SYMPHYS–9

IX International Conference on

Symmetry Methods in Physics

Yerevan, Armenia 2001

Joint Institute for Nuclear Research & Yerevan State University

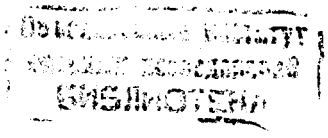
IX INTERNATIONAL

CONFERENCE ON

SYMMETRY METHODS IN PHYSICS

The Conference takes place in the year of celebration of the 1700-th anniversary of adoption of Christianity in Armenia

Yerevan, Armenia, July 3 - 8, 2001



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GENERAL INFORMATION

Location

The Conference will be held at the *Physics Department of Yerevan State University* from July 3 to July 8, 2001.

The Conference opens on July 3 at 10.00 in the Conference Hall of the Physics Department of Yerevan State University.

Proceedings

All contributions will be reviewed but only a limited number will be selected for the Proceedings. The deadline for submission of talks is October 31, 2001 however, to assure swift publication, we encourage the participants to submit their manuscripts already during the conference. For any information concerning publication please contact by

e-mail: symphys9@icas.ysu.ar

Submitted materials must be in English. Please use LaTeX format 12pt, 150x220mm. Size restrictions: for 45 min. and 30 min. talks - 15 and - 12 pages, for 20 min. contributions - 10 pages, for poster session - 6 pages.

Special Events

- **Monday, July 3**
  Welcome Party will be held in Yerevan State University (20:00 - 22:30). (For accompanying persons 10 US$)
- **Wednesday, July 4**
  Trip to Sevan lake with barbecue. (For accompanying persons 25 US$)
- **Saturday, July 7**
  The Conference Banquet (20:00-23:00). (For accompanying persons 20 US$).

Accompanying Program

- **Tuesday, July 3**:
  A tour round the town, a visit of the museum of ancient manuscripts. The price is 10$US.
- **Thursday, July 5** :
  A tour to Etchmiadzin, Picture Gallery. The price is 10 US$.
- **Friday, July 6**:
  A tour to Garni and Gegard. The price is 15 US$.

Transportation to the Airport

In Yerevan airport "Zvartnoz" all participants will be met by the representatives of the Organizing Committee carrying the label **SYMPHYS-9**.

From the airport there is also a regular bus service (bus N 107) to the University Hostel or metro "Yeritasardakan".

The Organizing Committee can be contacted from the airport by telephone 570-370.

ABSTRACTS

Invited Talks

Applications of Classical and Quantum Algebras to Molecular Thermodynamics

M. Angelova

School of Computing and Mathematics, University of Northumbria, Newcastle upon Tyne, England, GB-NE1 8ST

Lie-algebraic and quantum-algebraic techniques are used in the analysis of thermodynamic properties of molecules and solids. The local anharmonic effects are described by a Morse-like potential associated with the $SU(2)$ algebra. A vibrational high-temperature partition function and the related thermodynamic potentials are derived in terms of the parameters of the model. Symmetry-adapted wave functions, related to the local symmetry of the atoms, are used to analyze vibrational energies in molecules and crystals. Quantum analogues of anharmonic bosons, q-bosons, are introduced and used to describe anharmonic and superfluid properies of molecules and solids. A new algebraic realization of the q-bosons, for the case of q being a root of unity is given. This realization represents the symmetry of a linear lattice with periodic boundary conditions.

Quantum Conformal Equations and Their Solutions

V. Dobrev

Bulgarian Academy of Sciences (Sofia, Bulgaria) and University of Northumbria (Newcastle, UK)

We consider hierarchies of q-deformed equations which are quantum conformal invariant. We construct explicit solutions of these equations. The solutions are given in terms of two new q-deformations of the plane wave written in conjugated bases. We consider in more detail the solutions of the quantum conformal deformations of the Maxwell and potential equations. Compatibility of the equations leads to an asymmetry between the q-deformations of the fixed helicity constituents of the Maxwell field. This asymmetry and possible alternatives are discussed.

Novel Applications of Group Theory in Nuclear Physics

J. Draayer, A. Georgieva [3], *K. Sviracheva* [1], *Feng Pan* [2]

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[2] *Department of Physics, Liaoning Normal University, Dalian 116029, P. R. China*

[3] *Institute of Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, Sofia 1784, Bulgaria*

While large-scale shell-model calculations may prove useful for reproducing experimental data, insight into the physical underpinnings of many-body quantum phenomena, such as the structure of atomic nuclei, requires a deeper understanding of the underlying principles that can only be achieved through a study of the symmetry or near-symmetry properties of a system. We will review some standard as well as novel algebraic methods, including use of the Bethe ansatz and quantum groups, that have been used to explore special features of atomic nuclei: pairing correlations, quadrupole collectivity, scissors modes, etc. In each case the underlying physics will be linked to a symmetry of the system and its group theoretical representation.

Superintegrability for Curved Spaces in Two Dimensions.

E. Kalnins [2], *J. Kress* [2] *and P. Winternitz* [1]

[1] *CRM, Universite de Montreal, C.P.6128, Montreal, Quebec, Canada*

[2] *Mathematics department, University of Waikato, Hamilton, New Zealand.*

Building on already known completeness results [1] about quadratic superintegrability for constant curvature spaces in two dimensions we indicate how it is possible to make a complete discussion of the superintegrability property for general curved spaces in two dimensions.This is done by making use of a note given in Volume 4 of Darboux's treatise on the theory of surfaces written by G.M.Koenigs.From this note we are able to start to make a comprehensive account of Superintegrability in two dimensions and indicate the mechanism by which this is achieved.

[1] E.G.Kalnins, J.M.Kress, G.S.Pogosyan, W.Miller Jr., Completeness of superintegrability in two-dimensional constant-curvature spaces, J. Phys. A: Math. Gen. 34(2001), 1-16.

Invariant Variational Principles and Moving Frames

P. J. Olver

School of Mathematics, University of Minnesota, Minneapolis, MN, USA 55455

It has been known, since Lie, that any group-invariant variational problem can be expressed in terms of differential invariants. A similar result holds for the Euler-Lagrange equations. However, until now, except in a handful of particular cases, the general formula that enables one to go directly from the differential invariant form of the variational problem to that of its Euler-Lagrange equations has remained elusive. In this talk I will outline a complete solution to this problem, based on the new equivariant theory of moving frames. Additional applications to the classification of differential invariants, invariant differential operators, and their syzygies (identities) will be presented during the talk.

Superintegrability, Multiseparability and Exact Solvability in Quantum Mechanics.

P. Winternitz

CRM, Universite de Montreal, C.P.6128, Montreal, Quebec, Canada

Superintegrable systems are defined by the fact that they allow more integrals of motion than degrees of freedom. Exactly solvable systems are defined by the fact that their energy spectrum can be calculated algebraicly. Multiseparable systems allow the separation of variables in more than one coordinate system. We show that that at least in two dimensional Euclidean space all known superintegrable systems are also exactly solvable. The reason is that after an appropriate gauge transformation the corresponding Hamiltonians lie in the enveloping algebra of a parabolic subalgebra of $sl(3,R)$.

1. Integrable and Superintegrable Systems (ISS)

Algebraic Structures Associated to Nambu Dynamics

S. Codriansky

Departamento de Matemáticas y Física, Instituto Pedagógico de Caracas, Av Paez, Caracas, Venezuela

The role played by Grassmann and Clifford algebras in the description of the Nambu dynamical system is explored. Phase space has dimension 3N, the dynamical system is considered to be described by N triplets; functions over phase space are elements of the Clifford algebra with coefficients that are functions over R^{3N}. The algebra within a particular triplet is the ordinary exterior algebra while the algebra of triplets is the Clifford one.

On the Inintegrable Mass Deformed Calogero-Moser-Sutherland Type Hamiltonians

A. Khvedelidze, D. Mladenov

Joint Institute for Nuclear Research, Dubna, Russia

The geodesic motion on the $GL^+(n,R)$ group manifold endowed with the bi-invariant metric is studied using the polar decomposition of group elements. Owing to the action of $SO(n,R)$ isometry group the quotient space $GL^+(n,R)/SO(n,R)$ is stratified manifold and this geometric peculiarity leads to the dynamical consequences. It is shown that in the case of the *Principal orbit* stratum the dynamics is governed by the generalized Calogero-Moser-Sutherland Hamiltonian with two internal "spin" variables, while for the *Singular orbit* the derived Hamiltonian describes certain integrable deformation of the Calogero-Moser-Sutherland type model, when particles have a non-equal masses. The deformation parameters (ratios of masses) are not arbitrary, they depend on the isotropy group of a given singular stratum and are characterized by the partition of the $GL(n,R)$ group dimension.

2. Contractions of Lie Groups and Quantum Groups (CLGQG)

Contraction of the Finite Oscillator

N.Atakishiev[1], G.Pogosyan[2] and K.B.Wolf

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[2] *JINR, Dubna, 141980, Moscow Reg., Russia*
[3] *Centro de Ciencias Fisicas, Universidad Nacional Autonoma de Mexico*

The finite oscillator model has the dynamical algebra u(2), consisting of position, momentum and mode number, with a finite number of values. We examine the contraction of this model to the ordinary quantum oscillator as the number and density of points increases. This is done on the level of the algebra, of the wavefunctions, and of the fractional Fourier-Kravchuk transform.

Continuum Canonical Transforms as Inductive Limits of Discrete Canonical Transforms

L. Barker

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Phase space: the motion group E(2) is a "contraction" of SO(3). A refinement for configuration space: the $L^2(R)$ representation of the Heisenberg-Weyl motion group EHW(2) (described by the fractional Fourier transform and the Heisenberg-Weyl translates) is an *inductive* (to be explained) limit of finite-dimensional representations of U(2). How might we "discretize" the other affine canonical transforms on $L^2(R)$? How might we "discretize" toroidal configuration spaces? What continuum scenario might be "discretized" by $SL(2, Z/p^n)$? These questions (arising in quantum physics, optics, signal analysis) can be clarified by casting them as questions about inductive limits of representations.

Lie Algebra Contractions and Separation of Variables on n-Sphere. Interbases Expansions

A.Izmest'ev[1], G.Pogosyan[1], A.Sissakian[1], and P.Winternitz[2]

[1] *JINR, Dubna, 141980, Moscow Reg., Russia*
[2] *CRM, Universite de Montreal, C.P.6128, Montreal, Quebec, Canada*

Lie algebra contractions from $o(n+1)$ to $e(n)$ are used to obtain asymptotic limits of interbases expansions between bases corresponding to different subgroup chains for the group $O(n+1)$. The contractions lead to interbases expansions for different subgroup chains of the Euclidean group $E(n)$. They provide asymptotic formulae for quantities such as Wigner rotation matrices, Clebsch-Gordan coefficients and Racah coefficients.

Contractions of Quantum Groups and Quantum Vector Spaces

N. Gromov, I. Kostyakov, V. Kuratov

Syktyvkar Branch of IMM, Syktyvkar, Russia

Contractions of quantum orthogonal groups are studied unlike of Wigner–Inonu in a pure algebraic way with the help of Pimenov algebra $\mathbf{D}(\iota)$. Namely, the groups under consideration are regarded as an algebra of noncommutative functions but with nilpotent commutative generators. Possible contractions are essentially depended on the choice of primitive elements of Hopf algebra structure of quantum orthogonal group. All such choices are considered for quantum group $SO_q(N)$ and all allowed contractions in Cayley–Klein scheme are obtained. The quantum vector spaces corresponding to the appropriate contracted quantum group are described explicitly both in cartesian and symplectic generators. Quantum deformations of 1+3 kinematical spaces and groups are regarded as an illustration of the general theory.

Contractions of Superalgebras Osp(M/2N)

N. Gromov, I. Kostyakov, V. Kuratov

Syktyvkar Branch of IMM, Syktyvkar, Russia

We describe how dual numbers technique can be applied to the study of superalgebra contractions. A wide class of Cayley-Klein superalgebras are obtained by this method.

3. Algebraic Structures Beyond Lie Algebras (ASBLA)

Quantum Motion Algebras

A. Góźdź, M. Miśkiewicz, M. Pietrow

Institute of Physics, University of Maria Curie-Sklodowska, pl. M. Sklodowskiej-Curie 1, 20-031 Lublin, Poland

The notion of the groups of motions as the groups of elementary changes of quantum states leads to the Quantum Motion Algebras consisted of the formal sums and "integrals" of the group elements (A. Góźdź: Quantum Motion and Algebraic Generator Coordinate Method, Symmetries in Science VII, ed. B.Gruber and T.Otsuka, Plenum Press, 1993). These algebras can be considered as a tool for the quantum many-body problems -- especially for the quantum collective motions in the molecular, atomic and nuclear physics. In this sense the formalism is an algebraic generalization of the well known Generator Coordinate Method. In addition, the algebras can be used for constructing of the state spaces for more fundamental physical problems related to principles of quantum mechanics. The last possibility allows to think about some natural modifications of quantum mechanics.

Triality Structure of Exceptional Lie Algebras

Z. Silagadze

Budker Institute of Nuclear Physics, 630 090 Novosibirsk, Russia

Recently Ramond revealed a remarkable group-theoretical structure behind eleven dimensional supergravity multiplet: it was shown that the supergravity triplet of massless fields stems from the three equivalent ways to embed $SO(9)$ into F_4 exceptional Lie algebra. In fact F_4 is just an union of these three different copies of $SO(9)$, their intersection being $SO(8)$, with $SO(8)$ triality and octonions plaing the central role in this construction. We show that the similar simple triality structure holds also for E-type exceptional Lie algebras.

4. Quantum Algebras and Groups, Q-special Functions (QAGQF)

Deformations of the Boson and Fermion Representations of sp(4) and sp(4,R)

J. Draayer [2], M. Ivanov [1], A. Georgieva [1], K. Sviratcheva [2]

[1] *Institute of Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, Sofia 1784, Bulgaria* [2] *Louisiana State University, Department of Physics and Astronomy, Baton Rouge, Louisiana, 70808-4001 USA*

With a view towards future applications in nuclear physics, the boson and fermion realization of the compact sp(4) and noncompact sp(4,R) and their q-deformed versions are investigated and compared. The deformed realizations are based on distinct deformations of the boson and fermion creation and annihilation operators. In the boson case there is a simple transformation of the "classical" bosons to q-deformed ones. In the fermion case an additional index is introduced in order to satisfy the Pauli principle and in this case a simple transformation function between the "classical" and q-deformed operators is not known. Three important reduction chains of these algebras are explored in both the classical and deformed cases.

For the primary reduction, the su(2) sub-structure can be interpreted in both cases as a pseudospin algebra. The other two reductions in the fermion case are su(2) algebras, associated with pairing between identical fermions or coupling of two fermion of different kinds. In the boson case the infinite deformed ladder series $u_q^0(1,1)$ and two infinite deformed discrete series $u_q^{\pm}(1,1)$ are obtained. Each reduction provides for a complete classification of the basis states. In the boson case the initial as well as the deformed representations act in the same Fock space, but the deformation in the fermion case leads to basis states whose content is very different from the classical one. In a Hamiltonian theory this implies a dependance of the matrix elements on the deformation parameter, leading to the possibility of greater flexibility and richer structures within the framework of q-deformed algebraic descriptions

Noncommutative Instantons on the 4-sphere from Quantum Groups

M. Tarlini

I.N.F.N. Sez. Firenze and Dip. of Physics, Univ. of Firenze Italy

We describe an approach to the noncommutative instantons on the 4–sphere based on quantum group

theory. We quantize the Hopf bundle $\mathbf{S}^7 \to \mathbf{S}^4$ making use of the concept of quantum coisotropic subgroups. The analysis of the semiclassical Poisson–Lie structure of $U(4)$ shows that the diagonal $SU(2)$ must be conjugated to be properly quantized. The quantum coisotropic subgroup we obtain is the standard $SU_q(2)$; it determines a new deformation of the 4–sphere Σ^4_q as the algebra of coinvariants in $\mathbf{S}^7_q$. We show that the quantum vector bundle associated to the fundamental corepresentation of $SU_q(2)$ is finitely generated and projective and we compute the explicit projector. We give the unitary representations of Σ^4_q and we study the Chern–Connes pairing of the projector. It comes out that even the zero class in cyclic homology is non trivial.

5. Periodic and Aperiodic Structures (PAS)

Wave Functions for Erods with Periodic Structures

J. Valdes

Centro de Ciencias Fisicas, Universidad Nacional Autonoma de Mexico, Apartado Postal 48-3, 62251

We obtain, both from the theoretical and experimental points of view, the wave functions of longitudinal, bending and torsional modes of elastic rods with an increasing number of obstacles arranged in different ways. The wave functions and their related frequencies are calculated using the transfer matrix method and they are measured experimentally using a new detector based on eddy currents, which is not in contact with the rod. Experimental values agree very well with the theoretical ones.

Aperiodic Pseudorandom Number Generators

J. Patera [1], *J. Patera* [2], *L.-S. Guimond*

[1] *Dept. of Maths, Faculty of Nuclear Science and Physical Engineering, Czech Technical University, Trojanova 13, 120 00, Praha 2, Czech Republic*
[2] *Centre de recherches mathématiques, Université de Montréal, Montréal H3C 3J7, Québec, Canada*

We discuss the use of aperiodic point sets called quasicrystals in designing deterministic aperiodic pseudorandom number generators. The proposed scheme uses quasicrystals to combine two or three periodic number sequences. We prove that there exists an infinite class of quasicrystals for which the combination scheme (using any nontrivial periodic sequences) produces pseudorandom sequences having no lattice structure. We give empirical results when quasicrystals are used to combine linear congruential generators. Finally, we describe the implementation of two methods for generating quasicrystal points and discuss their respective computational complexities.

Recurrence Times in Dynamical Systems via Quasicrystal Techniques

R. Twarock

Department of Mathematics, City University Northampton Square, London EC1V 0HB, England

It is shown that techniques developed in the framework of cut-and-project quasicrystals can be used to derive information about recurrence times for Dynamical systems. Based on this, an alternative proof of results by Florek and Slater as well as Mayer and Lohoefer is deduced. The possibility to derive a generalization of their results to higher dimensions based on the cut-and-project approach is discussed.

6. Quantum Field Theory and Strings (QFTS)

The Diagonal Ghost Equation Ward Identity for Yang-Mills Theories in the Maximal Abelian Gauge

R. Fazio

Dipartimento di Fisica- Statale di Milano

A BRST perturbative analysis of SU(N) Yang-Mills theory in a class of maximal Abelian gauges is presented. We point out the existence of a new non-integrated renormalizable Ward identity which allows to control the dependence of the theory from the diagonal ghosts. This identity, called the diagonal ghost equation, plays a crucial role for the stability of the model under radiative corrections implying, in particular, the vanishing of the anomalous dimension of the diagonal ghosts. Moreover, the Ward identity corresponding to the Abelian Cartan subgroup is easily derived from the diagonal ghost equation. Finally, a simple proof of the fact that the beta function of the gauge coupling can be obtained from the vacuum polarization tensor with diagonal gauge fields as external legs is given. A possible mechanism for the decoupling of the diagonal ghosts at low energy is also suggested.

The Dual Gauge Model Symmetry and a Confinement of Test Charges

G. Kozlov

Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, 141980 Dubna, Russia

We reformulate the dual gauge model of the long-distance Yang-Mills theory in terms of two-point Wightman functions with the equations of motion involving higher derivatives. In the flux-tube scheme of monopole condensation , the analytic expressions of both monopole-and dual gauge boson-fields propagators are obtained. In the system of the test color charges an analytic expression for the string tension is derived.

Casimir Effect on Background of the Rindler Spacetime

R. Avagyan, A. Saharian, A. Yeranyan

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The Casimir effect is investigated for the standard geometry of two parallel plates moving with a constant proper acceleration through the Rindler-Fulling vacuum. The both cases of a scalar (with Dirichlet and Neumann boundary conditions) and electromagnetic fields are considered. The regularization procedure for the vacuum expectation values of the energy-momentum tensor is based on a variant of the Generalized Abel-Plana formula. Expressions are derived for the vacuum energy density and effective pressures in the region between the plates. The various asymptotic cases are considered. The results of the numerical evaluation are presented for the interaction force between the plates due to the vacuum fluctuations.

7. Gravitation, Cosmology, Quantum Gravity (GCQG)

New Insights in Particle Dynamics from Group Cohomology

V. Aldaya, J.L. Jaramillo, J. Guerrero

Institutop de Astrofísica de Andalucía (CSIC)

The dynamics of a particle moving in background electromagnetic and gravitational fields is revisited from a Lie group cohomological perspective. Physical constants characterising the particle appear as central extension parameters of a group which is obtained from a previously extended kinematical group (Poincaré or Galilei) by making *local* some subgroup. The corresponding dynamics is generated by a vector field inside the kernel of a presymplectic form which is derived from the canonical left-invariant one-form on the extended group. The non-relativistic (Newtonian) limit is derived from the *geodesic* motion via an Inönü-Wigner contraction. A deeper analysis of the cohomological structure reveals the possibility of a new force associated with a non-trivial mixing of gravity and electromagnetism leading to testable predictions, such as a mass difference between charged particles and anti-particles.

Chern–Simons Gravity: Non-Topological Approach

A. Borowiec, M. Ferrari, M. Francaviglia

Institute of Theoretical Physics, Wroclaw pl. M. Borna 9, 50-204 Wroclaw, Poland

Chern–Simons Lagrangians in $d = 3$ dimensions are analyzed from the point of view of their covariance and globality. We use the transgression formula to find out a new covariant and global but bimetric Lagrangian for Chern–Simons gravity. We discuss the problem of conservation laws for Yang–Mills and gravitational examples: in particular, the energy-momentum complex and the superpotential is calculated. It is shown that such bimetric formalism is not longer a topological one.

Higher-loop String Cosmology and Dilaton Stabilization

A. Saharian

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We consider the cosmolgical dynamics described by the low-energy string effective action with higher-loop corrections to the dilaton coupling functions. Under certain conditions on dilaton couplings these corrections provide an efficient mechanism for dilaton stabilization during the cosmological expansion proposed by Damour and Polyakov. By using qualitative methods we investigate another mechanism proposed by the author and based on the assumption that higher-loop corrections generate dialton couplings singular for some finite value of the dilaton field. The conditions are specified under which the cosmological evolution drives the dilaton to a stage with small cosmological variations. The phase space diagrams illustrating this type of dilaton stabilization are presented for various qualitatively different cases.

On the Nature of the Activity of Galactic Nuclei

L. Grigoryan

Department of Physics, Yerevan State University, 375025 Yerevan, Armenia

A model of compact nuclei of galaxies as star clusters far advanced to the state of statistical equilibrium is investigated. It is shown that rapidly spinning neutron stars and white dwarfs are the main constituents of compact galactic nuclei. The gamma radiation form active galactic nuclei is attributed to the radiation from pulsars that are in these nuclei. The X-ray and UV are considered to be synchrotron radiation from ultrarelativistic electrons ejected from pulsars and moved in the magnetic field of galactic nuclei.

The Vela Pulsar Angular Velocity Relaxation After Its First Eight Jumps

M. Hairapetian, D. Sedrakian

Department of Physics, Yerevan State University, 375025 Yerevan, Armenia

The theory of relaxation of the pulsars angular velocity is compared with the observational data for the first eight jumps of the Vela pulsar. The inverse problem in the theory of relaxation is solved in the exponential and linear relaxation regions. From this solutions the vortex distribution has been found, which leads to the observed relaxation of the Vela pulsar angular velocity. It is shown that the pinning of vortex lines plays a main role in the exponential relaxation regions, but it is necessary take into account the changes of angular velocity of the superfluid component in the linear relaxation region.

Description of Supernova Data in Conformal Cosmology without Cosmological Constant

D. Blaschke, D. Proskurin, V. Pervushin

Joint Institute for Nuclear Research, Dubna, Russia

We consider cosmological consequences of a conformal invariant formulation of Einstein's General Relativity where the scale factor of the spatial metrics in the action functional gets replaced by the massless scalar (dilaton) field. The dilaton scales all masses including the Planck mass. Instead of the expansion of the universe we get the Hoyle-Narlikar type of mass evolution, where the temperature history of the universe is replaced by the mass history. We show that this conformal invariant cosmological model gives a satisfactory description of the new supernova Ia data for the luminosity distance-redshift relation without a cosmological constant and make a prediction for the behavior at $z > 1$ which deviates from that of standard cosmology.

Meissner Effect for Color Superconducting Quark Matter

D. Blaschke [1], *K. Shahabasyan* [2], *D. Sedrakian* [2]

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[2] *Department of Physics, Yerevan State University, 375025 Yerevan, Armenia*

The behaviour of the magnetic field inside the superconducting quark matter core of a neutron star is investigated in the framework of the Ginzburg-Landau theory. We take into account the simultaneous coupling of the diquark condensate field to the usual magnetic and to the gluomagnetic gauge fields. We solve the problem for three different physical situations: a semi-infinite region with a planar boundary, a spherical region, and a cylindrical region. We show that Meissner currents near the quark core boundary effectively screen the external static magnetic field.

8. Condensed Matter and Statistical Physics (CMSP)

On Abnormal Strong Influence of Media on Relativistic Electron's Radiation Intensity

S. Arzumanyan

Institute of Applied Problems in Physics 25 Nersessian Str., 375014 Yerevan, Armenia

The radiation intensity of an arbitrary moving electron is calculated for a medium with $n \geq 1$ spherically-symmetric layers with different permittivities. In particular cases the obtained formulas coincide with previously known results. The intensity of radiation from an electron rotating around the equatorial plane inside a dielectric drop ($n = 1$) is developed. The numerical calculations showed that if Cherenkov's condition for the electron and the matter of sphere is satisfied then there exist discrete values of the ratio of the radius of drop on that of electron orbit, at which anomalously strong radiation takes place. Such an intense radiation is formed inside the dielectric drop as a result of repeated reflection of Cherenkov radiation from the surface of the drop. During one period of rotation $n_k >> e^2/hc$ quanta of electromagnetic field are emitted.

Two Particle Correlation on 2D Hubbard Lattice

A. Saakyan

Department of Physics, State Engineering University, of Armenia, 375009 Yerevan, Armenia

Two Hubbard particles problem on finite square lattice with open and closed boundare is solved. The complete classification of eigenstates of the factorizable parity operator is carried out.

Super-slipping Carbon Nanotubes

M. Damnjanović, I. Milošević, T. Vuković

Faculty of Physics, POB 368, YU-11001 Belgrade

Extremely low friction between walls of multi-wall carbon nanotubes is theoreticlly explained. The analysis stems from three quite general symmetry based principles. Their universality makes the result obtained relevant for the tribology in general offering a recipe for the lubricant selection. It is shown that friction decreases on the account of the symmetry breaking and that such a decrease is always robust in the nanotubes, even causing the Goldstone super-slippery sliding mode in the incommensurate multi-wall carbon nanotubes.

Vibronic (In)Stability of Diperiodic Systems

M. Damnjanović, B. Nikolić, I. Milošević

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Thin layers, multilayers and surfaces are the well known examples of the systems translationally periodic in two directions. Their symmetries are classified within 80 diperiodic groups. For all of them the Jahn-Teller (Peierls) electron-phonon coupling has been examined. This leading coupling term in the framework of the adiabatic approximation is responsible for the vibronic instability through the active vibrational modes.

The breakdown of the Jahn-Teller theorem is found: in some highly symmetrical special points of the Brillouin zones of tetragonal and hexagonal diperiodic groups there are degenerate electronic states which are not coupled to the ion vibrations. Remarkably enough, this reduction of the electron-phonon coupling concerns particularly the tetragonal CuO planes in HTS materials and conducting layers of many heavy fermion superconductors, as well as the hexagonal graphite layers.

Discrete Counterparts of $O(N)$-Model on Bethe Lattice: FC_N-Model

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We have considered the one of possible discrete version of $O(N)$-model, so-called Face-Cubic (FC_N) model on the recursive Bethe-lattice. The corresponding system of recursion relations for partition function and magnetization per site was found. Using this system of recursion relations we plot the diagrams of magnetization versus the external magnetic field for different finite temperatures. The system was found to exhibit a complex magnetic behavior, including the number of bifurcation and chaos. Corresponding phase diagram was obtained.

Electronic States In Parabolic Quantum Dot Taking Into Account Boundary Conditions

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In this paper electronic states in parabolic quantum dot (QD), taking into account boundary conditions, were studied. The threshold habit of level appearance inside the dot was discovered. Electron energy dependence from QD radius and confinement potential height was studied. The discussion of causes to remove random degeneration , as the consequence of confinement potential modernization.

To the Problems of Violation of Kohn's Theorem in Quantum Dots

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The problem of Kohn theorem abnormality in semiconductor QD's (Quantum Dot) is investigated. Based on the proof of the theorem and its generalization in case of QDs it is concluded that given theorem is sequent to the dynamic symmetry of oscillating hamiltonian. Two cases of Kohn theorem abnormality are discussed. In the first case theorem abnormality arises due to the account of the boundary conditions, in the second case due to the account of electron dispersion law nonparabolicity. In other words, in the above-mentioned cases there isn't any opportunity to build total system of wave functions, connected to each other by "stair" operator.

Four-loop RG Functions for φ^4-theory with $O(N)$-symmetric, cubic, and "chiral" interactions in Three Dimensions

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Using the massive field theory in three dimensions, the RG functions for a generalized GL model of N-vector complex order parameter with three independent quartic coupling constants associated with $O(N)$-symmetric, cubic, and "chiral" interactions are deduced within the four-loop approximation. The model is relevant to the phase transitions in a variety of substances among which unconventional superconductors with exotic pairing, including high-T_c superconductors, stacked triangular antiferromagnets, helical magnets, and certain antiferromagnets with complicated ordering. For all physical quantities of interest the most accurate numerical estimates are obtained. The results achieved are discussed along the line of the predictions given by other theoretical approaches and experimental data.

9. Quantum Optics and Coherent States (QOCS)

Transfer of nonclassical features via lossy channels

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The ultimate limits of continuous-variable quantum teleportation due to absorption are studied, with special emphasis on (quasi)-monochromatic optical fields propagating through fibers. It is shown that the amount of information that would be transferred quantum mechanically over a finite distance is limited and effectively approaches to zero on a length scale that is much shorter than the (classical) absorption length. Only for short distances the state-dependent teleportation fidelity can be close to unity. To realize the largest possibly fidelity, an asymmetrical equipment must be used, where the source of the two-mode squeezed vacuum is nearer to Alice than to Bob and in consequence the coherent displacement performed by Bob cannot be chosen independently of the transmission lengths.
The work is supported by the RFBR-BRFBR grant No. 00-02-81023 Bel 2000_a and the Heisenberg-Landau Program.

Nonclassical Statistics and Phase-Space Symmetry in Quantum Chaos

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Quantum manifestation of a classical chaotic dynamics is found in a framework of oscillatory excitation numbers statistics for a model of double driven nonlinear dissipative oscillator. The probability distributions, variances of oscillatory states, Wigner functions and von Neumann entropy are studied for order-chaos transition by numerical simulation of an ensemble of quantum trajectories. The nonclassical, sub-poissonian statistics of oscillatory number-states is established for chaotic dissipative dynamics in the frame of Fano factor and Wigner functions. It is shown that scaling invariance of strange attractor of the model violates in a quantum treatment of chaos. It is demonstrated the correlation between the emergence of chaos and quantum interference. These results are relevant for testing and experimental studing of quantum dissipative chaos.

Multiphoton Entangled States and n-Fold Symmetries of Wigner Function

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In this report we propose a novel approach for synthesizing and generating entangled light-states, using the idea of composite nonlinear interactions of photons in a cavity. We present new types of optical parametric oscillators (OPOs) - so called, three-photon OPOs and four-photon OPOs, which are experimentally feasible due to their low pump-power threshold and will play an important role in application to quantum information processing. The devices are based on cascaded down-conversion processes and consist of second-order media inserted in cavities. Discussion of dissipation and quantum features of the systems is performed by the quantum-jump simulation method, and concernes to the Wigner functions. The important features of three-photon and four-photon entangled states are threefold and fourfold symmetries of the Wigner functions in the phase-space.

Quest for the Separation of Discrete Variables

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The finite oscillator model based on u(2) has a finite number of energy levels and also the same number of values of position, and a proper limit to the continuum quantum oscillator. The wavefunctions are Wigner d($\pi/2$)'s given with a factor of Kravchuk polynomials. In two dimensions, there are a Cartesian and a Radial model; position space is a finite pixellation along Cartesian and polar coordinates. These correspond to the two chains $u(1) \oplus u(1) \subset u(2) \oplus u(2) = so(4) \oplus u(1) \supset so(3)$. The radial wavefunctions of the latter are so(3) Clebsch-Gordan's, given with a factor of Hahn polynomials. We propose finite unitary approximants to the Hankel (i.e. Fourier-Bessel) integral transforms, as well as a conversion between square- and round- pixellated images.

10. Symmetry in Nuclear and Atomic Physics (SNAP)

An Application of Vector Coherent State Theory to the $SO(5)$ Proton-Neutron Quasispin Group

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Vector coherent state theory (VCS), developed for computing Lie group and Lie algebra representations and coupling coefficients, has been used for many groups of interest in actual physical applications. We show that VCS construction of a rotor type can be performed for the $SO(5) \sim Sp(4)$ quasispin group where the relevant physical subgroup $SU(2) \times U(1)$ is generated by the isospin operators and the number of particles operator.

States with Moving Condensate in Nuclear Matter

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In this report we consider *np* superfluidity of nuclear matter with nonzero total momentum of Cooper pairs (nuclear LOFF phase). It is assumed that coupling between $T = 0$ and $T = 1$ isospin pairing channels leads to the emergence of multi–gap superfluid states, characterized by nonvanishing gaps in both pairing channels. The self–consistent equation for such states, generalizing the BCS equation, has been obtained. Various symmetry properties of this equation have been studied, allowing to find different solutions in the case, when one of these solutions, corresponding to the mixed pairing, is known. The structure of phase diagrams at zero temperature, including dependencies of the order parameters from density and superfluid momentum, has been clarified. It is shown, that multi–gap LOFF phase exists in finite density region, excluding some vicinity of zero density, where $T = 1$ order parameter is always finite and $T = 0$ one continuously appears and disappears from the zero value.

Applications of the Deformed Fermion Realization of sp(4)

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A fermion representation of the compact symplectic sp(4) algebra provides a natural description of the pairing interaction in nuclei. In the non-deformed and deformed cases the reduction chains to different realizations of u(2) and $u_q(2)$ are explored for multiple orbits. One of the realizations is associated with the SU(2) group of the valence isospin. The other reductions describe pairing between identical fermions or proton-neutron configurations. Microscopic non-deformed and deformed Hamiltonians are expressed in terms of the generators of Sp(4) and $Sp_q(4)$. In both cases eigenvalues of the Hamiltonian are fit to experimental ground state energies which allows the role of the deformation to be investigated. The q-deformation parameter varies the pairing strength, thereby providing for a non-linear expansion of the nuclear collective motion.

On Symmetry of Elementary Particles

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The new quantum number σ is introduced. It shown that the conservation of σ-number predicts that the electron type neutrino mass is exactly zero. The quark-lepton symmetry is discussed. It is shown that the nature of quark-lepton symmetry is reflected in the fact that elementary particles of the same generation are subject to the symmetry transformation represented by 4-group of diedr. It is also shown that colorless elementary particles are subject to the same symmetry transformation. The new elementary particles (transbaryons) are predicted. Using σ number definition Gell-Mann-Nishijima relation is obtained.

The Integrable Three-Body Problem with Induced Gauge Fields

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The Hilbert fiber bundle construction induced by the adiabatic expansion of the wave function of a three-body problem is considered. The canonical transformation of the problem is explicitly constructed

to reduce the coupled adiabatic equations with induced gauge field potentials to equations involving only the open channels we are interested in. To demonstrate the efficacy of this Canonical Adiabatic Approach, we choose the model of 3 particles on a line, with attractive pair δ-function potentials, since, for this case, exact results are known. The sixfold symmetry picture of the problem is used. The work is supported by the RFBR-BRFBR grant No. 00-02-81023 Bel 2000_a.

12. Mathematical Methods (MM)

The Quantum Motion of Charged Particles in the Circularly Polarized Magnetic Field

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We study the quantum theory of nonlinear interaction of charged particles with a given circularly polarized periodic magnetic field. The approximate nonlinear solution of the Mathieu equation to which the relativistic quantum equation of particle motion in the given field reduces if one ignores the spin -field interaction is found (the Klein-Gordon equation).At the high energy particle motion the obtained solution is valid in the case if the energy change of particle is in the order of particle energy in contrast to the Eikonal approximation. At the small field interaction the obtained solution is the analytic expression of the infinite sum of perturbation theory in the field. We study the stability of solutions and find a class of restricted solutions corresponding to the wave function of the particle. The method developed in the paper can be applied to a broad class of problems reducible to the solution of the Mathiue equation.

Moyal-Lie Theory and Phase Space Quantization

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Phase Space $\star$-quantization implies a deformed (noncommutative) symplectic phase space flow. The generators of this flow are the deformations of the classical Hamiltonian vector fields. These deformed Hamiltonian vector fields, contrary to their classical counterparts, form an associative algebra, i.e. the Moyal-Lie algebra, as the algebra of nonlinear symplectic maps in deformed phase space. The covariance properties of these symplectic maps are presented.

Second Order Irreducible Supersymmetry for Periodic Potentials

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We have found that second order Darboux transformations may create regular periodic potentials when the transformation functions involved have eigenvalues inside of a forbidden band. This transformation being presented as a sequence of first order ones is irreducible in the sense that intermediate potentials have poles. We observe that in some cases Darboux transformations result only in a displacement of the initial potential. We call such an effect *translationary invariance with respect to Darboux transformations*. Second order supersymmetrical quantum models built of Darboux transformation operators involved correspond to the case of broken supersymmetry.

Wavelet Analysis of Secondary Particles Angular Distributions in High Energy Nucleus-Nucleus Interactions

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Wavelet analysis is a modern mathematical method aimed to distinguish different unregularities and scale invariance. It is an extention of the well known Fourier analysis. The wavelet analysis is the study of any function by expanding it in the wavelet series (a complete orthonormal system). The system is a two-parametric function family. The main pionts of the analysis will be presented. An application of it for a study of the particles produced in high energy nuclear collisions well be given. The method allowed to find long-range clusterization of the particles in the pseudorapidity space. Quite interesting results were obtained at a study of the azimuthal distributions of the particles (collective flow signal). A preference scale was not found. Some experimental regularities of the wavelet spectra were observed. Another possibilities of the analysis are considered.

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