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PERSONALIA

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Lev Mitrofanovich Barkov (on his seventieth birthday)

On October 24, 1998 Academician Lev Mitrofanovich Barkov was 70. He is head of a laboratory at the G I Budker Institute for Nuclear Physics of the Siberian Branch of the Russian Academy of Sciences.

One of a galaxy of brilliant physicists of the first graduating class of the Physicotechnical Department of Moscow State University (today the Moscow Institute of Physics and Technology), L M Barkov began to work at the Accelerator Laboratory LAN-2 (later renamed LIPAN and today the internationally-known Russian Research Centre 'Kurchatov Institute') even when he was still a second-year student. Later he was transferred to the division headed by I I Gurevich, a Corresponding Member of the USSR Academy of Sciences, whom he deeply respected and considered his main teacher.

At the time his interests lay in the field of measurements of the energy spectra of neutrons that emerge in the fission of uranium and plutonium nuclei and the study of their moderation and diffusion in uranium – water systems. The methods of using photographic emulsions and counters developed in these experiments have been repeatedly used in Barkov's further research.

All this work was related to building uranium – water nuclear reactors for nuclear power stations, nuclear submarines, and atomic icebreakers. Only in 1955 did this work become known to the public: L M Barkov presented his findings at the First International Conference on Peaceful Uses of Atomic Energy in Geneva (he was probably the youngest participant of that conference).

During the same period in his scientific career, Lev Barkov became interested in experiments involving high-energy particles. From 1952 up to the end of the 1950s, he actively participated in research on the production and interaction of low-energy pions in the Dubna phasotron and synchrocyclotron. In experiments based on the emulsion method, the Coulomb shift in the spectra of charged pions was discovered for the first time.

The study of the physics of the interaction of pions and kaons was continued in experiments using a propane bubble chamber in a pulsed magnetic field. The setting-up of such experiments, as well as the entire experimental work, required a lot of effort and many working hours. To name just one example, to assemble the device used in scanning the pictures, the team of researchers developed a technique for manufacturing diffraction gratings on photographic emulsion plates with a spacing of 20 μm and more than 20 cm long, and the technique was simple, reliable, and extremely cost-effective (this is characteristic of all the work done by L M Barkov and is especially important for the present state of affairs in science in Russia). Equally simple and ingenious solutions was found at the stage when the electronics of the experiment was being developed.

The year 1967 began a new period in the scientific career of L M Barkov: Gersh Itskovich Budker invited him to work at the

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newly organized Institute for Nuclear Physics of the Siberian Branch of the USSR Academy of Sciences. Here he continued his research on the structure of hyperons. The experiment proposed by him to measure the magnetic moment of the Σ^--hyperon, which used the electron beam from the storage ring in VÈPP-3, was based on using a very high magnetic field with a strength of about one megagauss. To reach such field strengths, the newest ideas about explosive-magnetic generators were utilized. In these experiments, the magnitude of the pulsed magnetic field was determined by an ingenious optical method in which the angle of rotation of the light polarization plane in heavy flint glasses was measured. Solid hydrogen was taken for the target, and the hyperon decay products were registered by a nuclear photographic emulsion. Later the same method was used in experiments to measure the magnetic moment of the Λ^0-hyperon at the Serpukhov accelerator with 70 GeV protons. What was measured was the antiproton production cross section for the interaction of high-energy protons with various nuclei. This was very important in view of the construction of the proton – antiproton collider at CERN.

Lev Barkov became one of the initiators of building the electron – positron collider VÈPP-2M at the Institute for

Nuclear Physics of the Siberian Branch of the USSR Academy of Sciences. This device, with center-of-mass beam energies ranging from 2×180 MeV to 2×700 MeV and luminosities of about 3×10^{30} cm^{-2} s^{-1}, was a prototype of modern ϕ-factories. For this collider Lev Barkov designed an entirely new type of detector — there was simply no such detector in the entire Soviet Union! In it the magnetic field was induced by a superconducting solenoid and an optical spark chamber operating at cryogenic temperatures and elevated pressures. At the design stage he displayed his skills as a scientist and administrator: at the time the Institute had no specialists in the field of superconductivity, low-temperature physics, and the then new proportional chambers, and so Barkov posed the problem of building a cryogenic magnetic detector (CMD) to future scientists, who were then only students. The approach proved to be fruitful — the detector was built, and the chamber position resolution achieved in the real experimental conditions, 50 μm, is a record that has yet to be broken.

As a result of the experience acquired in building the CMD, the Institute became equipped with the necessary devices for producing liquid helium, and new knowledge was gathered in constructing large superconducting devices, knowledge that was later successfully used in manufacturing the famous 'Siberian snakes' (wigglers), the undulators and solenoids of a new generation of detectors.

In the mid-seventies, Lev Barkov became obsessed with the idea of using X-ray luminescent element analysis via synchrotron radiation to find the island of stability for superheavy elements. He helped to design and build the world's first twenty-pole superconducting wiggler, which made it possible to produce a 1.2-kW beam of X-ray synchrotron radiation, i.e. the brightness of the source in the X-ray range was increased by a factor of 200! At the same time, when work on building a new source of radiation was in progress, unique experimental devices for X-ray fluorescent analysis were under construction. These devices increased the sensitivity of the method by an additional factor of 100. Despite the fact that no superheavy elements were discovered in the experiments, Barkov's work contributed significantly to the development of the technology of generating synchrotron radiation and to applications involving synchrotron radiation.

Also, when the CMD was being developed, Lev Barkov carried out an experiment on VÈPP-2M in which the mass of a charged kaon was measured precisely. The reaction used in this experiment was $e^+e^- \to K^+K^-$, and the kaon momentum was measured by the path in the photoemulsion stack. To measure the beam's energy, the resonance depolarization method, which had just been developed at the Institute, was used.

The 1970s and 1980s proved to be a very intensive period in Barkov's life. In 1974 – 1978, he and M S Zolotarev conducted an experiment in which the rotation of the polarization plane of light emitted by atomic bismuth vapor was observed. The rotation of the polarization plane suggested that there is weak electron – nucleon interaction for which neutral currents are responsible. The magnitude of the observed effect amounted to 7×10^{-7} radians, which was thousands of times smaller than the background contributions. To measure such a minute effect, the researchers had to think up solutions and actually construct new devices, some of which were later protected by international patents. The results of these observations formed one of the cornerstones of the Standard Model.

The precision measurements of masses and widths were continued in CMD experiments. The accuracy of measuring the mass of the short-lived neutral kaon has yet to be surpassed. A USSR State Prize was awarded for the entire cycle of these precision experiments.

Experimenting with the VÈPP-2M electron – positron collider, Lev Barkov attempted, using a specially designed detector with a large decay volume, to extract new information about very subtle effects of combined-parity nonconservation from decays of the short-lived neutral kaon. These pioneering experiments began an extremely interesting avenue of research in modern physics, which was later developed in experiments with the KLOE detector at the Frascatti facility.

The CMD experiments had not been completed when Lev Barkov with collaborators initiated the development of a new universal detector, which became known as CMD-2. This detector had all the ingredients characteristic of modern devices of this type: a superconducting solenoid, a jet-type drift chamber, an electromagnetic calorimeter based on the use of CsI crystals in the cylindrical part and BGO crystals at the ends of the detector, and a muon identification system that used tubes with a restricted streamer discharge.

The new detector was mounted 'onto' the beam from the storage ring of VÈPP-2M in 1991, and experiments with it continue to this day. A vast body of data on rare decays of light vector mesons was gathered, including data on radiative decays of the ϕ-meson into a photon and a scalar meson (these decays could provide the answer to the problem of the possible four-quark structure of the f_0-meson). In these experiments the $\phi \to \eta'\gamma$ decay was detected for the first time (the probability of this decay depends to a great extent on the importance of gluons in the formation of the inner structure of the η'-meson). Just as with the problem of establishing the structure of the f_0-meson, finding the fraction of gluons inside the η'-meson is extremely important for the further development of QCD, which is the modern theory of strong interactions. Another major class of experiments involving the CMD-2 device is concerned with the study of the inner structure of charged pions. These experiments are based on the work done by Lev Barkov in the early days of his scientific career, when they occupied a notable place in the Institute's scientific program. Experiments in measuring the pion form factor continue and contribute invaluably to world science.

Lev Barkov combines intensive research with teaching and giving public lectures. His enlightening lectures and personal influence have helped several generations of students of Novosibirsk State University to become physicists.

Friends and colleagues congratulate Lev Mitrofanovich Barkov on his seventieth birthday and wish him a lot of health, happiness, and highly productive scientific work in the many years to come.

V E Balakin, S T Belyaev, N S Dikanskiĭ,
G I Dimov, È P Kruglyakov, G N Kulipanov,
V V Parkhomchuk, V A Sidorov, A N Skrinskiĭ,
B I Khazin, I B Khriplovich, B V Chirikov,