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PERSONALIA

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In memory of Aleksandr Mikhaĭlovich Baldin

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It has already been two years that the outstanding Russian physicist, full member of the Russian Academy of Sciences, Aleksandr Mikhaĭlovich Baldin, has sadly not been among us.

Baldin was born on February 26, 1926 in Moscow, in the Krasnaya Presnya district. His school and student years came during the trying times of World War II and the post-war reconstruction of the country. He graduated from the Railway Technical Secondary School and became a student of the Moscow Institute of Transport Engineers. In 1946, along with other excellent students, he was invited to continue his education at the just created Moscow Mechanics Institute of Ammunition, later renamed the Moscow Engineering Physics Institute (MIFI).

In 1949, after graduation from MIFI, Aleksandr Mikhaĭlovich was sent to the P N Lebedev Physics Institute of the Academy of Sciences of the USSR (FIAN) where he gradually rose from Junior Research Scientist to Head of the Theory Sector, and became a Doctor of Sciences (DSc) and Professor. He matured as a scientist under the tutelage of the illustrious group of FIAN physicists gathered together by S I Vavilov. Baldin regarded D V Skobel'tsyn and M A Markov as his teachers.

Even Baldin's first research papers on the theory of motion of particles in a cyclic accelerator attracted the attention of experts, first of all of V I Veksler. This research effort, supervised by M S Rabinovich together with V V Mikhaĭlov, was connected with solving a broad range of problems stemming from the theory of cyclic accelerators. They contributed greatly to the physical proof of the feasibility of constructing an accelerator that was the largest in its day: the synchrophasotron at the Joint Institute of Nuclear Research (JINR). The 'envelopes technique' developed by the authors of the theory became a classic tool and is still widely used in accelerator-design computations.

At this time, Baldin got engrossed in mountaineering and became an exceptional mountain climber. Alpine climbing helped him in developing such character traits as a focused drive to a target, the ability to make decisions and to assume complete responsibility for an undertaking, and a strong will and courage — the qualities that fully manifested themselves in the subsequent period of scientific leadership and in overcoming the trials that life is full of.

At the beginning of the 1950s, in connection with the expansion of work on FIAN's electron synchrotron, Baldin (in partial collaboration with V V Mikhaĭlov) carried out for the first time the calculations of meson creation cross sections on nucleons and nuclei irradiated with high-energy photons. The polar model that this work introduced, taking into account anomalous magnetic moments of nucleons, was later substantiated and became an inseparable part of the

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Aleksandr Mikhaĭlovich Baldin
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dispersion relations method. His work in this field was rewarded with the USSR State Prize for 1973.

The study of Compton scattering carried out at FIAN and interpreted theoretically by Baldin in terms of the coefficients of electromagnetic polarizability of nucleons showed that 'elementary' particles — to which nucleons were assumed to belong — were not only spatially extended but also dynamically deformable systems (the corresponding discovery received a certificate in 1957).

Baldin's dispersion sum rule for the coefficients of electric and magnetic polarizability of nucleons, suggested in 1960, formed the basis for the first realistic estimate of the electric polarizability of the proton.

The experiment on the leptonic decay of the neutral vector φ-meson with a mass of 1020 MeV, carried out at JINR on the initiative and with participation of Baldin, confirmed, among other things, the presence of a 'hadronic' component of the photon responsible for the hadron-like behavior of cross sections of interaction of high-energy photons with nucleons and nuclei, and thus defined — if the image can be forgiven — the 'nuclear' properties of light. The idea of the transition of a massive particle in an intermediate state to a photon received the discovery certificate in 1971.

Generalizing the concepts of molecular optics, Baldin introduced into nuclear physics the concepts of the tensor and vector polarizabilities of nuclei, which describe the 'optical anisotropy' of atomic nuclei with non-zero spin.

In 1968 Aleksandr Mikhaĭlovich, on M A Markov's suggestion, was elected Director of the Laboratory of High Energies (LHE) of the Joint Institute of Nuclear Research, Dubna. Baldin, still quite young, shouldered the responsibility for rethinking and reshaping the scientific program of the LHE founded by V I Veksler, for maintaining and expanding the research foundation, but first and foremost, for 'Veksler's baby' — the synchrophasotron. This unique facility, whose creation required an enormous effort in the difficult post-war years, made it possible to generate important results in elementary particle physics. It also launched the creative careers of an entire generation of experimentalists.

Baldin, as the new leader of a large research community, had to define the priorities in the development of the accelerator and of the experimental complex of the LHE. As the main target, Baldin chose the study of interactions between nuclei at relativistic energies. To achieve this, he led the work of transformation of the synchrophasotron into a unique accelerating complex of relativistic and polarized nuclei.

At the beginning of the 1970s Aleksandr Mikhaĭlovich defined long-term targets for research in relativistic nuclear physics — which for USSR physicists was a high-priority field of research at the junction of the physics of atomic nuclei and elementary particles. This orientation aimed at establishing the limits of applicability of the proton-neutron model of the atomic nucleus and of the construction of the physical picture of nuclear matter at the level of subnucleonic components — quarks and gluons. The synchrophasotron of the Laboratory of High Energies of JINR was the first accelerator in the world where beams of relativistic nuclei with energies on the order of several GeV per nucleon were produced.

Relativistic nuclear physics sprang from the foundation formed by the achievements of quantum field theory, elementary particle physics, nuclear physics, and accelerator physics. Born in Dubna, relativistic nuclear physics became an essential part of research programs in the largest accelerator centers of the USA, Europe, Russia, and JINR member states. In this context, the LHE dynamically developed an extensive experimental program of collaboration in particle physics with the High Energy Physics Institute at Protvino, the Fermi National Accelerator Laboratory and the Brookhaven National Laboratory in the USA, the European Organization of Nuclear Research (CERN) in Geneva, and many others.

The boundless energy, the gift of scientific foresight, the ability to work extra hard, and the knack for persuasion and forming a team which Aleksandr Mikhaĭlovich manifested during the period of maturation of relativistic nuclear physics were beyond the imagination. It seems that the entire potential of this extraordinary personality found an outlet to express itself. His broad scope of interests and exceptional erudition in many fields of modern physics and his profound understanding of the physical experiment earned him the reputation of a universal physicist in the scientific community. He not only suggested ideas for new experiments but was also their immediate organizer and participant.

The first success in this direction was Baldin's prediction of the nuclear cumulative effect. Experiments in Dubna showed that at energies on the order of several GeV, the creation of particles in nuclear collisions reached asymptotic mode. In other words, as collision energy kept increasing, either the physical picture of the creation of secondary particles in the fragmentation of nuclei remained unchanged or the state of the so-called limiting nuclear fragmentation was reached (this concept was introduced by Baldin). In this region the quark and gluon degrees of freedom begin to play a significant role. A spectacular feature of the nuclear fragmentation process is the extension of these properties to cumulative particles created beyond the kinematic limit of collisions between free nucleons. In terms of the parton model, this feature became an indication of the presence of multi-quark states in nuclei.

It was found that the picture of nuclear fragmentation at relativistic energies had many common features with the already familiar specifics of the proton – proton interaction and deep inelastic scattering of electrons by protons at high energies. The empiric regularities discovered in this work allowed Baldin to derive a universal momentum distribution of protons in nuclei — the quark-parton structural function of the nucleus — which immediately stimulated progress in the theoretical description of the nucleus at distances below the nucleon size.

Baldin suggested universal approaches to describing not only the spectra of singular particles but also the entire pattern apparent in the multiple creation of particles in nuclear collisions. He introduced the description of the nuclear collision process in the space of four-dimensional velocities based on the 'self-similarity principle'. A universal law was discovered and studied, allowing one to analyze cumulative sub-threshold processes, the formation of anti-nuclei, and processes in the transition region from nucleonic to quark-gluon degrees of freedom.

The spectacular results obtained by Baldin in relativistic nuclear physics were included in the collected papers published by a group of authors that in 1988 won the country's highest prize in scientific research — the Lenin Prize.

Aleksandr Mikhaĭlovich spearheaded important work on developing new ion sources. Experimental research with beams of polarized deutrons held a special place. Experiments with beams of polarized neutrons were also conducted. As a result, new important information was obtained on the spin structure of deutron at nuclear distances below the radius of nucleons.

The results of the first period of research with relativistic nuclei allowed Aleksandr Mikhaĭlovich to suggest and justify the idea of creating a specialized accelerator of relativistic nuclei — a nuclotron operating with superconducting magnets in a magnetic system. The clear recognition of the goal and the talent of the brilliant organizer helped Baldin to raise the enthusiasm of the LHE team around the new task. Under his guidance, unique engineering problems were solved, such as the most important problem of creating fast-cycling superconducting magnets and a helium liquefaction facility. The launching and subsequent expansion of the Nuclotron in the 1990s opened qualitatively new possibilities for studying the properties of atomic nuclei.

Aleksandr Mikhaĭlovich paid maximum attention to applying the achievements of relativistic nuclear physics and of nuclotron technologies to creating nuclear power facilities controlled by the accelerator and to problems of the transmutation of radioactive wastes and to radiation studies that benefited space flights.

Academician Aleksandr Mikhaĭlovich Baldin played a multifaceted role as science organizer. He was Chairman of the Council of the Russian Academy of Sciences on Electromagnetic Interactions, a member of the Bureau of the Nuclear Physics Division of the Academy, editor-in-chief of the journals *Fizika Elementarnykh Chastits i Atomnogo Yadra* (Physics of Particles and Nuclei) and *Pis'ma v EChAYa* (Physics of Particles and Nuclei, Lett.), and a member of editorial boards of many scientific publications. Among the conferences he organized were International Seminars on Problems of High Energy Physics, whose history dates back to 1969, and which hold a special place.

Baldin considered the training of new generations of scientists as his very important task. Among his students we find dozens of DSc and PhD physicists. He read lectures at the M V Lomonosov Moscow State University and at MIFI and taught at the research center of JINR and at many international physics schools. Baldin made very important contributions to fostering high-class specialists in JINR member states. In Dubna he created a scientific school that included well-known theorists and experimentalists, experts in accelerator technology.

In his talks and publications devoted to general aspects of the strategy of research, Baldin never tired of emphasizing the influence of centers of modern large-scale science on scientific and technological progress. His careful attention to these problems was dictated by the feeling of the important responsibility of a citizen to his country, by his state-wise approach, and by his profound understanding of the role played by science in modern society.

The achievements of Academician Baldin, an outstanding scientist, one of the foremost organizers of science, were rewarded by the Lenin and State Prizes, by the V I Veksler Prize of the Russian Academy of Sciences, and by orders and medals given to him by Russia, Bulgaria, Vietnam, Mongolia, Poland, the Czech Republic, and other countries. Aleksandr Mikhaĭlovich became an Honorary Citizen of the town of Dubna.

Aleksandr Mikhaĭlovich Baldin's devoted service to science, his impeccable record as a responsible citizen, his refined intelligence, his constant attention to people's needs, and his emphasis on social justice always earned him sincere respect. He worked hard and with exemplary honesty, and he did much good for people. We will always hold the memory of this outstanding man in our hearts.

V G Kadyshevskiĭ, A A Komar, O N Krokhin,
A A Logunov, A I Malakhov, V A Matveev,
Yu S Osipov, V A Rubakov, A N Sisakyan,
A N Skrinskiĭ, A N Tavkhelidze, D V Shirkov