MOISEĬ ALEKSANDROVICH MARKOV

(on his sixtieth birthday)

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ON May 1968 Academician Moiseĭ Aleksandrovich Markov reached his sixtieth birthday; approximately 40 of his years were devoted exclusively to physics, or more accurately to the physics of elementary particles. Elementary-particle physics was always his principal all-absorbing passion. It is very difficult to imagine Markov not attracted with a new idea pertaining to the most important problems of this branch of science. It is also difficult to imagine the development of the physics of elementary particles in the USSR without Markov's unique thinking, his striking intuition, and his ability to separate the most promising trends at the very start of their development.

Markov was born in the village Rasskazovo in the Tambov Province, and has been living in Moscow since 1921. In 1926 he enrolled at the Moscow University, in which he passed in succession through all stages: student, graduate student, lecturer, and professor. However, his main scientific activity is connected with the Lebedev Physics Institute of the USSR Academy of Sciences (FIAN), where he has been working since the very founding of the institute in 1934.

Markov's scientific activity is characterized by a tendency to investigate the most fundamental laws of nature. This is probably why he has been so attracted to theoretical problems in the early years.

At the center of his research are problems of quantum theory of pointlike particles (the well-known difficulties with infinite self-energy). One of the first to use the so-called many-time formalism, almost ten years before this method became universally recognized, Markov criticized in his 1940 article "On the Four-dimensional Extended Electron" the numerous attempts to overcome these difficulties by introducing finite particle dimensions. It was shown in that paper that the introduction of the particle dimensions is inevitably connected with rejection of the modern scheme of quantum mechanics, the so-called Hamiltonian formalism. In this important paper, Markov first advanced the idea of developing a theory of nonlocalizable fields. The premises developed by Markov in that paper exerted a tremendous influence on the succeeding development of the idea of nonlocalizable fields, which is presently among the most important ideas being developed in the world's literature. These thoughts were developed by Markov after the war in the papers "Concerning One Criterion of Relativistic Invariance" (1946), "On Nonlocalizable Fields" (1950), and many others. In a 1953 paper, Markov analyzed the situation that has developed with respect to this question and advanced, on the basis of his analysis, the concept of a dynamically deformable form factor.

Markov's significant work of the pre-war period includes also research on the theory of particles with spin $\frac{1}{2}$. It should be noted that he obtained in these

papers, using group-theory methods, all the laws of conservation and relativistic theory of the electron, and proposed an interesting variant of describing particles with spin $\frac{1}{2}$ on the basis of a second-order equation. This equation was used by Markov subsequently for a possible and very unexpected explanation of the origin of the mass difference between the new one and the electron.

In the post-war years Markov, perceiving the tremendous importance of accelerator experiments for the solution of fundamental problems in elementary-particle physics, was one of the first theoretical physicists in the Soviet Union who engaged actively in the development of programs for such experiments, first at FIAN, and then in Dubna. He revealed very clearly his ability to combine abstract research with the solution of concrete problems of elementary-particle physics.

As a rule, Markov separates and investigates, together with his students, precisely those problems which turn out later to be of decisive significance for the progress of theory, and estimates of ways of its development. For example, starting with the idea of the dynamically deformable form factor, he concluded

on the basis of a special model that there can exist a large number of short-lived excited states of baryons and mesons ("resonances"). These considerations were developed by Markov in 1955 in a more general form free of model concepts. A book on hyperons and K-mesons, written by him in 1957, summarized his important researches on models and classification of elementary particles, systematized the experimental data, and outlined an extensive experimental program. In this book, Markov posed a number of very important problems for experimenters. For example, he proposed ("as most urgent at the present time" (1957)) to seek for violation of time reversibility in experiments with neutral K mesons. The subsequent years demonstrated the validity of Markov's predictions, particularly those concerning searches for unstable very short-lived states of elementary particles.

Considering the possibilities of using field theory to justify the systematics elementary-particle proposed by him, Markov and his students carried out in the middle 50's a detailed analysis of nonlinear spinor field theories. In this work he obtained interesting results on the separability of the vector variant of four-fermion interaction, on the possible transition of weak interactions into strong ones, etc.

A large contribution was made by Markov to neutrino physics. In 1948 he investigated the influence of the neutrino mass on the upper end point of the spectrum of the beta-decay electrons. In 1950 he investigated the physical manifestations of neutrinos and antineutrinos. In 1957 he called attention to the fact that the large number of forbidden reactions give grounds for regarding the neutrino emitted together with the muon as a particle that is not identical to the neutrino emitted in beta decay. He also developed a concrete scheme, in which the muon and muonic neutrino are carriers of a new quantum number. (The existence of two types of neutrinos was confirmed experimentally in (1962.)

Special notice should be taken of the interesting suggestions made by Markov (1958–1961) concerning the organization of underground neutrino experiments aimed at studying the interaction between neutrinos and matter at high energies not attainable in accelerators, and also searches for possible sources of extragalactic neutrinos. These suggestions gained international recognition, and experiments performed in 1965 (in India and in Africa) confirmed Markov's calculations and demonstrated the effectiveness of the new research trend proposed by him. Markov's work on weak interactions were systematized in a recently published monograph "Neutrinos."

At Markov's initiative, a laboratory for neutrino physics was organized at FIAN a few years ago to carry out extensive investigations of the properties of cosmic neutrinos.

While working in laboratories devoted to the experimental investigations of high-energy physics, Markov was able to gather entire staffs or theoretical physicists, whose scientific interests were closely connected with the problems dealt with in these laboratories. Greatly contributing to this success were his many years of teaching experience at the Moscow State University. His lectures entranced the listeners from the very first words, and many physicists owe the choice of their specialty and their scientific interest to his influence. Markov's students are distinguished for a specific field of interest, connected in one manner or another with his deep ideas and independence of the whims of the latest scientific vogues.

Markov's organizing talent was particularly revealed recently. It is no accident that the scientific community has unanimously approved his candidacy for the post of Academician-Secretary of the Division of Nuclear Physics of the USSR Academy of Sciences.

Markov approached this activity, which was new to him, with his usual sense of responsibility and ability of introducing a creative element in everything. However, in spite of his tremendous preoccupation with the scientific-organizational matters, he continued his research. He is now attracted by the idea of the influence of gravitation on the elementary-particle properties.

Persons working closely with Markov are always struck by his great love for science, his tremendous enthusiasm, and his striking capacity for work. These qualities are proof that we shall be hearing from him concerning new unusual ideas and interesting undertakings.

Translated by J. G. Adashko