PERSONALIA

Boris Konstantinovich Vaĭnshteĭn (on his sixtieth birthday)

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The outstanding Soviet physicist and crystallographer, Academician Boris Konstantinovich Vaĭnshteĭn, celebrated his sixtieth birthday on July 10, 1981.

B.K. Vaĭnshteĭn's talents were already revealed during his youth: he was an excellent student, who was fascinated with physics, mathematics, and literature, and he was a good chess player. He graduated with distinction from two universities: from the Physics Department of Moscow University and from the Moscow Steel Institute. In 1945, B.K. Vaĭnshteĭn began post-graduate work at the Institute of Crystallography of the Academy of Sciences of the USSR, which was just (1944) organized, based on the Laboratory of Crystallography of the Academy of Sciences of the USSR. The small group at the institute brought together crystallographers, mineralogists, chemists, and some physicists, inspired by the general idea of A.V. Shubnikov: the problem of studying crystals, as the most important and interesting subject of natural science.

Boris Konstantinovich Vaĭnshteĭn

The combination of the abilities of an experimental physicist, a theoretician, and simultaneously that of an engineer, permitted B.K. Vaĭnshteĭn, already during the early years of his professional work, not only to solve scientific problems by himself, but also to disseminate rapidly his results (ideas, methods, algorithms, and apparatus) both into practice at the Institute of Crystallography and outside of the Institute.

B.K. Vaĭnshteĭn's first scientific passion was the diffraction of electrons. He discovered the wonderful and unique possibilities of this method of structural analysis and actually created structural electron diffraction analysis in its modern form. In 1948, he introduced into electron diffraction analysis Fourier synthesis of the crystal lattice potential, which formed the basis of his Candidate's Dissertation, completed under the direction of Professor Z.G. Pinsker. Since then, no structural work involving electron diffraction analysis is performed without application of this principle. In 1953, he published a work, which has since become a classic, in which he calculated the amplitude of elastic scattering of electrons by atoms and he constructed a table of such amplitudes.

B.K. Vaĭnshteĭn was the first, in the practice of structural analysis, to determine the position of hydrogen atoms in paraffin, diketopiperazine, and other crystals. During these years, he carried out a number of investigations on the geometrical theory of electron diffraction patterns, on the theory of scattering of electrons by crystals, and on calculating the integral characteristics of the potential distribution in atoms. Based on his Doctor's Dissertation (1955), he wrote a monograph entitled "Structural Electron Diffraction Analysis" (1956), which has become a handbook for researchers in electron diffraction analysis throughout the world. At the same time, he developed first an experimental, and then a production, model of an electron diffraction camera.

B.K. Vaĭnshteĭn soon became interested in more general problems of diffraction methods, in whose solution he freely used Fourier methods. He introduced new methods for normalizing the Fourier series of the electron density in x-ray diffraction analysis and he proposed new methods for determining the phases of the structural amplitudes. He generalized the theory of scattering to cover a wide class of noncrystalline condensed systems. In a unique (in this field) monograph entitled "Diffraction of X-Rays by Chain-like Molecules" (1963), he examined the structure and symmetry of chain-like macromolecules and the principles of their relative packing in aggregates, and he developed the theory of scattering of short-wavelength waves by polymers and liquid crystals.

Since the end of the 1950's, B.K. Vaĭnshteĭn was attracted to the most complicated problem in atomic-molecular structure of matter: the problem of the structure of biological objects. At the time, there was not even a single determination of the crystal structure of proteins, although work of this kind, begun in Eng-

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land at the end of the 1930's under the initiative of J. Bernal and W. L. Bragg, was moving forward successfully. B.K. Vaǐnshteǐn conceived, began and by now in many ways has already completed, a broad program for studying the structure of biological crystals and molecules: from the elementary components of all proteins (amino acids) to polypeptides, protein crystals, viruses, and ribosomes, containing thousands and millions of atoms. For this purpose, B.K. Vaǐnshteǐn and his co-workers developed new theoretical and experimental methods in x-ray crystallography, x-ray and neutron small-angle scattering methods, electron diffraction analysis and electron microscopy. Methods were found for growing perfect protein crystals and introducing into them heavy atom markers for determining phases.

The problem of identifying the atomic structure of proteins using x-rays is incredibly difficult, it is necessary to collect and process information concerning hundreds of thousands and millions of diffraction reflections. In order to solve such problems, a program was developed and implemented for automating x-ray diffraction analysis. This permitted determining the structure of the leg-hemoglobin protein, which transports oxygen in nitrogen-fixing plants. The positions of all 1200 C, N, and O atoms were found in the molecule, and the physical and atomic-molecular mechanism for the biological activity of this protein was clarified. In even more complicated studies of enzymes (ribonucleases, pyrophosphatases, aspartate-aminotransferases, catalases), the spatial structure of the enzymes was found: the placement of the polypeptide chains. Catalase is one of the largest proteins studied in the world: there are more than 20,000 atoms in the molecule.

Another method for determining the structure of biological macromolecules (but not with such high resolution as in x-ray diffraction analysis) is electron microscopy. In 1968, B.K. Vaǐnshteǐn found an algebraic method for reproducing the three-dimensional structure of objects from their electron microscopic images–projections (simultaneously with A. Klug, who used for this purpose a double Fourier transformation). Somewhat later, he gave another solution of this problem: the method of projection functions and the Radon transformation. With the help of these tools, B.K. Vaǐnshteǐn and his co-workers discovered and investigated tubular protein crystals, which have a spiral symmetry, and they studied the structure of icosahedral viruses and more complicated bacterial viruses. With the help of the small-angle scattering method, liquid crystal ordering of macromolecules in a solution was discovered.

Highly skilled researchers grew up around B.K. Vaǐnshteǐn: crystallographers, physicists, and biochemists, many of whom became Candidates and Doctors of Science. Some of his students have put forth their own scientific programs and separate directions in structural studies. In the Ivanov State University, under his direction, a scientific center arose for studying the structure and properties of liquid crystals.

Synthesis of individual and collective work is characteristic of B.K. Vaǐnshteǐn's creative style. When Boris Konstantinovich has not appeared in the laboratory for some time, he then soon proposes a new method, an original approach to solving a structural or physical problem, and his co-workers and students are immediately included in the new work. He prefers to make the sketches of the apparatus and the initial models himself. He does not like long explanations, understanding everything immediately, and he is always prepared to evaluate the point of view of his interlocuter and to help with an opinion, a proposal, and a suggestion for the possibility of realizing some scientific idea.

In 1962, B.K. Vaǐnshteǐn became the second (following A.V. Shubnikov) director of the Institute of Crystallography of the Academy of Sciences of the USSR. A very urgent problem of our science at that time was the creation of quantum electronics and especially crystals for lasers. Under the direction of B.K. Vaǐnshteǐn, the Institute rapidly and effectively solved this problem, creating highly pure ruby, yttrium aluminum garnet, and a number of other crystals. Under his initiative such scientific and scientific engineering work as the creation of new methods for synthesizing single crystals, the study of the structure and properties of liquid crystals, crystal physics of ideal and real single crystals, and the electron microscopy of crystals with atomic resolution were undertaken at the Institute. Such development of the Institute of Crystallography is appropriate for the present-day situation in this physical science, whose origins lie in mineralogy and chemistry. The studies of the structure, properties, and synthesis of crystals carried out at the institute find wide practical application. B.K. Vaǐnshteǐn is able to promote rapidly the developments of the Institute in synthesis and application of crystals, and creation of new instruments and techniques. Commercial production of single crystals, which is necessary for modern radio engineering, electronics, optics, and many other fields of technology, arose in our country largely due to his efforts.

A generalization of the theory and experimental data of crystal science is contained in a four-volume (three volumes have already been published) encyclopedic course entitled "Modern Crystallography." B.K. Vaǐnshteǐn is the principal editor of this edition, and he wrote Volume I, entitled "Symmetry of Crystals, Methods of Structural Analaysis" in its entirely and two chapters in Volume 2 entitled "Structure of Crystals."

In 1962, the Academy of Sciences of the USSR elected B.K. Vaǐnshteǐn Corresponding Member and Academician in 1976.

B.K. Vaǐnshteǐn has also accomplished a great deal as the organizer of crystallographic science within this country. He is the chairman of the following scientific committees of the Academy of Sciences of the USSR: Committee on the Formation and Structure of Crystals and the committee on Electron Microscopy. He is a member of the Division of General Physics and Astronomy of the Academy of Sciences of USSR. B. K. Vaĭnshteĭn's scientific results have received worldwide recognition. Today, B. K. Vaĭnshteĭn is one of the brightest and most creative figures active in the field of the structure of matter, and one of the leaders in the science of crystals.

The breadth of his scientific interests, his ability to approach with deep understanding unsolved problems in many areas of solid state physics, structural chemistry, and molecular biology, his ability to formulate clearly and solve scientific problems, his understanding of technical and applied problems of crystallography and crystal physics, and his scientific organizational talent are the qualities that determine B. K. Vaĭnshteĭn's work.

We congratulate Boris Konstantinovich on his sixtieth birthday, and wish him health, new scientific successes, and happy work surrounded by students and colleagues.

Translated by M. E. Alferieff