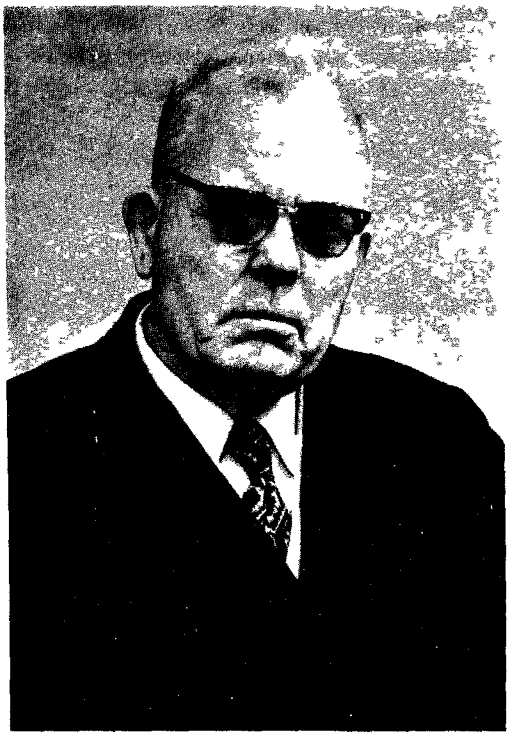
# Mikhail Grigor'evich Meshcheryakov (on his seventieth birthday)

L. S. Azhgireĭ, N. N. Bogolyubov, N. N. Govorun, and I. M. Frank

Usp. Fiz. Nauk 132, 197–200 (September 1980)
PACS numbers: 01.60. + q



MIKHAIL GRIGOR'EVICH MESHCHERYAKOV

Corresponding Member of the USSR Academy of Sciences Mikhail Grigor'evich Meshcheryakov, a noted Soviet physicist, a major organizer of scientific research, and twice a USSR State Prize Laureate, celebrated his seventieth birthday on September 17, 1980. He belongs to the circle of Soviet scientists who participated actively in solution of the nuclear problem in our country, tackled the development of large accelerators, performed research in the area of nuclear and elementary-particle physics, and began work toward the automation of scientific research.

Meshcheryakov was born into a peasant family in Rostov Oblast'. While still a student in the physics department at Leningrad University, he specialized in the physics of natural and artificial transformation of atomic nuclei in the seminar headed by Professor L.V. Mysovskiĭ. After completing his university studies with honors in 1936, he worked for three years as a graduate student under Prof. I.V. Kurchatov at the Radium Institute of the Academy of Sciences, of the USSR which was then building our country's first cyclotron and beginning pioneering research in neutron physics and the radiochemistry of the products of artificial nuclear transformations. Meshcheryakov emerged from the atmosphere of these studies as an experimental physicist.

The initial period of Meshcheryakov's scientific career was associated with research on the resonance absorption of slow neutrons by nuclei. In 1938, he became actively engaged in the work on startup of the one-meter cyclotron. He scored a major success in the experiments performed on the cyclotron, in which the radiative capture of 1 MeV neutrons by many nuclei was studied. He established that the cross section of this process fluctuates strongly as the mass number of the nucleus rises. This result, which was something of a sensation in that it contradicted the then generally recognized statistical theory of nuclear reactions that had been developed by N. Bohr, was later to become one of the basic arguments in favor of the shell model of the nucleus.

In 1940, Meshcheryakov headed up a laboratory at the Radium Institute of the Academy of Sciences of the USSR which had what was then the only working cyclotron in our country, or, for that matter, in Europe, that could accelerate deuterons to 4.4 MeV energies, and proceeded with a study of $(d,p)$ reactions on heavy nuclei, the mechanism of which had recently been extensively discussed by R. Oppenheimer, M. Phillips, and L.D. Landau on the assumption that the incident deuteron approaching the nucleus breaks up in its Coulomb field.

Meshcheryakov was at the front at the outbreak of the Second World War. After being discharged from a military hospital and demobilized, he resumed his work on the nuclear problem. He investigated the possibility of producing large amounts of fissioned heavy-element isotopes with the aid of electromagnetic separators and thermal-diffusion columns. In 1944, soon after the Siege of Leningrad was broken, he and his colleagues rebuilt the Radium Institute cyclotron and used it to perform a long series of bombardments of uranium blocks in connection with the development of a factory technology for production of plutonium from uranium. During this time, using the cyclotron as a mass spectrometer with very high resolution, he and his coworkers ran a series of experiments to determine the isotope composition of helium samples from various sources. An extremely sensitive method for recording single accelerated helium ions at the exit of the cyclotron with the aid of layers of nuclear emulsions applied to glass was first proposed and realized in these studies. It was established in this way that the ratio of the content of the isotope $He^3$ to that of $He^4$ in helium of radioactive origin is smaller than $3 \cdot 10^{-10}$, whereas the ratio in helium from gas wells is about $10^{-7}$. Hence a conclusion of importance for geochemistry: the helium released by the earth does not all originate from the natural decay of heavy radioactive nuclei. At the

 0038-5670/80/090625-03$01.10 © 1981 American Institute of Physics 

same time, the upper limit ($\sim 10^{-14}$) of occurrence of the isotope $He^5$ was established in helium samples of various origins, evidence clearly indicating the instability of the $He^5$ nucleus at a time when its existence was just being discussed. The first observation of the ($He^3, He^4$) reaction on nuclei in photoemulsions belongs to the same series of studies.

In 1946–1947, Meshcheryakov worked as a scientific expert for the Technical Committee of the United Nations Atomic Energy Commission.

After his return from the United States in 1947, Meshcheryakov was transferred to Moscow, to Laboratory No. 2 (now the I.V. Kurchatov Institute of Atomic Energy of the Academy of Sciences of the USSR) and was named scientific supervisor of research on the design and construction, near the settlement of Bol'shaya Volga (now Dubna), of what was then the world's largest accelerator—the six-meter synchrocyclotron. Using the experience gained in the construction and startup of the *one-meter cyclotron* at Leningrad, he and his co-workers met tightened schedules for physical modeling of the new accelerator and successfully solved a number of complex scientific-technical and organizational problems relating to the design and construction of the six-meter synchrocyclotron and providing it with a specialized scientific laboratory.

At the same time, Meshcheryakov was also conducting experimental studies in nuclear physics. In 1947–1949, he and his co-workers continued their study of the $(d,p)$ reaction at 15.4 MeV on the 1.4-meter cyclotron of Laboratory No. 2 and discovered a new feature of this reaction: deuteron capture into low-lying levels of nuclei.

The emission of subbarrier protons in the $(\alpha,p)$ reaction at 26.4 MeV with the probability much higher than would follow from the usual conceptions was also observed in the experiments on the 1.5-meter cyclotron.

With the successful startup of the synchrocyclotron at the end of 1949 and the rapid development of experiments performed on it by a number of institutes of the Academy of Sciences of the USSR, a new field of research, the physics of high-energy particles, appeared in our country. Soon thereafter, Meshcheryakov organized an independent research center for high-energy physics around the synchrocyclotron with the support of I.V. Kurchatov and became its scientific supervisor. In 1953, this center was reorganized as the Institute of Nuclear Problems of the Academy of Sciences of the USSR of which Meshcheryakov served as director to the middle of 1956, when the institute was incorporated into an international scientific center—the Joint Institute of Nuclear Research.

In 1950, Meshcheryakov plunged with his characteristic enthusiasm into a study of nucleon-nucleon interactions above the threshold of pion formation. Here we should mention first his discovery, jointly with B.S. Neganov, of the resonant nature of the $p+p\to\pi^+ +d$ reaction. This result, which has been widely recognized in world science and has unflinchingly withstood the onslaught of new studies in this area, started a new trend in the physics of nucleon-nucleon interactions—essentially, as it turned out, a physics of resonant states. The first study of pulsed spectra of charged pions and the associated secondary protons, which was made with the aid of large magnetic spectrometers, also established the resonant nature of other processes that form pions in $pp$-collisions. Meshcheryakov summarized this stage of the research in his address to a general assembly of the Academy of Sciences of the USSR in 1955.

Another internationally recognized area in which Meshcheryakov and his colleagues have worked was a detailed study of polarization effects in double and triple elastic $pp$-scattering in the 660 MeV energy range. In the aggregate, the results of these experiments led to determination of the matrix elements and phases of $pp$-scattering in a previously unstudied range of energies.

A series of studies that Meshcheryakov undertook in 1955 also proved highly productive: here high-energy *protons were used as test particles to study the structure of nuclei*. Using what was at that time the world's largest magnetic spectrometer to study momentum spectra of secondary particles emitted in proton-nucleus collisions, he and his colleagues discovered a new process—direct knockout of deuterons from nuclei by 675 MeV protons. This result, which was confirmed ten years later at Brookhaven with acknowledgment of the priority of Meshcheryakov's group, was a weighty proof of the existence of collective interactions of incident fast hadrons with intranuclear nucleons. A similar conclusion also resulted from experiments in which the energy spectra of pions formed by protons incident on nuclei and the momentum distributions of nucleons in nuclei were measured. Among other results of this broad range of studies we should note observation of the continuum in secondary-proton spectra that results from excitation of giant resonance in nuclei by incident photons, establishment of different radial dependences of the spin and spinless scattering amplitudes of the "isotropic depolarization" of pions in the original nuclei.

On the whole, Meshcheraykov's initiative in study of nuclear structure effects in secondary-particle spectra and of proton-nucleus collisions at high energies had a strong influence on the subsequent development of relativistic nuclear physics.

In 1966, Meshcheryakov took charge of the work to organize a special laboratory of the Joint Institute of Nuclear Research to equip scientific research in nuclear and elementary-particle physics with new computer and automation tools. With this redirection of his scientific activity, Meshcheryakov demonstrated profound understanding of contemporary trends in the development of several scientific fields. Working under a tight schedule, the new laboratory that he headed built a gigantic complex of powerful computers, designed highly productive scanning devices and projectors to process bubble-, spark-, and streamer-chamber photographs, and built graphic displays and electronic interfaces for use between the experimental setups and the computers.

The new hardware developed by the Laboratory of Computer Technology and Automation significantly broadened the spectrum of experimental and theoretical research in the Joint Institute and has found applications in various other organizations in our country.

In the early 1970s, Meshcheryakov resumed his studies in the field of relativistic nuclear physics. With his students, he built a large automated magnetic spectrometer with a detection system consisting of a set of scintillation counters and two-coordinate spark chambers and used it to investigate *dp* and *dd* interactions employing incident-deuteron momenta up to 8.9 GeV/*c*. These experiments results in the first observations of two-peak structure at high momenta in the spectra of secondary deuterons from *dd* collisions at 6.3 and 8.9 GeV/*c*, inelastic coherent processes of pion formation in *dp* and *dd* collisions without break-up of the incident deuterons, and also dissociation processes of relativistic deuterons incident on nuclei with simultaneous formation of pions. Also of unquestionable interest for the theory of hadron-nucleus interactions was the establishment in this series of studies of a quantitative difference in the nature of the space-time development of quasielastic scattering of high-energy protons and deuterons by nucleons within the nucleus.

In his work on problems of relativistic nuclear physics, Meshcheryakov devoted much attention, apart from the spectroscopic experiments listed above, which were inclusive in their design, to another approach as well: the observation of elementary nuclear-process events at high energies. In 1970–1978, he participated actively in the Joint Institute's work to develop a two-meter streamer chamber in a magnetic field, with which it was possible to obtain valuable information on processes that take place when nuclei collide with nuclei that have been accelerated to very high energies.

Meshcheryakov has devoted much time and effort to the training of scientific cadres. He has been a Professor at Moscow University since 1953, guiding the work of graduate students and teaching a course on elementary-particle physics that attracts continuing interest from physics-department graduates. Both as a lecturer and as a director of scientific seminars, he has had a great influence on the forming of many physicists who are now heads of important scientific teams.

Meshcheryakov combines his scientific work productively with social activity. At various times, he has been a member of the executive of the Division of Physico-Mathematical Sciences of the Academy of Sciences of the USSR, a member of the Scientific Council of the Physics Department of Moscow State University, he has served on the Editorial staffs of the journals "Átomnaya Énergiya," "Yadernaya Fizika," and "Zhurnal Éksperimental'noǐ i teoreticheskoǐ Fiziki," and as a member of the Physics Section of the Committee on Lenin and State Prizes and of the Expert Commission on Physics in the Commission on High Degree.

Meshcheryakov is now Chairman of the Scientific Council on Utilization of Computer Technology and Automation in Experimental Nuclear Physics of the Division of Nuclear Physics of the Academy of Sciences of the USSR. He is on the editorial boards of the journals "Nuclear Instruments and Methods" and "Fizika elementarnykh chastits i atomnogo yadra." He also had a major part in the organization within the JINR of creative scientific collaboration between physicists of the Soviet Union and of socialist countries.

Meshcheryakov's scientific work has been recognized with high honors. He was twice a winner of the USSR State Prize and has been awarded three Orders of Lenin, the Orders of the Red Banner of Labor and Red Star, the Badge of Honor, and numerous medals, as well as several orders and medals of socialist countries.

Meshcheryakov was elected a Corresponding Member of the Academy of Sciences of the USSR in 1953.

Such traits as a sense of responsibility for the general state of the physical sciences in our country, high professional mastery combined with a broad approach to the object of research, and the ability, with reliance on mathematical apparatus, to rise above the level of purely qualitative, descriptive analysis of experimental results are characteristic of Meshcheryakov's creative profile both as a citizen and as an experimental physicist. Those around him are astonished by his energy, which does not seem to diminish with the years, by his optimistic enthusiasm concerning science, by his untiring creative drive, and by his ability to concentrate his attention on the problem selected.

After seventy years, forty of which have been devoted to research activity, Mikhail Grigor'evich enjoys the flourishing state of his creative powers, and, is to many of his students and followers, an example of selfless devotion to Soviet science.

Translated by R. W. Bowers