CURRICULUM VITAE

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Personal information:

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Education:

1991, Moscow State University, Physical Department

1994, Graduated School of Steklov Mathematical Institute

1996, Ph.D., Steklov Mathematical Institute

2006, Doctor of Science, Steklov Mathematical Institute

Academic appointments:

2004 – present Department of Mathematical Physics,
Steklov Mathematical Institute;

1996–2003 Department of the Structure of Matter,
N.N.Semenov Institute of Chemical Physics, Academy of Science of Russia.

Publications:

About 40 papers. Some references see below.

Conferences, International collaboration

Member of the Organizing Committee and invited speaker at many international conferences. I have visited many countries, including Universities in Rome (Italy), Nagoya (Japan), Växjö (Sweden), Bonn (Germany).

Research:

Main scientific interests are connected with mathematical physics, p–adic and ultrametric analysis and applications, quantum theory, quantum probability.

p–ADIC AND ULTRAMETRIC ANALYSIS AND APPLICATIONS

Ultrametric and p–adic analysis — a new quickly developing field of mathematics, with application from the Planck scale physics and the string theory to applications to disordered systems and biophysics.

Let us list the main results. We also put some basic formulas.

- **p–Adic wavelet theory**

  Theory of p–adic wavelets with applications to spectral theory of p–adic pseudodifferential operators was constructed [1]:

  $$\psi(x) = \chi(p^{-1}x)\Omega(|x|_p), \qquad D^\alpha\psi(x) = p^\alpha\psi(x).$$

  The map of p–adic numbers onto real positive half–line which maps the basis of p–adic wavelets on the real Haar wavelets was constructed.

  We show that the orbit of a generic function from the space $D_0(\mathbb{Q}_p)$ of mean zero test functions of p–adic argument is a tight frame [2].

  New wide family of p–adic pseudodifferential operators, which are diagonal in the basis of p–adic wavelets, was constructed and the corresponding spectra were computed [3].

  Methods of the wavelet theory in the p–adic case are even more efficient compared to the real case.

- **Analysis on locally compact ultrametric spaces**

  Theory of wavelets and pseudodifferential operators on general locally compact ultrametric spaces is developed:

  $$Tf(x) = \int_X T(\sup(x,y))(f(x) - f(y))\, d\nu(y), \qquad T\Psi_{Ij} = \lambda_I\Psi_{Ij}.$$

  For construction of this theory we did not use any group structure (which is absent for general ultrametric space) [4], [5], [6].

  Using the ultrametric wavelet theory the exact solutions of the Cauchy problem with initial condition in $D_0(X)$ (the space of mean zero test functions on the locally compact ultrametric space) for some non linear integral ultrametric equation on locally compact ultrametric space are built [7].

- **p–Adic and ultrametric methods in theory of spin glasses**

  Applications to statistical physics of disordered systems are developed. p–Adic expression for the Parisi replica matrix from the theory of replica symmetry breaking for spin glasses was obtained [8]:

  $$Q_{ab} = q(|a-b|_p).$$

  Generalization of the Parisi replica symmetry breaking anzats is consructed and the new infinite family of replica solutions is found [9], [10], [11].

- **p–Adic models of protein dynamics**

  For the models of interbasin kinetics used for description of the dynamics of macromolecules the equivalent ultrametric pseudodifferential equation is obtained. In the simplest case this equation takes the form of the p–adic heat equation [8]

  $$\frac{\partial f(x,t)}{\partial t} + D_x^{\alpha} f(x,t) = 0, \qquad \alpha \sim \frac{1}{T}.$$

  We proposed to use this equation to describe the protein dynamics. For the model of the CO to Myoglobin rebinding dynamics — "the hydrogen atom model of biophysics" this equation is in a good agreement with the experimental data [12].

- **p–Adic models of the genetic code**

  The model of the genetic (amino acid) code on the 2–adic plane is constructed [13]. In this model almost all degeneracy of the genetic code is described by the local constancy of the map in the 2–dimensional 2–adic metric. Instead of a formula we put here the table of amino acids on the 2–adic plane for the mitochondrial genetic code:

Lys / Asn	Glu / Asp	Ter / Ser	Gly
Ter / Tyr	Gln / His	Trp / Cys	Arg
Met / Ile	Val	Thr	Ala
Leu / Phe	Leu	Ser	Pro

The considered here applications of ultrametric and p–adic analysis are the examples of complex systems in physics and biology. In particular the model of protein dynamics (a typical model of complex system) in the developed approach is described by the exactly solvable p–adic heat equation. The mentioned above results can be found in the monograph [14].

References

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THE STOCHASTIC LIMIT OF QUANTUM THEORY

The stochastic limit of quantum theory (developed by L.Accardi, Yu.G.Lu and I.V.Volovich) is a new approach to the semiclassical limit in quantum theory with quantum white noise as the leading term. In our joint work with L.Accardi and I.V.Volovich some quantum mechanical models were investigated.

In particular we have considered quantum electrodynamics (including the theory beyond the dypole approximation), the polaron model, the spin-boson model (in particular without using of the rotating wave approximation), and quantum dynamics of systems of many interacting particles. Some of the obtained results are as follows:

- Different regimes for the spin-boson model (including the regime of pure oscillations) were described [1]. Models of the system of many spins interacting with the quantum field were exposed in [2].
- New proof for the phenomenon (found first by L.Accardi and Y.G.Lu) of the arising of very special deformation of quantum Boltzmann commutation relations in the model of a particle interacting with the quantum field was obtained [3].
- Non-exponential relaxation for the polaron was described [4].

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