Lie algebras of order F in any space-time dimensions and induces a symmetry on p−forms. We then summarized some of the main results obtained in that context. Finally, we show that one is able to associate a group to these structures.

J. Rembielinski Probability current in the relativistic quantum mechanics

Abstract:
The probablity current for a quantum spinless relativistic particle is introduced in the context of the Hamiltonian approach utilizing the Foldy-Salpeter equation as an alternative of the Klein-Gordon equation. The presented formalism is illustrated by examples of exact solutions to the Foldy-Salpeter equation.

A. Sitarz On the geometry of kappa-Minkowski

K.S. Stelle Supergravity infinities versus counterterms

Abstract:
The control over nonabelian gauge invariances at the quantum level plays a critical role in the study of the ultraviolet divergences both in gauge theories and in theories of gravity. Recent dramatic cancellations of potentially divergent contributions to maximal supergravity require a careful revisit of the applicable nonrenormalization theorems, based on local gauge invariances and on duality symmetries. These imply cancellation of divergences through the 6-loop order, with an intriguing condition applying at 7 loops owing to the vanishing volume of the full superspace.

D. **Sorokin** Hyperparticles, twistors and any spins
Abstract:
We review various ways in which relativistic particles can be endowed with spin degrees of freedom with the use of twistor-like variables and supersymmetrization, which upon

quantization lead either to higher spin fields or anyons (in D=3).

P. Stichel Darkon fluid - a model for the dark sector of the Universe?
Abstract:
We introduce darkons as fluid particles of a Galilean massless self-gravitating fluid. This fluid exhibits anisotropic scaling with z=5/3. The minimal gravitational coupling dynamically generates a gravitational mass density of either sign. Hence such fluid may serve as a model for the dark sector of the Universe. Its cosmological solutions give a deceleration phase for the early Universe and an acceleration phase for the late Universe. Will the steady flow solutions lead to a confining potential and so a possible model for halos?

M. Szczachor Supersymmetric Holst action with matter coupling
Abstract:
We will discuss supersymmetric generalization of Holst action of gravity and its coupling to N=1 matter. Based on this we will deduce the form of supergravity with Holst action for higher N. We will argue that when the connection field equation holds the Holst term does not contribute to action and equations remaining field equations.

V.N. Tolstoy Alternative relativistic supersymmetries

J. Trampetic Photon-neutrino interaction in theta-exact covariant NCGFT: Phenomenology & Quantum properties

Abstract:
Photon-neutrino interactions arise quite naturally in noncommutative field theories. Such couplings are absent in ordinary field theory and imply experimental lower bounds on the energy scale theta ~ 1/Lambda^2_NC of noncommutativity. Using non-perturbative methods and a Seiberg-Witten map based covariant approach to noncommutative gauge theory, we obtain theta-exact expressions for the interactions, thereby eliminating previous restrictions to low-energy phenomena. We discuss implications for plasmon decay, neutrino charge radii, big bang nucleosynthesis and ultrahigh energy cosmic rays. Our results behave reasonably throughout all interaction energy scales, thus facilitating further phenomenological applications. Finally we discus Quantum propertis of our model, i.e. neutrino self-energy, and model independent connection of NCGFT to Holography with respect to UV/IR mixing in terms of IR/NC/Pl/UV cutoffs.

W.J. Zakrzewski Quasi-integrability of some field theories

A. Zheltukhin On non-linearity of p-brane dynamics

Abstract:
Relativistic membranes and p-branes in higher dimensional space-time are fundamental objects of string theory, and their macroscopic physics is explained by eective elastic forces, like QCD tubes in string theory. However, quantization of branes is blocked up by non-linearity of their equations. Solution of this problem implies investigation of relativistic elastic forces generated by membranes and p-branes. The behavior of the forces, encoded in non-linear equations of p-branes, is studied here considering a class of closed p-branes in D = 2p+1-dimensional Minkowski space. A new U(1)U(1): : :U(1) invariant anzats for the solution of p-brane equations is construced.
In particular, this class includes membranes (p = 2) in D = 5 and 5-branes (p = 5) in D = 11 spaces. As a result, the p-brane dynamics is reduced to the non-linear equations of p-dimensional anharmonic oscillator with their solutions expressed in terms of (hyper)elliptic

functions.