XXXIII Max Born Symposium

Noncommutative geometry, quantum symmetries and quantum gravity

Wroclaw, 6-10 July 2014

List of talks with abstracts

Giovanni Amelino-Camelia (Rome) Curved momentum spaces and quantum-gravity phenomenology

Abstract. I illustrate recent progress in the understanding of theories with Planck-scale-curved momentum space, focusing on cases where momentum space has de Sitter geometry. Of particular interest is to compare the relativistic properties of the case with Levi-Civita connection on momentum space and the case with the so-called kappa-Poincaré connection on momentum space. I also show that the geometry of momentum space provides a valuable tool for analyzing possible phenomenological implications, including dual redshift and dual gravity lensing, and observe that Planck-scale sensitivity for such experimental studies is within reach.

Michele Arzano (Rome) Purity is not eternal at the Planck scale

Abstract. Curved momentum space realized in terms of a Lie group manifold provides the main prototype for modelling relativistic symmetry deformation at the Planck scale. Under a generalization of the ordinary Fourier transform a field theory on momentum group manifold exhibits a "dual" representation in terms of a non-commutative field theory. The appeal of these models is that they naturally emerge in the description of a gravitating point particle in three dimensional gravity and in four dimensions they can lead to testable predictions, mainly based on their deformed energy-momentum dispersion relations. In this talk I will briefly review the basic notions of group momentum space in terms of non-local symmetry generators and how they emerge in the context of three-dimensional gravity. After introducing the kappa-Poincaré algebra as a four dimensional analogue of such model, I will discuss how the non-trivial integration measure on momentum space and deformed dispersion relation are related to the phenomenon of running dimensions and they can realize a scale-invariant spectrum of quantum fluctuations in the early universe. Finally I will introduce a new physical interpretation of the deformed action of time translation generators on operators which characterizes these models. I will show how such action leads to a Lindblad-like evolution equation for density matrices when expanded at leading order in the Planckian deformation parameter. This evolution equation allows pure states to evolve into mixed states. This observation has potential applications for the black hole information paradox and can open new phenomenological windows for Planck scale physics.

Paolo Aschieri (Alessandria) Deformation quantization of principal bundles

Abstract. Drinfeld twisting procedure leads to noncommutative (*-product) deformations of the algebra of functions of a usual manifold. First I briefly recall how this procedure can be extended to deform the differential and Riemannian geometry of the manifold, including diffeomorphisms and connections not necessarily equivariant under the Hopf algebra of the twist. Then I present how similar techniques allow to canonically deform principal G-bundles (and in general how Hopf-Galois extensions are canonically deformed to new Hopf-Galois extensions). Both the structure group and the base manifold can be rendered noncommutative, thus some examples studied in the literature are recovered by applying this general theory.

Edwin J. Beggs (Swansea) Semiquantisation functor and Poisson-Riemannian geometry

Abstract. I will begin with some remarks on noncommutative geometry in Physics. Next I will consider the first order deformation of a Riemannian manifold, including the vector bundles, differential calculus and metric. One example will be the Schwarzschild solution, which illustrates that not all the properties of the classical case can be simply carried into the quantum case. The other example is quantising the Kahler manifold, complex projective space. This case is much simpler, and here the complex geometry is also preserved. I will end with some comments on the connection between noncommutative complex geometry and noncommutative algebraic geometry.

Norbert Bodendorfer (Warsaw) The Verlinde formula and higher-dimensional black hole entropy

Abstract. Recent progress in computing black hole entropy from loop quantum gravity in higher dimensions will be reviewed. As a central result, it will be explained that the dimension of the horizon Hilbert space is computed by the Verlinde formula, independently of the number of spacetime dimensions. Counting strategies employed in 3+1 dimensions, where the Verlinde formula emerges from an SU(2) Chern-Simons theory on the horizon, are thus universally applicable.

Joseph Buchbinder (Tomsk) Towards harmonic superfield formulation of N=4, Usp(4) supersymmetric Yang-Mills theory

Abstract. We develop a superfield formulation of N=4 supersymmetric Yang-Mills theory with the rigid central charge in USp(4) harmonic superspace. The component formulation of this theory was given by Sohnius, Stelle and West in 1980, but its superfield formulation is not constructed so far. We construct the superfield action, corresponding to this model, and show that it reproduces the known component.

Francesco Cianfrani (Wrocław) Generally covariant Lagrangian formulation of relative locality

Abstract. I will present a formulation of Relative Locality in curved spacetime and momentum space with manifest General Covariance. Within this scheme free particles move on spacetime geodesics and momentum dependent translations are replaced with momentum dependent geodesic deviations.

Gaetano Fiore (Naples) On covariance of QFT on Moyal spaces under finite deformed Poincaré transformations, and quantum reference frames

Abstract. We point out why "finite" space-time transformations on a quantum group covariant non-commutative space are to be described using the coaction of the (deformed) Hopf algebra H of functions on the group G, rather than the action of the Hopf algebra H' deformation of the UEA of Lie(G), dual to H. The noncommutativity of H, i.e. of the parameters of a change of reference frames, hints at the quantum nature of the latter. Using H we then propose, at least at the formal level, a formulation of "twisted" Poincaré covariance of quantum field theory on Groenewold-Moyal-Weyl noncommutative spaces, as developed in previous works, and explore its consequences. A distinction between active and passive transformations is also proposed.

Klaus Fredenhagen (Hamburg) A generally covariant approach to perturbative quantum gravity

Abstract. The perturbative approach to quantum gravity is reconsidered, from the point of view of generally covariant local quantum field theory. Following older ideas of Nakanishi and De Witt, it is shown that a consistent perturbative treatment is possible. Crucial is the tretament of coordinates as dynamical quantum fields. In view of non-renormalizability the theory has to be interpreted as an effective theory.

Khrystyna Gnatenko (Lviv) Hydrogen atom spectrum in rotationally invariant noncommutative space

Abstract. We propose the generalization of the parameter of noncommutativity which gives the possibility to preserve the rotational symmetry in three-dimensional noncommutative space. The noncommutative algebra which is rotationally invariant is constructed. The hydrogen atom is considered in the rotationally invariant noncommutative space. We find the corrections to the energy levels of this atom up to the second order in parameter of noncommutativity.

Andrzej Goerlich (Cracow) Geometry of the universe in CDT

Abstract. Causal Dynamical Triangulations (CDT) introduce a regularization of quantum gravity.
In this framework, a quantum universe with the global shape of a Euclidean de Sitter spacetime emerges as dynamically generated background geometry. We investigate the microscopic and macroscopic properties of the geometry of this universe, using geodesic shell decompositions of spacetime. We focus on evidence of fractality and global anisotropy.

Thupil R. Govindarajan (Chennai) Noncommutative geometry and manifolds with boundary – fuzzy disc revisited

Abstract. Quantum Physics on manifolds with boundary exhibits novel features. These arise due to a variety of boundary conditions that will satisfy the requirement of self adjoint Hamiltonian. We study Laplace Beltrami operator on such manifolds and exhibit `edge states'. When fuzzy geometry with `boundary' is considered whose commutative limit leads to such manifolds one gets only Dirichlet conditions. We revisit the fuzzy geometry with boundary to enlarge the set of boundary conditions. We point out new features in quantum field theories on these fuzzy geometries.

Giulia Gubitosi Finsler geometry with kappa-Poincaré symmetries
(Rome)

Abstract. Finsler geometry provides a well-studied generalization of Riemannian geometry which allows to account for non trivial properties of the space of configurations of a massive relativistic particle. I show that within Finsler geometry it is possible to introduce deformations of the special relativistic mass shell compatible with kappa-Poincaré group symmetries and I discuss whether the Finsler geometry so obtained gives a description of the physical properties of a relativistic particle which is equivalent to the one emerging from the quantum group approach.

Dimitri Gurevich Noncommutative geometry on enveloping algebras and its applications to physics
(Valenciennes)

Abstract. The central problem of Noncommutative Geometry is constructing differential calculus on a given noncommutative algebra. Some known approaches to this problem will be mentioned in my talk. Also, I shall exhibit a new approach to constructing such a calculus on the enveloping algebras of Lie algebras gl(n) and their super-analogs. This approach is based on a new form of the Leibniz rule. As a result, the corresponding differential algebra can be treated as a quantization (deformation) of its commutative counterpart, namely, the differential algebra on the symmetric algebra of a given Lie algebra gl(n). The role of braided algebras (i.e., those related to the corresponding quantum groups) in constructing this calculus will be exhibited. Applications to quantization of some dynamical models by means of so-called "quantum spherical coordinates" will be also exhibited.

Evgenij Ivanov Deforming N=4 supersymmetric quantum mechanics
(Dubna)

Abstract. We present new models of N=4 supersymmetric mechanics based on the worldline superspace realizations of the superalgebra su(2|1) and its central extension, following recent works with S. Sidorov (1307.7690, 1312.6821 [hep-th]).

Igor Kanatchikov On precanonical quantization of gravity
(Gdańsk)

Peter Lavrov A systematic study of finite BRST-BFV transformations in generalized Hamiltonian formalism
(Tomsk)

Abstract. We study systematically finite BRST-BFV transformations in generalized Hamiltonian formalism. We present explicitly their Jacobians and the form of a solution to the compensation equation determining the functional field dependence of finite fermionic parameters, necessary to generate arbitrary finite change of gauge-fixing functions in the path integral.

Jerzy Lewandowski The issues and advances in LQG
(Warsaw)

Shahn Majid Emergence of Riemannian geometry out of the Leibniz rule for quantum spacetime
(London)

Abstract. We overview a new mechanism whereby classical Riemannian geometry emerges out of the differential structure on quantum spacetime, as extension data for the classical algebra of differential forms. Outcomes for physics include a new formula for the standard Levi-Civita connection, a new point of view of the cosmological constant as a very small mass for the graviton of around 10^{−33}ev, and a weakening of metric-compatibility in the presence of torsion. The same mechanism also provides a new construction for quantum bimodule connections on quantum spacetimes and a new approach to the quantum Ricci tensor.

Jakub Mielczarek Loop deformations of space-time symmetries and their consequences
(Cracow)

Abstract. In the Hamiltonian formulation of general relativity, general covariance is encoded in the hypersurface deformation algebra of constraints, which reduces to the Poincaré algebra in the limit of linear deformations of the hypersurace. While quantum deformations of the Poincaré algebra are a subject of intense investigations, until recently there was only very limited interest in studying quantum deformations of the more general objects, hypersurface deformation algebras. In recent years, deformations of this form have emerged from analysis of several effective models of loop quantum gravity. In the cosmological context, it has been shown that some of the quantum deformations lead to Euclideanization of spacetime at the Planck epoch and a BKL-type ultralocality. Furthermore, with use of the loop-deformed hypersurface deformation algebras, symmetries of the corresponding flat quantum spacetimes can be studied. Based on the derived loop-deformed Poincaré algebras, analysis of modified dispersion relations as well as multi-particle states can be performed. In combination with the effects in cosmology, this allows to impose observational constrains on the underlying Planck scale physics.

Pedro Naranjo (Burgos) From (A)dS to Galilean (2+1)-gravity: Drinfel'd doubles and non-commutative space-times

Abstract. It is shown that the Drinfel'd double structure underlying the 'exotic' (2+1) Galilean and Newton-Hooke Lie algebras (with either zero or non-zero cosmological constant ω, respectively) originates as a well-defined non-relativistic contraction of a one-parameter family AdSω of relativistic Lie algebras. The underlying non-commutative space-times, along with the corresponding full quantum group structure, are analysed. [Joint work with A. Ballesteros and F.J. Herranz.]

Anatol Nowicki (Zielona Gora) On relation between deformed Heisenberg algebra and finite dimensional Lie algebras

Abstract. The relation between nonlinear algebras and linear ones is discussed. For one-dimensional nonlinear deformed Heisenberg algebra with two operators we find the function of deformation for which this nonlinear algebra can be transformed to a linear one. We consider two cases: (1) the linear algebra realized as three dimensional Lie algebra iso(1,1) or iso(2), and (2) the linear algebra realized as four dimensional Lie algebra (Heisenberg algebra extended by the affine algebra on the real line).

Daniele Oriti (Golm) Non-commutative tools in loop quantum gravity, spin foam models and group field theory

Abstract. We present recent results on the so-called non-commutative Fourier transform for quantum systems with Lie groups as configuration space and on the associated algebra representation. We highlight its dependence on quantisation maps, and we show the non-commutative plane waves corresponding to a few of them (in particular, the Duflo map). Next, we review the application of these tools to: 1) the definition of a non-commutative flux representation for loop quantum gravity, spin foam models and group field theories; 2) the study of the asymptotic semi-classical limit of spin foam models; 3) the construction of models for 4d quantum gravity.

Prince Osei (Ghana) Semiduality and family of compatible r-matrices for 3d gravity

Abstract. The combinatorial quantisation approach to 3d gravity requires the existence of a classical r-matrix which is compatible with the classical theory, in a suitable way. However, the compatible requirement does not uniquely specify the r-matrix, leading to an apparent ambiguity in the quantisation. In this talk I will use the concept of semiduality to obtain and classify the family of compatible r-matrices, which are the classical limits of universal quantum R-matrices associated to certain quantum groups.

Anna Pachoł (Iceland) Unified view on κ-deformation

Abstract. I will provide universal formulas describing Drinfeld-type quantization of inhomogeneous orthogonal groups determined by a metric tensor of an arbitrary signature living in a spacetime of arbitrary dimension. The metric tensor does not need to be in diagonal form and κ-deformed coproducts are presented in terms of classical generators. It opens the possibility for future applications in deformed general relativity. The formulas depend on the choice of an additional vector field which parametrizes classical *r* -matrices. Non-equivalent deformations are then labeled by the corresponding type of stability subgroups. For the Lorentzian signature it covers three (non-equivalent) Hopf-algebraic deformations: time-like, space-like (a.k.a. tachyonic) and light-like (a.k.a. light-cone) quantizations of the Poincaré algebra.

Krzysztof Pilch (Los Angeles) (0,2) SCFTs from the Leigh-Strassler fixed point

Abstract. We show that there is a family of two-dimensional (0,2) SCFTs associated with twisted compactifications of the four-dimensional N=1 Leigh-Strassler fixed point on a closed hyperbolic Riemann surface. We calculate the central charges for this class of theories using anomalies and c-extremization. In a suitable truncation of the five-dimensional maximal supergravity, we construct supersymmetric AdS3 solutions that are holographic duals of those two-dimensional (0,2) SCFTs. We also exhibit supersymmetric domain wall solutions that are holographically dual to the RG flows between the four-dimensional and two-dimensional theories. arXiv:1403.7131

Valentina Giangreco M. Puletti (Iceland) Hidden symmetries in gauge/gravity dualities

Abstract. The holographic principle is rigorously realized in String Theory by the so-called AdS/CFT, or gauge/gravity, duality. A key feature of the correspondence is that the gauge and string theory perturbative regimes do not overlap. This makes the correspondence on one side rather difficult to be proven, but on the other hand extremely powerful. The discovery of two-dimensional hidden symmetries, i.e. the presence of underlying integrable structures, on both sides of AdS/CFT has allowed us to reach immense progresses in understanding and confirming the duality. A natural question is whether we can extend such intricate and beautiful mathematical structures to less (super)symmetric examples of gauge/gravity duality and to observables which are fully un-protected by (super)symmetries. I will start by reviewing the main concepts of integrability in the AdS/CFT context. Then, I will discuss recent works which focus on the spectral analysis of the string world-sheet theory in AdS backgrounds, and on extending these symmetries to Wilson loop operators.

Giacomo Rosati Covariant quantum mechanics formulation of κ-Minkowski/κ-Poincaré
(Wrocław)

Abstract. I present a description of κ-Minkowski noncommutative spacetime, κ-Poincaré (Hopf-algebra) symmetry generators and relativistic-transformation parameters on a single Hilbert space. The relevant operators act on the kinematical Hilbert space of the covariant formulation of quantum mechanics, in which both time and space coordinates are quantum operators. The observable features are coded in the physical Hilbert space, obtained by enforcing the on-shellness constraint. Introducing a suitable localization operator, one can characterize "spacetime fuzziness" for particles propagating in this framework. It turns out that κ-Minkowski, also at a quantum level, presents relativity of locality, which takes the shape, in the physical Hilbert space, of a dependence of the fuzziness on the particle's energy and propagation distance.

Mykola Samar Relativistic particle dynamics and deformed Poincaré symmetry
(Lviv)

Abstract. We study the quantized spacetime Lorentz-covariant algebra proposed in [1]. This algebra contains that of Snyder as a partial case. We present the action of a relativistic particle invariant under the deformed Poincaré symmetry corresponding to the chosen algebra. It is shown that the Dirac constraint analysis of the model yields the classical version of the algebra. We also discuss algebraic transformations mapping the deformed symmetries with the undeformed ones. In the case of the considered algebra leading to Snyder's one, our results coincide with those obtained in [3].

[1] C. Quesne and V.M. Tkachuk, J. Phys. A 39 (2006) 10909
[2] H.S. Snyder, Phys. Rev. 71 (1947) 38
[3] R. Banerjee et. al., JHEP 05 (2006) 077

Andjelo Samsarov Entanglement entropy for the noncommutative BTZ
(Zagreb)

Abstract. The entanglement entropy is a fundamental quantity which characterizes the correlations between sub-systems in a larger quantum-mechanical system. For two sub-systems separated by a surface the entanglement entropy is proportional to the area of the surface and depends on the UV cutoff which regulates the short-distance correlations. This naturally poses a question as to whether the entanglement entropy can account for the black hole entropy. In this talk the entanglement entropy for the noncommutative BTZ (NC BTZ) black hole shall be presented and it will be confronted with other results for the entropy of NC BTZ obtained by different approaches, particularly of that of the 't Hooft's brick wall model.

Bernd Schroers Deformed Poincaré symmetry, Fourier transformations and wave equations in 2+1 dimensions
(Edinburgh)

Abstract. Lorentz-covariant wave equations like the Proca, Dirac or Klein-Gordon equation can be obtained from the Mackey-Wigner formulation of irreducible representations of the Poincaré group via Fourier transformation. In this talk I will discuss how this picture changes when one deforms the Poincaré symmetry to the quantum double of the Lorentz group in 2+1 dimensions. This deformation arises in 2+1 dimensional quantum gravity, but the focus on this talk will be on various possible notions of Fourier transforms in this context and on the resulting wave equations in non-commutative spacetimes.

Artur Sergyeyev A broad new class of integrable 4D systems related to contact geometry
(Opava)

Abstract. We introduce a broad new class of dispersionless integrable systems in four independent variables having Lax pairs written in terms of contact vector fields. Our results show inter alia that integrable systems in four dimensions are considerably less exceptional than it was believed. In particular, we present a new 4D dispersionless integrable system with an arbitrarily large finite number of components. In the simplest special case this system yields a four-dimensional integrable generalization of the (2+1)-dimensional dispersionless Kadomtsev—Petviashvili equation.

Roman Sverdlov Caianello based causal set theory
(California)

Abstract. Causal set, proposed by Rafael Sorkin, is a model of spacetime as a partially ordered set whose elements are identified with spacetime events, and partial ordering is identified with causal relation. One of the fundamental problems of causal set theory is that it seems impossible to meet three conditions at the same time: relativistic covariance, discreteness, and locality. After all, if specetime is discrete with discreteness scale d, then relativistic covariance implies that the neighborhood of any point can be found anywhere within d-neighborhood of light cone, which, in turn, is non-local. I propose to resolve this

problem in the following way: instead of viewing an element of causal set as a point in spacetime, I will view it as an element of "phase-space-time". In other words, it will have both spacetime location as well as velocity. Thus, velocity will set up "preferred frame" in which I will "cut off" the lightcone, thus restoring locality. In particular, two points can only be within a "neighborhood" of each other if they move with almost the same velocity and their coordinate displacements from each other in each of their reference frames is small. It can be argued that what I just said does not violate relativity: after all, the definition of a neighborhood based on its position does not violate translational invariance; thus, by analogy, the definition of neighborhood based on velocity should not be said to violate Lorentz covariance either.

Valery N. Tolstoy
(Moscow)
Relativistic supersymmetries with double geometry

Abstract.

Francesco Toppan
(Rio de Janeiro)
Snyder non-commutativity from Jordanian twist

Abstract. I review the framework of the "Unfolded Quantization" in application to Drinfeld twist-deformations of non-relativistic quantum mechanical systems. Several examples of abelian twist (leading to constant non-commutativity) will be discussed, as well as the case of the Jordanian twist, leading to a Snyder-type non commutativity for the space coordinates. In the Jordan-Snyder case the deformed Hamiltonian is pseudo-hermitian. The non-additive effects (encoded in the coproduct) of deformed multi-particle Hamiltonians are computed and discussed.

Tomasz Trzesniewski
(Wrocław)
Euclidean κ-Minkowski and the spectral dimension

Abstract. κ-Minkowski spacetime is characterized by the non-commutativity between time and spatial positions. Meanwhile, its momentum space lives on the group AN(n). The latter, in a certain sense, can be represented as (half of) the de Sitter space. A novel pre-scription for the Euclideanization of the momentum space shows that it can also be represented as (half of) the Euclidean anti-de Sitter space. This provides a curious link between the two realizations of the group momentum space. At the same time, this allows us to study the effective dimensionality of spacetime by means of the spectral dimension (which was partially explored before). Results of the corresponding calculations for three Laplacians in the (Euclidean) momentum space will be presented. This can also give us a hint for the choice of a physical Laplacian among the different proposed ones.

Stanislaw L. Woronowicz
(Warsaw)
Quantum symmetries and description of composed systems

Abstract.

List of posters

Javier Chagoya
(Guanajuato/Portsmouth)
On 2+1 gravity, topological M-theory and the Immirzi parameter

Abstract. It is known that the equations of motion for 2+1 gravity can be obtained from topological M-theory. It is also well known that such equations can be derived from either one of two classically equivalent 2+1 Chern-Simons actions, namely the standard and exotic actions. In this work we show explicitly the two equivalent decompositions for the seven dimensional manifold of topological M-theory giving rise to these actions. We also show how the Immirzi parameter of a particular 3+1 gravitational theory can appear, after dimensional reduction, as a coefficient in a linear combination of the standard and exotic actions; this in turn provides an interpretation for the Immirzi parameter in terms of the volume of the manifold for the topological M-theory.

Danijel Pikutić
(Zagreb)
Light-like kappa-Poincaré/conformal Hopf algebra and covariant Drinfeld twist

Abstract. Starting with light-like κ-Poincaré Hopf algebra in classical basis the covariant Drinfeld twist is constructed. It is proved that cocycle condition is satisified. When applied to undeformed Hopf algebra, this twist reproduces the starting κ-Poincaré Hopf algebra. We have also applied this twist to undeformed conformal Hopf algebra and obtained light-like κ-deformed conformal Hopf algebra. The κ-Minkowski generators are also constructed using this twist and the dual generators are constructed from the opposite twist.

The list of registered participants:

1. Emanuele Alesci (Warszawa)
2. Giovanni Amelino-Camelia (Rome)
3. Michele Arzano (Rome)
4. Paolo Aschieri (Alessandria)
5. Edwin J. Beggs (Swansea)
6. Jakub Bilski (Wroclaw)
7. Norbert Bodendorfer (Warsaw)
8. Andrzej Borowiec (Wroclaw)
9. Joseph Buchbinder (Tomsk)
10. Francesco Cianfrani (Wroclaw)
11. Javier Chagoya (Guanajuato/Portsmouth)
12. Gaetano Fiore (Naples)
13. Marco Finocchiaro (Potsdam/Golm)
14. Klaus Fredenhagen (Hamburg)
15. Andrzej Frydryszak (Wroclaw)
16. Andrzej Goerlich (Krakow)
17. T R Govindarajan (Chennai)
18. Khrystyna Gnatenko (Lviv)
19. Giulia Gubitosi (Rome)
20. Dimitri Gurevich (Valenciennes)
21. Philipp Haehnel (Dublin)
22. Sergio Inglima (Edinburgh)
23. Evgenij Ivanov (Dubna)
24. Igor Kanatchikov (Gdansk)
25. Jerzy Kowalski-Glikman (Wroclaw)
26. Jerzy Lewandowski (Warsaw)
27. Peter Lavrov (Tomsk)
28. Jerzy Lukierski (Wroclaw)
29. Anatol Nowicki (Zielona Gora)
30. Shahn Majid (London)
31. Jakub Mielczarek (Krakow)
32. Jesus Alberto Cazares Montes (Zagreb)
33. Pedro Naranjo (Burgos)
34. Daniele Oriti (Potsdam/Golm)
35. Prince Osei (Ghana)
36. Anna Pachol (Wroclaw)
37. Danijel Pikutic (Zagreb)
38. Krzysztof Pilch (California)
39. Ziemowit Popowicz (Wroclaw)
40. Valentina Giangreco M. Puletti (Iceland)
41. Giacomo Rosati (Wroclaw)
42. Mykola Samar (Lviv)
43. Andjelo Samsarov (Zagreb)
44. Bernd Schroers (Edinburgh)
45. Artur Sergeyev (Opava)
46. Rina Strajn (Cagliari)
47. Roman Sverdlov (California)
48. Valery N. Tolstoy (Moscow)
49. Francesco Toppan (Rio de Janeiro)
50. Tomasz Trzesniewski (Wroclaw)
51. Aneta Wojnar (Wroclaw)
52. Stanislaw L. Woronowicz (Warsaw)
53. Mauricio Valenzuela (Valdivia)