Anatoliĭ Petrovich Aleksandrov (on his seventieth birthday)

L. A. Artsimovich, I. I. Guervich, S. N. Zhurkov, I. K. Kikoin, Yu. S. Lazurkin, V. A. Sidorenko, V. M. Tuchkevich, and N. A. Chernoplekov

Usp. Fiz. Nauk 109, 415-418 (February 1973)

Anatoliĭ Petrovich Aleksandrov, Academician and a prominent Soviet physical scientist, one of the foremost organizers and directors of research on atomic science and engineering in our country, celebrates his 70th birthday in February of 1973.

Aleksandrov was born into the family of a teacher at Tarashcha in the Ukraine. After completing studies at the First Trade School in Kiev, he worked as an electrician, and then taught physics and chemistry at one of the Kiev schools from 1923 through 1930; also in 1930, he graduated from the Physicomathematical Department of Kiev University. His first scientific paper, "High-Voltage Polarization in Ceresin," had been published in 1929. Academician A. F. Ioffe became aware of it at the 1930 Congress of Physicists at Odessa, and invited Aleksandrov to work at the Leningrad Physico-technical Institute. The young physicist accepted with pleasure.

Aleksandrov's early studies at the LPTI were devoted to the electrical breakdown of dielectrics. They demonstrated that the dielectric strength of thin films is independent of their thickness, and forced abandonment of the avalanche theory of impact ionization of solids, which had been taking form at the time. Aleksandrov's experiments demonstrated the importance of so-called "weak spots" in electrical breakdown. The notion of the special role of weak spots was also productive later in application to study of the laws of brittle fracture in solids under mechanical loads.

A statistical theory of brittle strength was elaborated and substantiated experimentally in these studies. The ideas that it enunciates retain their validity even for the modern physical theory of the service lives of materials.

In 1933—1934, Aleksandrov performed a series of studies of the physical and especially the chemical properties of polystyrene—a dielectric that was later to be used extensively in high-frequency technology. The selection of polystyrene as an object of investigation had been dictated by theoretical considerations pertaining to the creation of a material with minimal dielectric losses at high frequencies, as set forth in the paper "The Physicochemical Properties of Styrene" (1933). In this same paper, Aleksandrov arrived at the conclusion that "the physicochemical properties of styrene give us reason to believe that it will come into widespread use," and that "its high viscosity and low polarizability will naturally result in very small dielectric losses. This will permit successful use of polystyrene for purposes of high-frequency insulation." These predictions were to be fully borne out.

The foundations of a new science—polymer physics—were being laid in the mid-1930's. Synthetic polymers were beginning to find rapid acceptance in technology, chiefly as structural and electrical-insulation materials. In this context, study of their mechanical and electrical properties was of substantial practical as well as purely scientific interest. It was such lines of investi-

gation that Aleksandrov invariably found most attractive. Having foreseen the enormous future importance of macromolecular compounds, he began, with his colleagues (some of the projects were collaborations with P. P. Kobeko), his development of physical polymer research.

Aleksandrov's most important contributions to polymer physics pertained to mechanical and electrical relaxation phenomena in polymers. This work was begun during a period when the basic concepts of the statistical-thermodynamic theory of high elasticity were being worked out. While predicting the equilibrium elastic properties of polymers, this theory naturally told us nothing concerning the possibility of realization of equilibrium states. Aleksandrov and Kobeko and their colleagues showed that the real properties of polymers depend to a tremendous degree on the kinetics of development of highly elastic deformation, and that the glass transition of polymers is itself the result of the increase in relaxation time with decreasing temperature. With his co-workers, Aleksandrov developed methods for study of these relationships in broad disturbance-time (frequency) and temperature ranges. These studies, which were done on a wide variety of polymeric substances, led to establishment of common kinetic relations applying to the high elasticity of all polymers and the discovery of a close relationship between mechanical and electrical relaxation effects in polymers. Further development of these studies led to the construction of a nonlinear theory of mechanical relaxation phenomena in polymers in the solid state. This theory takes account of the stress dependence of relaxation time predicted by Aleksandrov on the basis of experiments on induced elasticity in polymers.

The results of this research by Aleksandrov, which dates from 1933—1941, served as groundwork for a number of departments of modern polymer science, were incorporated into monographs and textbooks, and were to determine trends in the development of many areas of modern polymer physics in our country for many years to come.

It was a characteristic of all of Alexsandrov's studies during this period that they attempted to extract a maximum of practical results from fundamental research. This effort was especially clearly in evidence in his later wartime and postwar activities.

During the war of 1941—1945, Aleksandrov was in charge of naval development of systems to protect ships from magnetic mines, making large-scale use of methods that had been developed for this purpose at his laboratory during the years before the war. In addition to his immediate associates, very many of the staff of other LPTI laboratories participated in this project, including I. V. Kurchatov and others. Protection of ships by the LPTI method made a major contribution to the success of Soviet naval operation during the war.

It was during this time that Alexandrov's talents, not only as a scientist, but also as a capable organizer of scientific and engineering developments and projects and as a skillful director of their practical implementation, first burst forth in their full vigor.

His depth of physical erudition, his ability to perceive the engineering aspects of problems and possible ways to their solution, and his high authority as an interested and benevolent, but at the same time strict and demanding individual—all were qualities that unfailingly enabled him to rally his people to the solution of major and responsible problems.

The year 1943 was a banner year in the history of science and engineering in our country. This year saw the sweeping mobilization of the Soviet Union's physical scientists for solution of the central scientific and technical problem of the Twentieth Century—the harnessing of nuclear energy. As we all know, this scientific program was headed up by Igor' Vasil'evich Kurchatov. Aleksandrov and his laboratory were put to work on it at the outset, and soon he was in charge of a large staff of scientists and engineers. In 1946, he transferred from Leningrad to Moscow.

Aleksandrov's activity came into full flower in the application of atomic energy in various segments of the national economy—a goal to which most of his energies have been devoted over the past 25 years. Since 1948, when he was named deputy to Kurchatov, Aleksandrov has poured all of his scientific talent and all of his enormous experience and energy into the development of nuclear reactors.

The astonishing diversity and breadth of his erudition has become apparent in his reactor projects. An outstanding physical scientist, Aleksandrov has directed and organized the work of designers, production engineers, materials specialists, and electrical engineers; more than that, he has criticized all details of their work brilliantly, proposed solutions, and appraised results. Aleksandrov understands any design, any problem on which he is asked to comment, perceiving it not only in its general and salient features, but also in minute detail. This is the approach that inspites confidence in the solutions adopted, and the one that he teaches to others and requires that his colleagues inculcate.

The clarity and realism with which his projects are submitted, the reasoned organization of his research and experimental studies, his practice of involving the design and industrial organizations at an early stage in the work and, finally, the dedication that he transmits to those around him enable Aleksandrov to avoid the "underwater reefs" associated with the implementation of scientific achievements and to maintain close and productive relations with industry.

Monumental scientific-technical projects have been carried out under his scientific supervision as part of the creation of a Soviet nuclear-power industry, including the building of the Siberian nuclear-power generating stations, which were at the time the most powerful in the world.

Nuclear powerplants for ships were developed and built under his most direct supervision and with his participation. The icebreaker Lenin, the world's first nuclear-powered surface vessel, has been breaking ice in the northern seas since 1959 in a vivid demonstration of the broad opportunities for the use of nuclear energy by the fleet.

Aleksandrov played a major role in the development of a series of research reactors—primarily the VVR water-moderated water-cooled reactor(VVR), the SM high-flux reactor (the IGR graphite pulsed reactors, and others.

Equipment of the advanced institutes of the USSR and various other countries with modern water-cooled water-moderated reactors led to the creation of an experimental base for research in reactor design, neutron physics, radiochemistry, and biology and for the implementation of many other projects.

Upon Kurchatov's death in 1960, Aleksandrov succeeded to his position, and has since headed the I. V. Kurchatov Institute of Atomic Energy.

As before, Aleksandrov is in charge of all reactor projects worked on at the Institute or under its scientific guidance. An experimental base for research on the thermophysical characteristics of power reactors has been established and expanded under Aleksandrov's supervision. Core compositions have been studied in detail and the basic physical parameters of reactor projects have been determined on a whole series of one-of-a-kind physical test stands and full-scale critical assemblies.

In 1964—1965, Aleksandrov directed the construction of the first generation of one of the most important trends in large-scale nuclear-power engineering--the first nuclear power stations with water-cooled water-moderated reactors—at Novo-Voronezh and in the German Democratic Republic. A series of reactor installations of this type with a 440-MW capacity en bloc was commissioned. At the same time, Aleksandrov was addressing himself to the monumental task of designing a huge power reactor rated at 1000 MW (electrical) en bloc. This is a channel-type uranium-graphite reactor with boiling in zirconium tubes and direct delivery of the steam to the turbines. Its flexible fuel cycle and the possibility of further increasing its unit power make this reactor the base for a second major trend in big nuclear-power engineering. Nuclear power is now no longer only a goal—it is a current activity. And at the head of the scientific and engineering nuclear-power corps stands A. P. Aleksandrov—the greatest authority in the field.

Aleksandrov has an uncommonly broad range of interests as a scientist. We should take not first of problems in biology and solid-state physics. In the context of the crystallization and glass-transition problems on which he worked during the Leningrad phase of his career, he has always been concerned with questions relating to biology. However, the era in which physics, along with genetics and biochemistry, could make a decisive contribution to biology and change radically the face of that science came later, during the 1950's, when molecular biology was born.

In 1958, when biological science was just emerging from a difficult period in the Soviet Union and decisive measures were needed to bring it up to date, a seminar on biophysics was organized in the Institute of Atomic Energy on the initiative of I. E. Tamm, I. V. Kurchatov, and Aleksandrov. Here, physicists heard papers by the promenint biologists B. L. Astaurov, V. A. Engel'gardt, and others. Shortly thereafter, a biology division was set up at the IAE on the initiative of Kurchatov and Aleksandrov, with physics, genetics, biochemistry, and chemistry laboratories. This division has now become one of the Soviet Union's foremost centers for the development of molecular biology. Molecular genetics, i.e., the investigation of the molecular mechanisms of heredity, is the scientific specialty of this division. Out of his interest in borderline problems between biology and physics, Aleksandrov, acting here not only as the director of the Institute, but basically as a scientist, organized the "symbiosis" of biologists and physicists that is of such great importance for modern molecular biology. The remarkable critical facility demonstrated by Aleksandrov has very often promoted rapid and efficient development of these studies.

A division of solid-state physics was later established at the Kurchatov IAE on Aleksandrov's recommendation. Like any new scientific trend, it required scientific and organizational assistance, which Alekandrov provided in liberal quantities. This division is unique in that its scientific subject matter has nuclear physics—the original scientific discipline of the Kurchatov Institute—as its source. It is sufficient to note the work done on the structure and excitation spectra of real crystals, using both neutrons and Mossbauer-effect methods, and the research on the interaction of nuclear radiation with ideal crystals and the interesting collective phenomena that arise on this interaction.

A second and no less important concern of the IAE division of solid-state physics has been its major attempt to solve, in our country, the extremely important problem of technical applications of superconductivity. Aleksandrov is very directly involved in the attack on this problem.

Aleksandrov was elected a Corresponding Member of the USSR Academy of Sciences in 1943 and a Full Member in 1953. He has twice been made a Hero of Soviet Labor for outstanding service to Soviet science and engineering. He has been awarded six Orders of Lenin, an Order of the October Revolution, and others of our country's honors. He is a Laureate of the Lenin Prize and State Prizes of the Soviet Union.

Alexandrov was elected to the Central Committee of the Communist Party of the Soviet Union at the 23rd and 24th Party Congresses.

To all who know him, it remains a mystery when and how Aleksandrov, overburdened as he is with enormous scientific and administrative responsibilities, the importance of which is generally recognized, finds the time and strength to remain a searching physicist with a youthful passion for arguing the most recent physics articles, advancing new ideas, and embarking on new research and development projects. And then, to the grudging admiration of those around him, to relax, tease, go hunting or fishing when the opportunity presents itself, and, of course, to play drawn games with his friends.

Aleksandrov greets his seventieth birthday full of creative vigor and energy. His remarkable benevolence and sensitivity and his interest in what is new make him one of the most stimulating factors in the environment of all those who work with him.

We all wish him long years of health with all of his remarkable qualities as a scientist and a human being unimpaired.

Translated by R. W. Bowers