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Foreword

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Dedicated to 70-th Birthday Jubilee of prominent Russian mathematician and theoretical physicist Nikolai N. Bogolubov (Jr.)

Nikolai N. Bogolubov (Jr.) was born on March 7, 1940 in Kyiv, Ukraine, and moved to Moscow jointly with his parents in 1952. In 1963 he graduated from the Physics Department of M. Lomonosov Moscow State University with major in theoretical physics.

N. Bogolubov (Jr.) began his scientific activities in 1962. The direction of scientific interests of a young scientist was certainly defined and strongly influenced by the well-known school in theoretical and mathematical physics of academician N. N. Bogolubov (Sr.). From the very first steps in science N. Bogolubov (Jr.) showed unusual analytical abilities, diligence and such an important quality for scientist as aspiration to create an independent way in his studies. N. Bogolubov (Jr.) was able to find and form his own scientific style in modern theoretical and mathematical physics, to unite around himself and to involve into active scientific work many friends and pupils, amongst whom first of all it is necessary to mention B. Sadovnikov, A. Kurbatov, A. Shumovsky, J. Brankov, D. Sankovich, A. Prykarpatsky, A. Kireev, V. Plechko, A. Soldatov, A. Kazaryan. Being initially interested in mathematical properties of nonlinear dynamical systems, N. Bogolubov (Jr.) defended his Ph.D. devoted to some mathematical problems of weakly perturbed evolution equations of mathematical physics and their applications. The obtained experience in mathematical studies was very beneficial for N. Bogolubov (Jr.) since soon he started to study very interesting mathematical problems of quantum statistical mechanics related with rigorous proofs of the results obtained by means of the well known N. Bogolubov's (Sr.) method of approximating Hamiltonian for models of BCS-types. These results were accumulated in the first N. Bogolubov's (Jr.) monograph [1] "Method of studying model Hamiltonians" published in 1974, and which were also successfully defended as his Doctor of Mathematical and Physical Sciences thesis in 1971. In the meanwhile N. Bogolubov (Jr.) was nominated the head of Statistical Mechanics division at the Laboratory of Theoretical Physics of Joint Institute for Nuclear Research, Dubna, and became a leading researcher at the V. A. Steklov Mathematical Institute of the Russian Academy of Sciences, where he is working permanently up to the present.

Actively working at modern problems of quantum statistical physics N. Bogolubov (Jr.) jointly with his colleagues and disciples published new scientific monographs [2, 3]. In the collective monograph [3], the method of approximating Hamiltonian obtained a new trend of development to which strong proofs were constructed for a wide class of model systems. N. Bogolubov's (Jr.) works on the approximating Hamiltonian method have greatly contributed to the development of rigorous methods of statistical mechanics. The developed technique of majorizing estimates of differences subject to the corresponding thermodynamic quantities for the model and the approximating system makes it possible to get rid of many difficulties which, as was first noted by Bogolubov (Sr.), had been severely bounding the applications of statistical mechanics.

The work of N. Bogolubov (Jr.) [1] stimulated a further development of the approximating Hamiltonian method in the modern quantum theory of many-particle systems. Originally devised for solving statistical physics model problems connected with fermion operators, owing to the results of Bogolubov (Jr.), this method has naturally found many applications for a wider range of problems. So, in the well-known work by Ginibre [4], an essential part of his results is based on the N. Bogolubov's (Jr.) remarkable work [5]. Recently the approximating Hamiltonian method has been also applied to the rigorous research of some bose-systems [6, 7].

An important contribution to the development of foundations of modern mathematical physics was made by monograph [8] written jointly with with N. Bogolubov (Sr.). In this work the Authors managed to unveil a deep physical meaning underlying the second quantization method, owing to which a so important notion as "quasi-particle" acquired its modern status and physical argumentation. For the first time in the world literature there was shown a way of formulating a classical analogue of the second quantization method. As concerns the uniform study of quantum and classical problems, the potential underlying this method is far from being exhausted.

N. Bogolubov's (Jr.) scientific works on the polaron theory are extremely valuable [9, 10]. In 1954 N. Bogolubov (Sr.) [11] developed an approach that makes it possible to express some physical observables as continual path integrals. This approach was based on the representation of suitable Green functions in terms of vacuum expectations of chronological products. The corresponding operation of averaging over the boson vacuum was interpreted as a functional integral. In 1981 N. Bogolubov (Sr.) and N. Bogolubov (Jr.) [9] developed this construction within the framework of quantum statistical mechanics. A measure that arises in this approach is the Gaussian measure defined in an appropriate space of continuous functions. The Gibbs equilibrium averages of the operator chronological products are, respectively, expressed as functional integrals with respect to this measure. Subsequently, some important mathematical problems of functional integration with respect to this Bogolubov's measure were considered in detail in [12]. It was found that the Bogolubov-Bogolubov (Jr.) approach is highly beneficial in quantum statistical mechanics side by side with the Feynman functional integration. Unlike the Feynman approach, the Bogolubov-Bogolubov (Jr.) approach is based on the well defined Gaussian measure. (It is worth mentioning that the natural analogue of the Wiener measure with complex variance parameter is not a countably additive complex measure).

The next topic of studies related with the integrability of nonlinear quantum and classical dynamical systems by means of the new and very powerful inverse spectral transform method [13], was initiated by N. Bogolubov (Jr.) in 1977 jointly with his collaborators from Lviv and Kyiv, A. Prykarpatsky and V. Samoylenko. These investigations were first started in Moscow and Leningrad by prominent Soviet scientists academicians V. Zakharov, S. Novikov and L. Faddeev jointly with their collaborators, and in Kharkiv and Kyiv by academicians V. Marchenko and O. Parasyuk with his very talented disciple P. Holod. Very soon their results were profoundly substantiated by members of this N. Bogolubov's (Jr.) Ukrainian group and applied to many other important problems of mathematical and quantum statistical physics. In particular, there was devised a very powerful direct gradient-holonomic algorithm [13–15] for an analytical study of the so-called Lax type integrability of a wide class of nonlinear differential and differential-difference dynamical systems on functional and operator manifolds. As concerns the Lax type integrable nonlinear quantum mechanical models, N. Bogolubov (Jr.) jointly with his disciple A. Prykarpatsky proposed a new quantum many-particle Schrödinger type dynamical system on the real axis with a combined $(\delta + i\delta')$-interparticle potential. They also proved its both classical and quantum Lax type integrability and analyzed its quantum statistical mechanical properties by means of the Quantum Inverse Scattering Transform [14], devised by the Leningrad research group of L. Faddeev. A part of these results was published by N. Bogolubov (Jr.) in 1987 in monograph [16], written jointly with his Ukrainian collaborators. Developing his former research on operator approaches to the study of quantum statistical many-body problems, N. Bogolubov (Jr.) jointly with his disciple A. Prykarpatsky started the investigation of the old problem, posed many years ago by N. Bogolubov (Sr.), and consisting in constructing a rigorous mathematical theory of the

Bogolubov's generating functional for many-particle distribution functions both in classical and quantum cases. This problem was very uniquely and completely solved [17] by introducing into the field such mathematical tools as quantum Lie algebras of currents and their representations in the generalized Hilbert-Fock type spaces. Moreover, making use of some results from the spectral theory of operators, N. Bogolubov (Jr.) jointly with A. Prykarpatsky studied special solutions to the Bogolubov's generating functional equation and found new and very compact proofs of the statistical sum expansions related with the well-known Bogolubov-Zubarev-Yukhnovsky collective variable method. Later these results were further developed and extended in N. Bogolubov's (Jr.) work [18] which founded a new field in modern mathematical physics and is referred to as "quantum mathematics".

Here it is also worth mentioning a cycle of investigations initiated by N. Bogolubov (Jr.) jointly with his colleagues and disciples in such fields as quantum model systems of statistical physics and quantum optics. Part of these studies was later published both in the Lecture Notes [19], written jointly with his collaborators A. Prykarpatsky and U. Taneri, and in books [2, 20, 21], written jointly with A. Shumovsky, B. Sadovnikov and V. Yukalov.

One can say with satisfaction that the hard and intensive work of N. Bogolubov (Jr.) was highly estimated by the scientific community in 1984, having elected him a corresponding member of the USSR Academy of Sciences.

For many years the Ukrainian scientific community has been maintaining a fruitful cooperation with N. Bogolubov (Jr.). In 1989 he was awarded the M. Krylov prize and in 2000 he got the N. Bogolubov (Sr.) prize of the Ukrainian Academy of Sciences for his works in statistical and mathematical physics fulfilled jointly with Ukrainian scientists.

Nikolai Bogolubov (Jr.) is worldwide recognized as a leading figure and contributor to sizable communities within modern mathematical and theoretical physics, in particular, in nonlinear dynamical systems of quantum many-body theory and condensed matter physics. He has played indispensable roles in the promotion, organization, and guidance of many prominent conferences in these subfields. As a major voice in statistical mechanics community, N. Bogolubov (Jr.) has gained respect from his colleagues for his integrity and wisdom, his dedication, and his clear-headed approach to problems.

One of the characteristics which features N. Bogolubov's (Jr.) activities is an extremely close tie between his research work and his teaching. For many years N. Bogolubov (Jr.) keeps a professor position at the M. Lomonosov State University in Moscow, being a Mr. and Ph.D. adviser for many gifted students and graduates, respectively. His monograph on quantum statistical physics [8], being translated and published abroad, is one of the best manuals on the second quantization method in quantum statistical physics used by students worldwide. The formulation of new problems and unexpected questions, a tendency to look at seemingly well-known things from a novel view-point characterizes N. Bogolubov (Jr.) as a teacher, regardless of whether at the present moment he is holding a conversation with students or with his own colleagues or disciples. He is not only a teacher to the young. We continue to learn from him, year by year.

N. Bogolubov (Jr.) is a very open minded, good willing and extremely polite man, he knows and likes talking of diverse scientific histories he had heard or had been himself a witness. Having a spare time, he enjoys much to converse, to discuss, to argue with friends and colleagues. He also likes to travel visiting historical cities and villages in Europe, Asia and other countries worldwide.

Celebrating this year his 70-th Birthday Jubilee, Nikolai N. Bogolubov (Jr.) intensively continues his scientific research in most urgent and hot fields of modern mathematical and theoretical physics including quantum statistical mechanics and field theory, hydrodynamics, classical and quantum electrodynamics. He remains to be full of new ideas and challenging scientific plans.

From the bottom of our hearts we congratulate Professor Nikolai N. Bogolubov (Jr.) with his Jubilee, wishing him to stay in robust health, enjoy simple human pleasures and further success in his scientific life for many years.

A. Prykarpatsky, D. Sankovich

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