Physics – Uspekhi **56** (10) 1038 – 1040 (2013)

PERSONALIA

PACS number: **01.60. + q**

Spartak Timofeevich Belyaev * (on his 90th birthday)

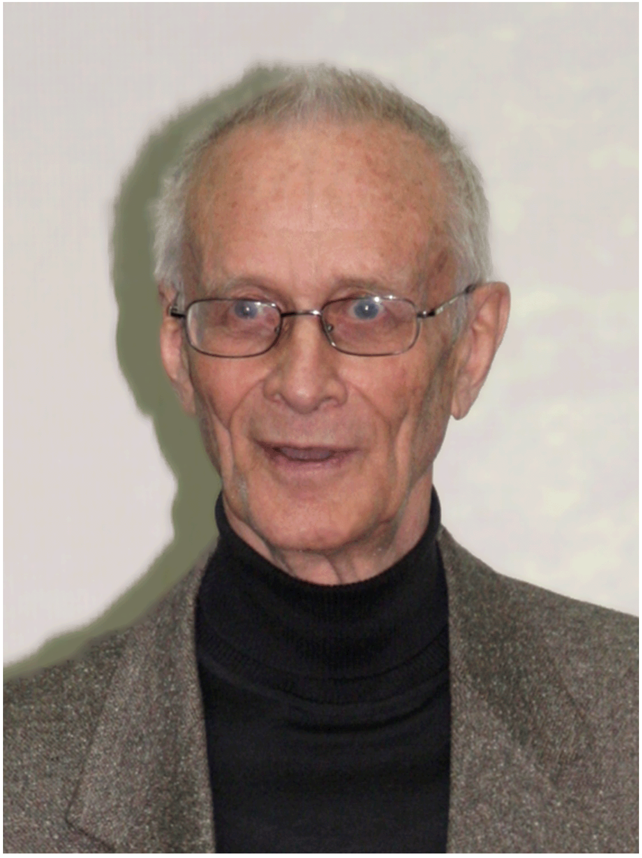
DOI: 10.3367/UFNe.0183.201310k.1141

October 27, 2013 is the 90th birthday of academician Spartak Timofeevich Belyaev — an outstanding Russian theoretical physicist, science administrator, and brilliant physics teacher. S T Belyaev is one of the creators of the modern quantum theory of many bodies and the theory of the nucleus.

S T Belyaev was born and raised in Moscow, attending an ordinary school in Sokolniki. During his latter school years, fate brought him together with an outstanding mathematics teacher, E Ya Tanatar (who later worked in the famous 'Second school'), whose principle was to give individually strong pupils individual tasks. The graduation ball occurred in June 1941, and a week later war started, which put an end to all plans. Thus, S T Belyaev received his first university education on the active front of the Great Patriotic War. In August 1941, he volunteered for active duty and served as a radio operator and intelligence analyzer throughout the war. After demobilizing in 1946, he immediately enrolled in the Moscow State University Physics Department. A year later, he transferred to the second year of the just opened FizTekh where, in addition to ordinary lectures and seminars, there were days of practical work in the field. This is how in 1947 S T Belyaev became a staffer in the laboratory of "Measurement Systems" at the Academy of Sciences, which we now know as the Kurchatov Institute, at its famous Sector 10 headed by A B Migdal. In addition to Belyaev, the Sector guided such brilliant scientists as G I Budker, V M Galitsky (both came from active front duty), A I Larkin, and many others who brought an outstanding input into modern physics research.

S T Belyaev's first research papers, written together with Budker, were devoted to the kinetics of rarified ionized gas in strong external fields. They treated problems connected with new types of electron accelerators suggested by Budker and included the relativistic kinetic equation. The versions of these equations suggested earlier proved erroneous and, therefore, Belyaev and Budker derived them anew in their famous paper, which is still quoted in papers dealing, for instance, with collisions between relativistic ions. The same series of papers completed the solution of a very new and important problem of multi-quantum recombination of ionized gas, where a very elegant idea was applied of describing the process in terms of diffusion in energy space. The methods developed in these papers were used and later developed in a whole number of publications on the physics of electron beams and plasmas.

In 1955, S T Belyaev turned for the first time to the physics of the atomic nucleus. His first work in this field dealt with experimental problems at the juncture of atomic and nuclear



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physics: the creation of sources of polarized nuclei. At that time, this was a very hot issue, since the paucity of data on the spin dependence of nuclear interactions was considerably slowing down progress on the theory of nuclei. S T Belyaev was the first to make use of strong nonuniform magnetic fields in which the atoms of the source are separated into components of fine structure, while the hyperfine structure of the atom is destroyed, so that the magnetic quantum numbers of the electron shell and the nucleus are fixed. The practical implementation of this idea and its further development allowed to obtain, first at the Kurchatov Institute and then at other physics centers, the high-intensity beams of polarized nuclei that are widely employed in nuclear research.

By the end of the 1950s, Sector 10 had become one of the centers of development of the new field of theoretical physics related to the application of the methods of quantum field theory, including Green's functions, to many-body problems. A B Migdal and V M Galitsky turned to Fermi systems, while S T Belyaev worked on Bose systems. Systems of the latter type are especially difficult for microscopic description because of the presence of the Bose condensate. Belyaev invented a new method: anomalous Green's functions,

* Also transliterated in scientific literature as S T Belyayev and S T Beliaev.

Uspekhi Fizicheskikh Nauk **183** (10) 1141 – 1142 (2013)
DOI: 10.3367/UFNr.0183.201310k.1141
Translated by V I Kisin

which was adequate for solving the problem. In 1957, he sent two papers to the *Journal of Experimental and Theoretical Physics* (*JETP*), the first of which outlined the method, with the second describing its application to a nonideal Bose gas. The papers were published in 1958 and immediately brought him worldwide fame. It would be sufficient to mention that the translations of his papers into English for the English version of *JETP* were prepared by F Dyson himself. A similar method was applied independently by L P Gorkov to describe, with the method of Green's functions, superconductors in which Bose condensation of Cooper pairs also occurs. S T Belyaev's papers on Bose systems are included in all textbooks on many-body quantum field theory. However, a direct comparison of their results with experimental data remained difficult, because for many years the only known quantum Bose system was the liquid ^{4}He at low temperatures, at which formulas for gas are not applicable. Only in the 1990s did the S T Belyaev's work on nonideal Bose gas gain a second life, because quantum Bose gases made of atoms in magnetic traps were created in laboratory conditions. Experiments with these gases not only confirmed the main results of Belyaev's theory (the value of the Bose condensate, the shape of the phonon spectrum) but also detected the predicted effect — the breakup of phonons into two, which became known as Belyaev damping.

In autumn 1957, S T Belyaev went on a year-long exchange trip to the Niels Bohr Institute in Copenhagen, where he was completely absorbed in a very new problem connected with applying specifically superconductivity methods to atomic nuclei. O Bohr, B Mottleson, and D Pines suggested an idea that the observed energy gap in spectra of spherical nuclei was caused by the formation of Cooper pairs of nucleons of the same type. Belyaev formulated a more general problem for himself: to study the feasibility of Cooper pairing of nucleons in nuclei, plus all the consequences of this pairing. Using the method of canonical Bogoliubov transformation and a simplified model ('pairing plus quadruple forces' model of interaction), which at the first stage was sufficiently realistic, he treated a wide range of problems: one-particle and collective spectra of nuclei, transition from a spherical shape to a deformed one, and some others. He was able to explain in terms of Cooper pairing a phenomenon which at the time seemed enigmatic: the difference between moments of inertia of deformed nuclei and the solid-state values. He also explained the existence of low-lying 2^+ vibrations and the variation in their characteristics with filling the shells. All these results were published in 1959 in his paper, "Effects of pairing correlations on nuclear properties," which appeared in an individual issue of the *Proceedings of the Danish Royal Academy*. This paper played a very important role in the progress in nuclear physics. It is still widely used, even though Belyaev himself later left this model behind and preferred more general approaches.

At the end of 1958, S T Belyaev returned to Moscow, to the Kurchatov Institute, where he completed a number of generalizations of his Copenhagen paper using quantum field theory methods. On the basis of this work, he submitted and defended at the beginning of 1962 his DSc thesis, "Effects of pair correlations of nucleons in nuclei."

In 1962, S T Belyaev, jointly with V M Galitsky, A I Larkin, and several younger physicists (among them being a future co-author of a large number of papers, V G Zelevinsky) moved to the Novosibirsk Academgorodok. At the Institute of Nuclear Physics (INP) of the Siberian branch of the Academy of Sciences of the USSR, he became head of the theory department.

In 1964, S T Belyaev was elected corresponding member and in 1968 full member of the Academy of Sciences of the USSR. In 1965, he rose to head of the Chair of Theoretical Physics of Novosibirsk State University (NSU) and rector of NSU. These formal posts actually hide the enormous amount of energy devoted by Belyaev, the organizer of science and teacher of younger generations. His own work on principally important problems of the structure of the atomic nucleus continued at high intensity. Suffice it to briefly enumerate the main results obtained by Belyaev and his colleagues in these years: the theory of interaction of nucleons in the nucleus with collective excitations (nuclear phonons), the theory of the unharmonic effects in nuclei, the consistent analysis of the conclusions drawn from the properties of gauge invariance of nucleon interactions, the prediction of new types of nuclear collective excitations, the theory of nuclear rotation based on microscopic treatment of rotation as equal-rights collective excitation, the development of the general methods of generating nuclear Hamiltonians for collective motions, and a study of nonstatistic mechanisms of nuclear reactions.

Being a typical theoretician by the type of brain activity and one of the brilliant representatives of the school of theoretical physics inseparable from the name L D Landau, S T Belyaev is perfectly familiar with the specifics of the physical experiment. He took active part in discussions of the program of development of the Institute of Nuclear Physics and suggestions to set up specific experiments. His erudition, the breadth of his outlook on physics and his enviable understanding of reality, played an enormous role in the turning of the Novosibirsk Institute of Nuclear Physics into a research center of world renown. At the same time, functioning as the NSU rector, S T Belyaev conducted a huge program on creating new educational programs in close cooperation with the institutes of the Novosibirsk research center.

In 1978, S T Belyaev returned to Moscow to the Kurchatov Institute, first as head of the theoretical laboratory, into which by that time has been transformed Sector 10. In 1981, he became director of the division and then of the Institute of General and Nuclear Physics (IGNP) as part of the Kurchatov Institute at the same time that he became head of the Chair of Theoretical Physics of Moscow Physico-Technical Institute (MPTI) (now Moscow Institute of Physics and Technology — MIPT). The new ideas and initiatives that he advanced, the profound and attentive attitude towards each problem and each member of staff, and his quiet and kind style of communication had a fruitful effect on the work of IGNP. He fully participated in experimental programs on double beta-decay and the search for quark-gluon plasma and created along with A L Barabanov a consistent theory of interaction of ultra-cold neutrons with matter, initiated by the unusual results obtained at IGNP by V I Morozov and his colleagues in experiments on precision measurements of the neutron lifetime.

An individual brilliant chapter in S T Belyaev's work as director of IGNP was the epochal effort of building at the Kurchatov Institute a source of high-power synchrotron radiation. It is simply impossible to overlook his many years of active participation in the work on elimination of the consequences of the tragic accident at the Chernobyl Atomic Power Station. S T Belyaev was one of the creators and the first head of the educational institute at the Kurchatov Institute which, with time, grew into a new department of

MIPT — the Department of Nano, Bio, Information, and Cognitive Technologies.

Having resigned from the position of IGNP director, S T Belyaev continues to actively participate in the work of the institute as its scientific supervisor. For many years, he has headed the leading research school, a team of IGNP theoretical physicists. This work is subsidized by grants from the President of the Russian Federation.

On top of numerous orders and medals, S T Belyaev was awarded the L D Landau Gold Medal of the Russian Academy of Sciences (1998), and the M V Lomonosov Great Gold Medal of the Russian Academy of Sciences (2010). In 2004, S T Belyaev was awarded the International Eugene Feenberg Medal, which is handed out once every three years for an outstanding contribution to many-body quantum field theory. In 2012, he received the I Ya Pomeranchuk prize for theoretical physics.

Spartak Timofeevich is full of creative plans. He continues to stimulate people around him with his powerful intellect. We are happy to wish him good health and new contributions to his field of research.

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