doi: 10.15407/ujpe61.01.0088

THE 50-th ANNIVERSARY OF M.M. BOGOLYUBOV INSTITUTE FOR THEORETICAL PHYSICS OF THE NAS OF UKRAINE

Founder and the first Director of the Institute, Academician M.M. Bogolyubov

In 2016, M.M. Bogolyubov Institute for Theoretical Physics of the NAS of Ukraine celebrates its 50-th anniversary. It was founded by the Order of the Council of Ministers of the UkrSSR dated January 5, 1966. The idea of creating such a scientific center belongs to the outstanding physicist-theorist and mathematician, Academician Mykola Mykolayovych Bogolyubov, who became its first director. In 1970, before the 15-th Rochester Conference on High-Energy Physics, which was to be held in Kyiv, the Institute, as a host organization, was removed to a new place in the Theophany natural park.

The foundation of a new institute was preceded by the intense preparation activity. Academician M.M. Bogolyubov was assisted in this task by Corresponding member of the AS of the UkrSSR V.P. Shelest, who became the first Deputy Director of the Institute, and Professor A.N. Tavkhelidze. The support provided by President of the AS of the UkrSSR B.E. Paton and the First secretary of the Central Committee of the Communist Party of Ukraine P.Yu. Shelest was also very important.

The foundation of the Institute was aimed at favoring the development of theoretical researches in challenging domains of physics at a world-rank level. As such, nuclear theory, theory of elementary particles, and statistical physics were selected first. Together with other new directions which arose lately, they determined the scientific profile of the institute until now.

At first, the Institute was composed of three departments: mathematical methods in the theoretical physics (headed by O.S. Parasyuk), nuclear theory (headed by O.S. Davydov), and theory of elementary particles (headed first by A.N. Tavkhelidze and afterward by V.P. Shelest). In time, its structure was modernized. In 1969, the department of the statistical theory of condensed media (headed by I.R. Yukhnovskyi) was created in Lviv, and in 1990 it was transformed into the Institute for Condensed Matter Physics of the NAS of Ukraine. In 1982–1985, the institute included the department of solid state theory headed by V.G. Bar'yakhtar.

The first director of the institute was M.M. Bogolyubov, one of the brightest theorists at that time. To a great extent, this circumstance had determined a high level of researches carried out at the Institute. In a few years, Institute's staff transformed into a team of highly skilled experts in the quantum field theory, the theory of elementary particles, the gravitation theory, the theory of nuclei and nuclear reactions, the solid state theory, and the plasma theory. Among them, there were Academicians of the AS of the UkrSSR O.S. Davydov, O.S. Parasyuk, O.Z. Petrov,

O.G. Sitenko, and I.R. Yukhnovskyi, the Corresponding members of the AS of the UkrSSR V.P. Shelest and P.I. Fomin, the Doctors of Science in physics and mathematics V.P. Gachok, Yu.B. Gaididei, I.P. Dzyub, G.M. Zinov'ev, A.U. Klimyk, M.A. Kobylinskyi, V.M. Loktev, Yu.M. Lomsadze, A.F. Lubchenko, D.Ya. Petryna, E.G. Petrov, I.V. Simenog, B.V. Struminskyi, I.I. Ukrainskyi, V.F. Kharchenko, G.F. Filippov, I.P. Yakymenko, and many others.

The names of the first scientific researchers of the Institute are connected with the discoveries of new effects and the creation of new theories, which were named after the discoverers. Among those results, let us recall, in particular, the renormalization method in the unified field theories (the Bogolyubov–Parasyuk theorem), the theory of collective excitations of atomic nuclei with regard for their non-axiality and deformation (the Davydov–Filippov and Davydov–Chaban models), the theory of absorption band splitting in molecular crystals (the Davydov splitting), the theory of nonlinear excitations in molecular chains (the Davydov solitons), the diffraction theory of nuclear processes at high energies (the Sitenko–Glauber theory), the classification of gravitation fields (the Petrov types), the prediction of the magnetic structure of the β-phase of solid oxygen (the Loktev structure), the discovery of physical vacuum instability that allows the vacuum to be considered as the initial Universe state (the Fomin model), and some others. Soon after its foundation, the Institute became a leader in researches in some directions of theoretical physics.

After M.M. Bogolyubov, the Institute was headed by the physicists famous around the world: O.S. Davydov (in 1973–1988) and O.G. Sitenko (in 1988–2002). They continued to develop the Institute further. There arose new research directions. The scientific staff of the Institute became more skilled. A number of scientific schools in topical fields of theoretical physics such as mathematical physics and quantum field theory (M.M. Bogolyubov and O.S. Parasyuk), solid state theory and nuclear theory (O.S. Davydov), theoretical nuclear physics and plasma theory (O.G. Sitenko), and relativistic astrophysics, cosmology, and elementary particles (P.I. Fomin) were formed.

At present, the Institute consists of 14 scientific departments and 4 laboratories. Among 120 scientific researchers, there are 43 Doctors of Science (including 2 Academicians and 4 Corresponding Members of the NAS of Ukraine), and 58 PhDs. Since 2002, the Institute is headed by the author of the present article.

The researches carried out by Institute's scientists are concentrated on modern challenging scientific directions in theoretical physics. These are astrophysics and high-energy physics; relativistic and quantum cosmology; theory of nuclear systems; quantum field theory and theory of symmetries; theory of nonlinear processes in macromolecular structures, nanosystems, and plasma; dynamics of open strongly nonequilibrium physical, biological, economic, and information systems. In all the areas concerned, the results obtained gained a wide recognition of the international physical community. Let us recall only a few of those which were obtained in recent years.

Recently, two independent international groups, with one of them including D.A. Yakubovskyi, revealed a new radiation line in the X-ray spectra of some space objects. It was found that this line can be a signal of that the dark matter does exist. The interpretation of its origin became a basis for planning new observations of the dark matter, in particular, on the board of the Japanese-American space observatory Astro-H, which is scheduled to be launched at the beginning of 2016. The corresponding observations should provide us with benchmarks for constructing the Standard model expansion.

On the basis of the statistical model of nuclear collisions, M.I. Gorenshtein predicted the appearance of a sharp maximum in the dependence of the ratio between the number of strange particles and the number of pions on the nucleus-nucleus collision energy. This theoretical result had stimulated an experimental program with the energy scanning at the CERN SPS accelerator. Soon, the experiments confirmed this prediction.

Even before the discovery of graphene, V.P. Gusynin and S.G. Sharapov had carried out pioneering works, in which they predicted a number of effects inherent in this material, in particular, the unconventional quantum Hall effect. Later, this effect was observed experimentally, which became a confirmation of the fact that charged quasiparticles in graphene are described by the Dirac equation.

In 2006, the Bose–Einstein condensate was discovered experimentally at unexpectedly high room tem-

perature. However, it was observed in a system of quasiparticles, magnons, rather than in a system of particles. This result stimulated a great interest of theorists. In particular, A.I. Bugrii and V.M. Loktev developed a consistent theory of the Bose condensation for magnons. They managed to quantitatively describe effects that were observed experimentally.

The Institute's scientists V.P. Kravchuk and Yu.B. Gaididei proposed a method to change the polarity of a magnetic vortex in thin ferromagnetic films with the help of an alternating magnetic field. This is a key task for the creation of the non-volatile computer memory of a new generation, in which a bit of information is stored as the vortex polarity.

For certain interaction potentials, the partition function diverges. Such potentials are called catastrophic, and the study of corresponding systems demands the development of special methods. Institute's scientists B.I. Lev and K.V. Grygoryshyn proposed a new approach to the statistical description of the systems of interacting particles. It was used to explain a number of different phenomena, such as the formation of a Wigner crystal in Coulomb systems and the behavior of self-gravitating systems with the formation of a spatially non-uniform distribution of particles.

E.G. Petrov, A.L. Kapitanchuk, and E.V. Shevchenko developed a theory of electron transport processes in electrode–molecule–electrode nanodevices. The crucial role of the molecular recharging in the formation of hopping and direct tunnel currents between electrodes was demonstrated. The theory describes the experiment quite well. It also predicts that a rapid switching of electric potentials applied to the contacts results in turn-on and turn-off currents through the diode that are much higher in comparison with stationary ones. This effect has to be taken into consideration while analyzing the operation of molecular diodes, transistors, transmitters, switches, and so on.

In recent years, attention has been attracted to dusty plasma. This object is widespread under natural (in space) and laboratory conditions (gas discharges, plasma in technological devices, tokamaks, *etc.*). The corresponding consistent description demands that the self-consistent dynamics of charged dusty particles should be taken into account. A required generalization was performed on the basis of the first principles of statistical mechanics. The obtained kinetic equations formed a basis for the further development of the dusty plasma theory and the calculation of plasma properties.

Because of the limited volume of this publication, it is impossible to consider all trends of studies or to list all significant results. Impossible to present a full list of the results obtained. The corresponding detailed information can be found in the book *M.M. Bogolyubov Institute for Theoretical Physics of the NAS of Ukraine in 1966–2016* (Akademperiodyka, Kyiv, 2015).

An important piece of Institute's activity consists in its cooperation with leading scientific institutions abroad, and the efforts aimed at expanding the international cooperation are continued. The Institute initiated the creation of the Ukrainian National Grid, which coordinates the activity in this sphere and participates in supporting the communications with international networks. Institute's scientists are engaged to work in international research associations, conference organizing committees, editorial boards, and expert commissions for reviewing scientific projects. Every year, the Institute hosts several conferences on various branches of theoretical physics, often together with other institutions.

Large attention is paid to engaging the youth in scientific researches. Students and senior schoolchildren can obtain additional knowledge in physics and mathematics, as well as the first experience of a scientific work at the Scientific and Educational Center, which has been going at the Institute on a voluntary basis since 1999. Institute's scientists lecture more than 30 courses at leading universities of Ukraine. In addition, many of them are supervisors of B.Sc., M.Sc, and post-graduate student's theses.

During 50 years of the existence of the Institute, more than 10000 scientific works and 140 books were published, 83 Dr.Sci. and about 200 Ph.D. theses were defended. The Institute has the highest citation index among the scientific institutions of Ukraine. In 2015, 10 Institute's employees were included into the list of 100 most cited Ukrainian scientists. Among the awards for scientific achievements, there are two Lenin Prizes, 15 State Prizes of Ukraine in science and engineering, 22 Prizes named after the outstanding scientists of the NAS of Ukraine, 8 Prizes of the President of Ukraine for young sci-

entists and the NAS of Ukraine for young scientists. Today, the Institute is a recognized center of theoretical physics not only in Ukraine, but also in the world.

Together with other centers and institutions aimed at basic researches in theoretical physics, the Institute gives opportunity not to lag behind the developed countries and to keep a high educational level in physical disciplines. The Institute should undoubtedly continue to hold its worthy place in world's theoretical physics. This is one of its major tasks in the future. Institute's scientists meet the anniversary with the desire to successfully fulfil this task and to be worthy of their famous predecessors.

Director of M.M. Bogolyubov Institute
for Theoretical Physics of the NAS of Ukraine
Academician of the NAS of Ukraine
A.G. ZAGORODNY