International Conference on Mathematical Physics

in Memory of Academic V. S. Vladimirov

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Organizers

Steklov Mathematical Institute of Russian Academy of Sciences, Moscow

Steklov International Mathematical Center, Moscow

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Titles and Abstracts of Talks

Luigi Accardi

University of Rome Tor Vergata

The Stochastic Limit as mathematical theory of quantum transport, dissipation and decays

In the first part of my talk I will briefly sketch the philosophy and some achievements of the stochastic limit of quantum theory (\textbf{from now on: SLQT}). This will be based on a decades collaboration with \textbf{Yun Gang Lu} and \textbf{Igor Volovich}, enriched by fundamental contributions coming from the collaboration with: {Alberto Frigerio, Irina Arefeva, Sergei Kozyrev,}} {Alexander Pechen, Roman Roshin, Kentaro Imafuku, }} {Shuichi Tasaki, Masanori Ohya}} (in chronological order of my interaction with each of them). The second part of my talk can be considered as an introduction to Roberto Quezada's talk in this conference for reasons that will be clear later on. This will also be based on a decades collaboration with all the persons mentioned above and in addition with: Franco Fagnola, Roberto Quezada, Skander Hachicha, Julio Garcia, Fernando Guerrero--Poblete. In it I will restrict my attention to Markov generators arising from SLQT. I will try to explain why this very special class of generators contains much more information than the GKSL form which, just because of its generality, cannot contain the finer information required for real physical applications. The main idea of this part of the talk is that the old picture according to which an environment drives a system interacting with it to a dynamical equilibrium (stationary) state must be modified because, if the system Hamiltonian has degeneracies in its spectrum, the equilibrium states can be many and each of them has a domain of attraction that in several cases can be explicitly described. This leads to the idea of \textbf{physical control of quantum systems}. The information contained in the master equation is only a small part of the full information included in the stochastic limit. If time allows, I will give some examples of this additional information.

Alexander Aptekarev

Keldysh Institute of Applied Mathematics

Multiple Orthogonal Polynomials with respect to Hermite weights: Applications and asymptotics

We start with the definition of the Hermite multiple orthogonal polynomials by means of orthogonality relations. Then we present several recent applications, such as eigenvalues distribution of random matrices ensembles with external field and Brownian bridges. The main goal of the talk will be the asymptotics of this polynomial sequence when the degree of the polynomial is growing in the scale corresponding to its variable (so called Plancherel – Rotach type asymptotics). The starting point for our asymptotical analysis is the recurrence relations for multiple orthogonal polynomials. We will present an approach based on the construction of decompositions of bases of homogeneous difference equations. Another approach, based on the semiclassical asymptotics in the case of complex-valued phases will be presented in S. Yu. Dobrokhotov’s talk.

Goran Djordjevic

University of Nis

Classical and Quantum Dynamics of DBI Type Lagrangians in p-Adic Context

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Dynamics of a class of Dirac-Born-Infeld (DBI) type Lagrangians is considered. Motivation comes from string and D-brane theory with possible application in inflation theory. Our consideration is done in the context of classical and quantum mechanics with tachyon like potentials. In this lecture an accent is on p-adic aspects, quantization is done in the form of the path integrals on real and p-adic spaces, followed by discussion on conditions for their ``adelization``.

Sergey Dobrokhotov

Institute for Problems in Mechanics RAS

Asymptotics of Hermitian type orthogonal polynomials: real semiclassical approximation for the asymptotics with complex-valued phases

We consider orthogonal polynomials determined by the recurrence relations. We obtain a uniform asymptotics of diagonal polynomials (z,a) in the form of an Airy function for n>>1, which is a far-reaching generalization of the Plancherel-Rotach asymptotic formulas for Hermitian polynomials. We discuss one of the possible approach which we call "real semiclassics for asymptotics with complex-valued phases", another approach based on the construction of decompositions of bases of homogeneous difference equations is discussed in A.I.Aptekarev's talk. Introducing an artificial small parameter h=O(1/n) and a continuous function φ(x,z,a) such that (z,a) = φ(kh,z,a), we reduce the described to a pseudo – differential equation for φ, where x is a variable and (z,a) are parameters. Seeking its solution in the WKB- form, one obtains the Hamilton-Jacobi equations with complex Hamiltonians connected with a third-order algebraic curve. This circumstance is the main difficulty of solving the problem and, as a rule, leads to the transition from the real variable x to the complex one. In this problem, we propose a different approach. We divide the pseudodifferential equation in question into two with the following properties. The symbol of the first equation is real, the corresponding phase is real and is defined globally for all x. The operator defining the second equation has a complex-valued symbol, (complex Hamiltonian). However, this equation can be approximated by two equations, one of which has asymptotics with a purely imaginary phase, and the symbol of the second is pure real and has the form cosp+V_0 (x)+hV_1 (x)+O(h^2). This ultimately allows us to represent the desired asymptotic uniformly through the Airy function of the complex argument.

Branko Dragovich

Institute of Physics Belgrade

COSMOLOGY OF NONLOCAL GRAVITY

Despite numerous significant phenomenological confirmations and many nice theoretical properties, General Relativity (GR) is not final theory of gravity. Problems mainly come from quantum gravity, cosmology and astrophysics. Therefore many attempts are under consideration to adequately extend GR. In this talk, we consider some models of nonlocal modified GR, where nonlocality is presented by an analytic function of the d'Alembert-Beltrami operator. We obtained some exact vacuum cosmological solutions of the corresponding equations of motion. We pay special attention to the model which exact cosmological solutions contain effects that mimic dark matter and dark energy. Here, dark energy is produced by the cosmological constant Λ. For this solution, computed cosmological parameters are in good agreement with cosmological observations. Details can be found in our recent papers, see [1, 2] and references therein.

Lyudmila Efremova

Lobachevsky State University of Nizhny Novgorod; Moscow Institute of Physics and Technology

On the partial integrability property of maps obtained by small smooth perturbations of skew products

The concept of the partial integrability is introduced for discrete dynamical systems in the plane. Sufficient conditions of the partial integrability are proved for maps obtained by small smooth perturbations of skew products. Dynamical properties of the partially integrable maps are investigated. Examples of the partially integrable maps are given.

Pavel Exner

Doppler Institute for Mathematical Physics and Applied Mathematics in Prague

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On the discrete spectrum of soft quantum waveguides

The talk deals with soft quantum waveguides described by a two-dimensional Schr\"odinger operators with an attractive potential in the form of a channel of a fixed profile built along a smooth curve in $\mathbb{R}^2$. If the latter is infinite and not straight, but asymptotically straight in a suitable sense, we show using Birman-Schwinger principle that the discrete spectrum of such an operator is nonempty if the potential well defining the channel profile is deep and narrow enough. We also address the question about ground state optimization in the situation when the generating curve has a for of a loop. Some related results and problems are also mentioned.

Anatolii Gushchin

Steklov Mathematical Institute of RAS

Extensions of the space of continuous functions and its application to the Dirichlet problem for elliptic equations.

Рассматриваются слабые решения задачи Дирихле, обобщающие как классические, так и обобщенные решения. Дается обзор результатов в этом направлении. В частности, приводятся теоремы о разрешимости задачи Дирихле при граничной функции из пространства L_p и правых частей уравнения из достаточно широкого класса. Обсуждаются нерешенные задачи.

Alexander Holevo

Steklov Mathematical Institute of RAS

Multimode quantum Gaussian observables: structure and capacities

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Mikhail Katanaev

Steklov Mathematical Institute of RAS

Point disclinations in the geometric theory of defects

We use the Chern--Simons action for a SO(3)-connection for the description of point disclinations in the geometric theory of defects. The most general spherically symmetric SO(3)-connection with zero curvature is found. The corresponding orthogonal spherically symmetric SO(3)-matrix and n-field are computed. Two examples of point disclinations are described.

Khachatur Khachatryan

Yerevan State University, Institute of Mathematics NAS, Armenian

О знакопеременных решениях одного класса многомерных интегральных уравнений с выпуклой нелинейностью

Доклад посвящен вопросу разрешимости одного класса нелинейных 2 двумерных интегральных уравнений сверточного типа на R^2. Указанный класс уравнений имеет приложение в теории p-адических открыто-замкнутых струн, в математической теории пространственно-временного распространения эпидемии. Доказывается существование знакопеременного и ограниченного решения. В одном частном случае исследуется также асимптотическое поведение построенного решения. В конце приводятся конкретные прикладные примеры указанных уравнений для иллюстрации полученных результатов.

Alexey Koshelev

Universidade da Beira Interior, Covilh

Analytic infinite derivative field theories: classical and quantum aspects

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Valery Kozlov

Steklov Mathematical Institute of RAS

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Linear system with quadratic invariant as Schrodinger equation

We consider linear systems of differential equations in a real Hilbert space admitting an invariant as a positive definite quadratic form. It is assumed that the system has a simple discrete spectrum and that the eigenvectors form a complete orthonormal system. Under these conditions, the linear system is reduced to the form of the Schrödinger equation by introducing a suitable complex structure. As an example, such a reduction was carried out for the system of Maxwell's equations in space without currents. These observations allow us to consider the dynamics determined by some linear differential equations of mathematical physics from the point of view of the basic principles and methods of quantum mechanics.

Nikolay Marchuk and Dmitriy Shirokov

Steklov Mathematical Institute of RAS, HSE University, IITP RAS

On some equations modeling the Yang-Mills equations

We considers plane-wave solutions of the Yang–Mills equations, which allow one to write out three systems of equations modeling the Yang–Mills system. An explicit form of all plane-wave solutions of the Yang–Mills equations with the SU(2) gauge symmetry and zero current in a (pseudo)Euclidean space of arbitrary finite dimension is presented.

Farrukh Mukhamedov

United Arab Emirates University

A Quantum Markov Chain approach to Phase Transitions for quantum Ising model with competing XY-interactions on a Cayley tree

The main aim of the present talk by means of the quantum Markov chain (QMC) approach is to establish the existence of a phase transition for the quantum Ising model with competing XY interaction. In this scheme, the C^*-algebraic approach is employed to the phase transition problem. Note that these kinds of models do not have one-dimensional analogues, i.e. the considered model persists only on trees. It turns out that if the Ising part interactions vanishes, then the model with only competing XY-interactions on the Cayley tree of order two does not have a phase transition. By phase transition we mean the existence of two distinct QMC which are not quasi-equivalent and their supports do not overlap. Moreover, it is also shown that the QMC associated with the model have clustering property which implies that the von Neumann algebras corresponding to the states are factors.

Ekaterina Pozdeeva

Skobeltsyn Institute of Nuclear Physics MSU

Cosmological attractor in Einstein-Gauss-Bonnet gravity

We use the equations of the Einstein-Gauss-Bonnet gravity in the Friedmann universe and inflationary parameters in term of e-folding number for the slow-roll regime. With help of this formulation, we obtain gravity models with the Gauss-Bonnet term leading to analytical expressions of inflationary parameters coinciding with inflationary parameters of cosmological attractor models in the leading order approximation. The model is a generalization to the cosmological attractor of exponential form initially proposed for general relativity. We consider the possible expanding of our models for a large field. We calculate and compare the inflationary parameters for the both models estimate order of accuracies for large field expansion.

Vsevolod Sakbaev

Moscow Institute of Physics and Technology

On the operator approach to the weak convergence of measures and limit theorems

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We show that the weak convergence of the sequence of probability measures is the pointwise convergence of the convolution with measures operators in the topological vector space of bounded continuous functions with the topology of pointwise convergence. The generalized convergence of the sequence of probability measures is defined by choosing another topological vector space of function for convolution operators. This approach gives the opportunity to obtain the limit theorem for the distribution of the sums of independent random vector values variables and for the distribution of the compositions of independent random mappings. The limit theorem for the composition of independent random orthogonal operators in finite dimensional Euclidian space is obtained.

Armen Sergeev

Steklov Mathematical Institute of RAS

Topological insulators invariant under time reversal

The talk is devoted to the theory of topological insulators which is an actively developing direction in the solid state physics. The search for new topological objects is reduced to the search of appropriate topological invariants and systems having non-trivial invariants. Such systems are characterized by wide energetic gaps stable with respect to small deformations. The quantum spin Hall insulator may be considered as a non-trivial example of such systems. It is a two-dimensional insulator invariant under time reversal. It has a non-zero topological $\mathbb Z_2$-invariant introduced by Kane and Mele. Our talk is devoted to the topological insulators invariant under time reversal transform. In the first part we consider the physical basics of the theory of topological insulators while in the second part we deal with its mathematical aspects.

Andrei Shafarevich

Moscow State University

Localized asymptotic solutions of hyperbolic systems, homogeneous Lagrangian manifolds and modifications of Maslov canonic operator

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Evgeniy Shavgulidze

Moscow State University

Polar Decompozition of the Wiener Measure and the Schwarzian Theory

We construct the series of functional integrals in the Schwarzian theory as the integrals on the group of diffeomorphisms. The Schwarzian theory is behind various physical models including the SYK model and the two-dimensional dilaton gravity. A polar decomposition of the Wiener measure based on its quasi-invariance under the group of diffeomorphisms is proposed. As a result, the functional integrals in the Schwarzian theory can be written as Fourier transform of the integrals in a model with the Calogero potential.

Oleg Smolyanov

Moscow State University

Quantum anomalies and differential properties of generalized Lebesgue-Feynman measures

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Dmitry Treschev

Steklov Mathematical Institute of RAS

Quantum heavy particle in a periodic potential

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Igor Volovich

Steklov Mathematical Institute of RAS

Integrability of quantum dynamical systems and categories

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Evgeny Zelenov

Steklov Mathematical Institute of RAS

p-Adic quantized calculus and ideals of compact operators

A quantum Connes calculus is constructed on the spaces of complex-valued functions of the p-adic argument. Preimages of ideals of compact operators (Macaev, Schatten-von Neumann) under the quantization map investigated.

Victor Zharinov

Steklov Mathematical Institute of RAS

Binary relations and fuzzy logic

A mathematical apparatus based on binary relations is proposed expanding the feasibility of traditional analysis in applications to problems of mathematical and theoretical physics. General constructions are illustrated by the algebraic approach to Backlund transformations of nonlinear systems of PDE and by the dynamics of traveling wave packets.

Alexander Zubarev

Samara University

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