Curriculum Vitae for Yuli V. Nazarov

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Short scientific biography:

I graduated from Moscow Physical-Technical University in 1982 and has received Ph.D. in physics from Landau Institute for Theoretical physics in 1985. My supervisor was G.M. Eliashberg. I became the researcher in the same institute. In 1989 I moved to Nuclear Physics Institute of Moscow State University. After collapse of Soviet Union in 1991, I took visiting positions in Germany and the Netherlands. In 1995 I took an assistant professor position in Delft where I was promoted to full professor rank in 2001. In 2004, I have become one of the co-founders of Kavli Institute of Nanoscience Delft, by that time the first Kavli Institute outside US.

In the end of eighties I have entered a just emerged field of quantum transport. My whole career was devoted to this broad field that encompasses diverse concepts, ideas and approaches. I was lucky to make primary and pioneering contributions to many subfields of quantum transport and still remain one of the most original and influential theorists in the field. My scientific style strives to theoretical elegance, generality of formulation and conclusions, broad spectrum and immediate relevance to experiments. Besides theoretical research, I have co-authored many experimental advances in collaboration with the groups in Delft and beyond.

Main research field:

Theoretical research in quantum transport

Expert in subfields:

Coulomb Blockade and Electromagnetic Environment
Mesoscopic Superconductivity
General Theory of Quantum Transport
Noise and Full Counting Statistics
Spintronics
Resonant Tunneling and Quantum Manipulation
Kondo effect and Luttinger liquids

Main contributions:

The list of main scientific advances arranged by subfields is as follows:

Coulomb blockade.

- My entrance to the field was the theory of electron tunnelling in the electromagnetic environment, nowadays known as dynamical Coulomb blockade. It has resolved a local-global rule paradox that prevented the development of the field in its early days.
- With D. Averin, I have theoretically predicted inelastic and elastic electron co-tunneling and coined down these terms.
- I have shown that tunnel barriers are not needed for Coulomb blockade: any scatterer would do. This work has advanced field-theoretical methods and is my most important contribution to general theoretical physics.

Superconductivity.

With D. Averin, I proved the inexorability of parity effect in superconducting islands. This work contradicted to experiments of that time and has only been published to accompany the experimental discovery of parity effect by M. Tinkham.

- With F. Hekking, I considered two-electron tunnelling into superconductor thereby laying the basis of modern understanding of proximity effect.
- In 1994, I proposed an ingenious circuit theory of proximity effect. Later it has been extended to non-equlibrium superconductivity, and became a base model of the general finite-element approach to quantum transport phenomena
- My research team was the first to achieve quantitative understanding of Andreev interferometers and re-entrance effect in hybrid structures following pioneering experiments of V. Petrashov and P. Delsing. Later extended to noise properties (with W. Belzig and Yale experimental team).
- In 2007, with V. Braude explained fully developed triplet proximity effect following experiments of T.M. Klapwijk.
- In 2006-2012, with J.E. Moij and my team we have investigated quantum phase-slips in superconducting nanowires, proposed three unique device schemes employing the phenomenon and contributed to its microscopic understanding thereby facilitating a recent outburst of experimental activity in the field.
- In 2012-2017, with M. Houzet and J. Meyer I have laid the basics of topological effects in multi-terminal superconducting nanosructures. We have also made a pioneering work on slow dynamics of superconducting quasiparticles that explained the abundance of excess quasiparticles in the realistic structures.

Spintronics.

- With my Ph.D. supervisor G.M. Eliashberg and L.S. Levitov, we have considered mutual conversion of electric and spin currents long before the field of spintronics has started.
- With G.E.W. Bauer and A. Braatas, I have founded finite-element theory of spin transport indispensible for non-collinear spin configurations that has been used in more than 250 articles.
- With A. Khaetski, we have listed the mechanisms of spin relaxation of confined electrons.

Full counting statistics, noise and large fluctuations.
I have developed a non-trivial Green's function method for full counting statistics of electron transport. Later I extended it to the systems obeying master and Bloch equations. In 2000-2009, I and collaborators have applied these methods to a variety of quantum transport systems: superconductors, hybrid structures, quantum dots, coherent junctions; have included environmental effects necessary to explain pioneering experiments of B. Reulet on third cumulant of current noise. For the part of this work, W. Belzig has been awarded a prestigious Walter Schottky Prize (2005). All this have initiated a broad field of research contributed by dozens of research groups by thousands of publications. I coined the term "counting field".

General theory of quantum transport.
A hallmark of my research is the development of non-trivial finite-element methods for quantum transport: this is outlined in detail in proposal synopsis. Another major advance is the Keldysh action for an arbitraty scatterrer (1999-2008) that completes the scattering approach of Landauer and Buttiker.

Kondo physics in quantum dots.
With L. Glazman and M. Eto, I have put forward the first consistent theory of Kondo effect under non-equilibrium conditions and explained Kondo effect in the dots with even number of electrons (so-called singlet-triplet enhancement). These articles are regarded as pioneering contributions to this very active field.

Nuclear spins in quantum dots.
In 2000-2009 with my students and V. Falko, I have pioneered and accomplished studies of nuclear spin degree of freedom in spin valve, single quantum dots and double quantum dots, mostly with using semiclassical methods. These works have had a great impact on the field and provided explanation for numerous experiments published in Science/Nature.
Solid-state quantum information processing and other devices.

- Early papers have formulated theory of resonant tunnelling in double quantum dots that has been experimentally confirmed and later has become a basis to describe charge qubits and quantum-dot-based

spin qubits.
- With Delft experimentalists, we proved all-electric manipulation of electron spin in quantum dots (Science 2007)
- My team has proposed a novel class of qubits, spin superconducting qubits (two designs of 2003, 2009).
- We have shown how to reveal spin singlets in a continuous electronic flow (with A. Lorenzo).
- Works with H. Wei, A.F. Gonzalez establish statistical theory of quantum information acquisition and propose quantum monitoring of non-commuting variables.
- With M. Ansari, I have investigated Renyi entropy flows extending the concepts of quantum transport to informational quantities
- Within Grenoble collaboration, we have discovered Weyl points and transconductance quantization in multi-terminal superconducting junctions

In 2009, me and Yaroslav Blanter have published the book *Quantum Transport: Introduction to Nanoscience* summarizing the developments of the whole field, the first book of this scope.

Languages: Russian, Dutch, English
Teaching: Courses in advanced quantum mechanics and quantum transport

Books:
Quantum Transport: Introduction to Nanoscience, Cambridge University Press, 2009 (with Y. Blanter)
Advanced Quantum Mechanics: a practical guide, Cambridge University Press, 2013 (with Y. Danon)

Publications:
I am an author of more than 280 scientific publications, including 63 Physical Review Letters and 4 Nature/Science articles cited about 12000 times and my h-index amounts to 58.

Five most cited journal publications:

1. *Coherent control of a single electron spin with electric fields ,*
with: K.C. Novack, F.H.L. Koppens , L.M.K. Van der Sypen,
SCIENCE 318, 1430 (2007) Cited: ***662***

2. *Virtual electron-diffusion during quantum tunneling of the electric charge***,**
With D.V. Averin
PHYSICAL REVIEW LETTERS **65,** 2446 (1990). Cited: ***451***

3. *Spin relaxation in semiconductor quantum dots*
with: A.V. Khaetskii
PHYSICAL REVIEW B **61**, 12639 (2000) Cited: ***472***

4. *Finite-element theory of transport in ferromagnet-normal metal systems*
with: A. Brataas, G.E.W. Bauer
PHYSICAL REVIEW LETTERS 84 , 2481 (2000) Cited: ***385***

5. *Spin-flip transitions between Zeeman sublevels in semiconductor quantum dots*
with: A. V. Khaetskii
PHYSICAL REVIEW B **64**, 125316 (2001) Cited: ***374***

International awards
Outstanding Referee, American Physical Society, 2008.
Chair of Excellence, Grenoble Nanoscience Foundation, 2013.