Leonid Fedorovich Vereshchagin (Obituary)

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The prominent Soviet physicist, founder and Director of the Institute for High Pressure Physics of the Academy of Sciences of the USSR, Academician Leonid Fedorovich Vereshchagin died suddenly in the 68-th year of his life on February 20, 1977.

The scientific activity of L. F. Vereshchagin began in the thirties in the leading physics center of that period—the Khar'kov Physical-Technical Institute in the laboratory of one of the leading specialists in solid state physics Professor L. V. Shubnikov from whose school emerged many prominent physicists of our country. The first scientific paper of L. F. Vereshchagin was devoted to an investigation of the magnetic susceptibility of rare earth metals. At the same time his activities began in the domain of high pressures.

In those years high pressure physics had already begun its development as an independent direction primarily in the USA where worked its creator the Nobel laureate Professor P. Bridgman. In the Soviet Union high pressures were utilized only in geophysical investigations and partially in chemical thermodynamics.

L. F. Vereshchagin began his activity by broadening the roster of phenomena in solids investigated under pressure by simultaneously simplifying and raising the effectiveness of high pressure apparatus.

L. F. Vereshchagin approached physics through chemistry. In the prewar years work on organic chemistry began to be widely developed. The necessity appeared to carry out investigations at high pressures, and Academician N. D. Zelinsky invited Leonid Fedorovich to Moscow to the Institute for Organic Chemistry of the Academy of Sciences of the USSR. The start of the Great Patriotic War changed the direction of the scientific investigations of L. F. Vereshchagin, he began active participation in defense activity, undertaking special technological and construction work.

After the end of the war Leonid Fedorovich together with a group of chemists from the Institute of Organic Chemistry continued a large range of investigations of chemical reactions at high pressures and temperatures begun on the initiative of N. D. Zelinsky: studies were made of rates of reactions, polymerization, catalytic properties, all very important characteristics influencing the efficiency of synthesis of new substances. L. F. Vereshchagin investigated physical properties of a number of organic substances: viscosity, dielectric permittivity, molecular isomerism. The considerable broadening of investigations gave the necessary experience, and produced a real possibility of going over to physics problems.

LEONID FEDOROVICH VERESHCHAGIN
(1909–1977)

In 1954 the laboratory of Leonid Fedorovich was separated from the Institute of Organic Chemistry into a separate independent laboratory within the organizational structure of the Division of Technical Sciences of the Academy, and he was appointed its Director.

In the new laboratory, Leonid Fedorovich developed a number of important directions in parallel, preparing conditions for a large qualitative step forward. First of all, methods of producing pressures applicable to physical problems were perfected. A range of light weight laboratory gas and hydraulic compressors and presses was constructed, making possible obtaining forces up to 1000 tons. Different types of chambers were developed. By measuring sharp changes in volume and electrical resistance accompanying transitions (P, T)-phase diagrams were studied, work was begun on measuring compressibility and the speed of sound, on the study of plasticity in solids and, of particular importance, on the investigation of the structure of crystals with the aid of X-ray analysis in the domain of hydrostatic pressures. Already at that time considerable at-

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tention was devoted to technological applications of pressure: investigation of extrusion of metals and alloys at high pressure, study and use of jets emerging from a high pressure chamber at high (supersonic) velocities, in particular for breaking up rocks. Extrusion turned out to be a very promising method for working with metals that are difficult to deform.

During the short four-year period of the existence of the laboratory Leonid Fedorovich succeeded in accomplishing much: investigations of the dependence of the fundamental constants of the elements on their position in the periodic system were extended to such characteristics as compressibility, and limiting shear stress. A tendency was established towards smoothing out this dependence in the case of compressibility at high pressures (up to 100 kbar). Interesting results were obtained in the study of the compressibility of molecular and highly anisotropic crystals.

In 1958 using the laboratory as a base an Institute of High Pressure Physics (IHPP) was established which under the direction of L. F. Vereshchagin became the principal center in the Soviet Union for the study of physical properties of solids under pressure. On the initiative of L. F. Vereshchagin of the Academy of Sciences of the USSR approved as the principal aims of the Institute investigation of the essential problesm of modern solid state physics and the study of reversible and irreversible phase transformations, and on the basis of these studies the solution of the problems of synethesis of diamonds and other superhard or technically important materials. Naturally for the solution of these problems it was necessary to increase significantly the limit of pressures available for experimentation.

Under the direction of Leonid Fedorovich and with his direct participation phase diagrams of a whole series of elements and compounds were studied in recent years. A most important factor which led to success in this field was the construction of a number of light-weight X-ray chambers which enabled one to decode the crystalline structure of new phases directly under pressure over a wide range–up to 160 kbar. Detailed studies were made of phase diagrams and structures of elements of the third and fifth groups, of compounds of the type $A^{IV}B^{VI}$ closely resembling elements of the fifth group (tellurides of germanium, tin, lead), of diagrams of fluorides of transition metals.

The results obtained established the order of polymorphic transformations observed in these sequences with increasing pressure, and this enabled one to draw conclusions concerning relations between different structural types. Polymorphic transitions were observed associated with a radical change of crystal structure, with an increase in the coordination number and with a significant decrease in volume. Also polymorphic transformations were found characterized by appearance of high pressure phases, the structures of which are related by small deformations to the initial structure (elements of group V and compounds $A^{IV}B^{VI}$). A generalization of all the data from the study of crystalline structures at high pressures enabled one to formulate empirical rules successfully utilized for predictions and search of structures of different solids.

Of particular significance for the production of materials with new properties is the study of irreversible polymorphic transformations. In several countries, among them also in the Soviet Union, the most important irreversible high pressure phase—that of diamond—was synthesized, and also its superhard analog—cubic boron nitride.

The first work on the synthesis of diamonds in the USSR was carried out in the IHPP in 1958–60. In the course of the solution of this problem the scientific and organizational gifts of Leonid Fedorovich became vividly manifest. In him were combined the ability for a deep analysis of each stage of experimentation with original ideas for the solution of problems that arose, and a knack for skillful placement of people and arrangement of their interrelationships.

The synthesis of diamonds successfully carried out at the Institute was rapidly transferred to industry and provided it with crystals (of dimensions up to 1 mm) suitable for abrasive purposes. Development of work with diamonds also continued later. A method was discovered of growing diamonds and cubic boron nitride in the form of strong polycrystalline samples of given structure and shape: ballas, carbonado, etc., used for working of metals and for obtaining mineral resources.

Together with the tremendous economic advantages presented by materials with the hardness of diamond a possibility appeared to increase with their aid the range of attainable static pressures. Diamonds of the "carbonado" type formed the basis of an apparatus in which under the direction of Leonid Fedorovich pressures were attained up to $P \approx 3$ Mbar. In the megabar range of pressures transitions into a conducting state were observed for diamonds, silica (SiO_2), corundum (Al_2O_3), water (H_2O) and other substances. These results are of interest for solid state physics, and for the physics of the earth and planets. At a pressure of $P \approx 1$ Mbar and $T = 4.2\,^{\circ}K$ a transition of solid hydrogen from a dielectric state into a conducting state was observed.

On the initiative of L. F. Vereshchagin and with his support investigations were developed in the IHPP of important properties of solids under pressure: of the energy spectra of quasiparticles, in particular of the wide range of quantum effects in the case of metals and semiconductors, of their electronic structure, and of different resonance phenomena.

L. F. Vereshchagin and his pupils carried out a synthesis under high pressure of new superconducting dense modifications of a number of carbides and nitrides of transition metals and of rare earth sulphides.

In recent years, under the direction of L. F. Vereshchagin considerable progress was achieved in the development of the extrusion of solids at high pressures. A method of gaseous extrusion was developed which enabled one to combine effectively plastic deformation with heat treatment of materials. High values of the parameters were attained ($P = 100$ kbar) in extrusion with the aid of plastic solids, and this enabled one to deform even

hard alloys based on tungsten carbide.

Leonid Fedorovich devoted considerable attention to the training of research manpower in the fields of physics and high pressure technology. He organized and headed special chairs in the Moscow State University and the Moscow Physical-Technical Institute.

An outstanding personality has left us replete with new ideas which he did not have time to realize. His sensitivity, kindness and accessibility earned for him the respect of all who had the good fortune of having worked with him.

For his scientific attainments, L. F. Vereshchagin was in 1960 elected corresponding member of the Academy of Sciences of the USSR, and in 1966 he was elected to full membership in the Academy of Sciences of the USSR. For his work in high pressure chemistry, he was awarded the State Prize of the USSR, and for his work on the synthesis of diamonds he was awarded the Lenin prize. He was a member of the Engineering Academy of Sweden.

For his meritorious services in the development of Soviet science and for his active participation in social affairs, the Soviet government awarded to L. F. Vereshchagin the title of Hero of Socialist Labor, and rewarded him with orders and medals.

The fond memory of Leonid Fedorovich Vereshchagin will forever live in our hearts.

Translated by G. Volkoff

Rem Viktorovich Khokhlov (Obituary)

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Soviet and world science has suffered a grievous loss. Academician Rem Viktorovich Khokhlov, a prominent Soviet physicist and organizer of science and of higher education died suddenly on 8 August 1977.

The range of scientific interests of Rem Viktorovich was very wide. To him belong fundamental results in the nonlinear theory of oscillations, in quantum electronics, in optics and in acoustics. World fame was brought to R. V. Khokhlov by his work on the theory of nonlinear wave processes, nonlinear optics, tunable lasers, effect of intense radiation on matter.

REM VIKTOROVICH KHOKHLOV (1926-1977).

Rem Viktorovich Khokhlov was born on 15 July, 1926 in the city of Livna of the Orlov district. On completion of the seventh year of secondary school in 1941, he began work as an auto mechanic. In 1944 having passed the external examinations for the 8–10 years of secondary school, he entered the Moscow Aviation Institute. A year later, he transferred to the physics faculty of the Moscow State University and from that moment the rest of Rem Viktorovich's life was inseparably associated with the Moscow State University.

R. V. Khokhlov published his first scientific paper "On nonstationary processes in wave guides" in 1948 while he was still a student. The theory of nonstationary processes in distributed systems became the subject of his candidate's dissertation defended by Rem Viktorovich in 1952. Subsequent papers of R. V. Khokhlov in mid-fifties were related to nonlinear theory of oscillations. In 1954 Rem Viktorovich published one of his basic papers "On the theory of capture in the case of small amplitude of the external force."

In this paper the asymptotic methods of the theory of nonlinear oscillations developed in our country received their further development.

R. V. Khokhlov was the first to direct attention to the

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