Nikolaĭ Nikolaevich Bogolyubov (on his eightieth birthday)

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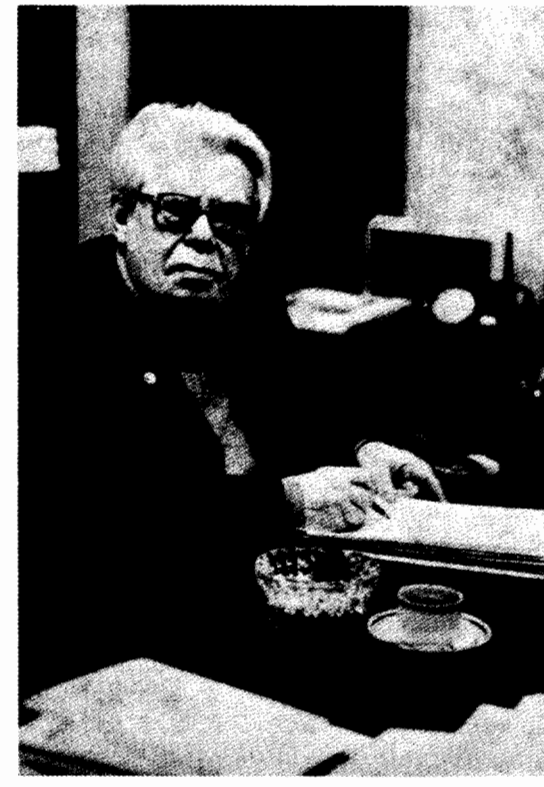
On August 21 Academician Nikolaĭ Nikolaevich Bogolyubov attained the age of eighty years. He is one of the major modern scientists, a prominent Soviet mathematician and theoretical physicist, the founder of a number of new scientific directions in physics and mathematics. Bogolyubov's creative output is characterized by wholeness and unity. His research encompasses a varied set of problems from very subtle questions of classical mathematics to deep problems of microphysics. His outstanding talent enabled Nickolaĭ Nikolaevich to pose and solve key problems of theoretical physics, which determined the principal directions of scientific and technical progress. Bogolyubov's work brought out the unity of the mathematical structure of theories belonging to different fields of physics, specifically nonlinear mechanics, astronomy, statistical physics and theory of dynamical systems of quantum field theory. He to a great extent stimulated the mutual interpenetration and influence of mathematical methods and physical ideas originating in different fields of science. Bogolyubov's fundamental investigations led to the creation of entirely new fruitful directions in theoretical physics. In the course of 65 years of his scientific activity Bogolyubov published more than 300 papers on nonlinear mechanics, statistical physics, elementary particle physics, quantum field theory, mathematical physics and mathematics. Naturally in this article we can touch upon only some of them.



NIKOLAĬ NIKOLAEVICH BOGOLYUBOV

Bogolyubov began his scientific work in 1923 at the age of 13; already in the following year he wrote his first scientific article. Bogolyubov's early papers were devoted to the development of direct methods of the calculus of variations, the theory of almost-periodic functions, and approximate methods of solving problems of mathematical physics. Already this initial period of Bogolyubov's scientific work brought him wide recognition. Starting with 1932 the leading place among Bogolyubov's scientific interests was occupied by problems of mathematical physics including the more complex aspects of the theory of dynamic systems, statistical mechanics and quantum field theory.

N. N. Bogolyubov (together with N. M. Krylov) created a new direction in mechanics which acquired the name of "nonlinear mechanics". The elaboration of new methods of the theory of nonlinear oscillations was associated in the work of N. N. Bogolyubov and N. M. Krylov with the problem of asymptotic integration of nonlinear equations. Bogolyubov proved a number of subtle theorems for nonconservative systems with a small parameter which made it possible to investigate rigorously questions of existence and stability of quasiperiodic solutions. Subsequently Bogolyubov developed the method of averaging and the method of integral manifolds which have by now become classical. The solution of the problems of nonlinear mechanics made it possible to look in a fundamentally new way on the problem of qualitative investigation of nonlinear differential equations and, in particular, to obtain a number of interesting and unexpected results in ergodic theory.

In statistical mechanics Bogolyubov was in fact the first to construct a mathematically rigorous theory of the appearance of stochastic regularities in dynamic systems of a large number of particles, and gave a microscopic description of the most interesting collective effects of macrosystems—superfluidity and superconductivity. He proposed a consistent approach to the problem of the greatest importance for equilibrium statistical mechanics—the problem of phase transitions utilizing the concepts of the symmetries of the system and their violation which are fundamental for physics.

The fundamental work of N. N. Bogolyubov on laying the foundations for and a strict microscopic approach to nonequilibrium statistical mechanics was a natural development of asymptotic methods of nonlinear mechanics. In

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these publications a consistent method was created for describing stochastic regularities in dynamical systems with a large number of particles, and fundamentally new laws were formulated for the establishment in such systems of statistical equilibrium. Fundamental problems in statistical mechanics are key ones for N. N. Bogolyubov's scientific accomplishments. He more than once turned to their study in the course of his scientific journey. In 1946 N. N. Bogolyubov developed a microscopic theory of superfluidity. Having created the concept of pair correlations in quantum physics and the scheme of symmetry violation in the theory of a weakly nonideal Bose-gas, Bogolyubov explained the appearance of superfluidity in such a system and obtained a quantitatively correct spectrum of elementary excitations. Later Bogolyubov applied the method of canonical transformations and the method of compensation of dangerous diagrams in the theory of a Fermi-gas having constructed a microscopic theory of superconductivity. In 1961 Bogolyubov published a paper in which deep physical ideas on a degenerate and unstable vacuum led to the introduction of the fundamental concept of a quasiaverage and to the development of an essentially new theory of phase transitions. The extension of these ideas to particle physics became known as spontaneous symmetry breaking.

From the early 1950's Bogolyubov's attention was attracted to quantum field theory. His studies in this field led first of all to the appearance of new concepts. At that time in quantum field theory only a single effective apparatus was available—perturbation theory, and a basic defect of this apparatus—ultraviolet divergences—was eliminated by means of considerations of the possibility of mass and charge renormalizations. In Bogolyubov's articles it was emphasized that the view of divergences as a defect of the theory was essentially associated with the transfer to quantum field theory of the usual concepts of macrophysics. Bogolyubov proposed an adequate solution of this problem which required the introduction into field theory of the modern mathematical apparatus of generalized functions and its essential development. In particular, he defined the operation of a product of generalized functions, and discovered a new principle of the analytic continuation of generalized functions of many variables. The theorem proved by him (and currently associated with Bogolyubov's name) concerning the "edge of the wedge" has become the basis of a new direction in mathematics. Bogolyubov developed a new general method in theoretical physics—the method of the renormalization group.

Bogolyubov is responsible for developing the axiomatic theory based on the concept of the S-matrix which includes a new causality principle (the Bogolyubov microcausality condition). Bogolyubov's papers on the foundations of dispersion relations have opened up a new stage in the theory of strong interactions. Physicists acquired a new concept of the scattering amplitude as a unified analytic function of the scattering variables, and it is this concept which became the decisive one for the subsequent development of the theory.

A most important role in elementary particle theory has been played by the new concept of color proposed by N. N. Bogolyubov. The introduction of color made it possible to resolve the well-known problem of the statistics of quarks and led to the construction of quantum chromodynamics—the modern gauge theory of strong interactions.

The entire scientific output of N. N. Bogolyubov is penetrated by a variety of mathematical approaches to the investigation of physical problems, the ability to pick out logically the basic features in the phenomenon being investigated, to see the problem as a whole, to appreciate its essence. His knowledge and experience, the very style of his scientific work, N. N. Bogolyubov generously passes on to the younger generation. He founded scientific schools well known all over the world.

N. N. Bogolyubov has done much for developing international scientific collaboration. Under his guidance a beginning was made of Soviet-American collaboration at the largest accelerators of the world long before the conclusion of the corresponding government agreements. For a quarter of a century he headed the Joint Institute for Nuclear Research—a very large international physics center of which he is at present the honorary director.

The scientific and the organizational activity of N. N. Bogolyubov is greatly valued both in our country and in the entire world. N. N. Bogolyubov has twice been named Hero of Socialist Labor. He is the laureate of the Lenin, and State Prizes, of the A. P. Karpinski Prize (FRG) and of many other Soviet and international prizes. He has been awarded the M. V. Lomonosov Gold Medal, the Benjamin Franklin Gold Medal (USA), the Max Planck Gold Medal (FRG). N. N. Bogolyubov is an honorary member of a number of foreign academies and an honorary doctor of the universities of many countries.

Translated by G. M. Volkoff