Viktor Robertovich Bursian (1886–1945)

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This article gives a portrait of a pioneer of Soviet physics, who played a large role in building up theoretical physics in the USSR. At the beginning of this century V. R. Bursian carried out research on the physics of currents in gases and in a vacuum, on dispersion and gyration, on the electron theory of matter, and on the kinetics of chain reactions. Electrophysical methods for geological exploration were first developed by him.

Viktor Robertovich Bursian—one of the founders of the Soviet school of theoretical physics—was born in St. Petersburg on December 25, 1886, according to the old style calendar. His father, Robert Robertovich Bursian, was a well-known St. Petersburg doctor; his mother, Anna Antonovna Val'ter, was the daughter of Anton Val'ter, whose family contributed an assemblage of people famous in the USSR, including Academician of the Ukrainian SSR Academy of Sciences A. K. Val'ter and Corresponding Member of the USSR Academy of Sciences A. F. Val'ter.

V. R. Bursian finished preparatory school with a gold medal in 1904; he studied at the University of St. Petersburg and in Germany at the Tübingen University at the invitation of F. Paschen. In 1910 V. R. Bursian started to teach and in 1918 he became a lecturer at the University and the Polytechnical Institute.

In 1918 V. R. Bursian became the first scientific secretary of the Physico-Technical Institute founded by Academician A. F. Ioffe; he was later appointed the first director of the Theoretical Division of the Institute. In 1932 he became a professor in and chairman of the Department of Theoretical Physics at the Leningrad State University; in 1933 he became Dean of the Physics School; and, in 1934 he became the director of the Scientific-Research Institute of Physics at Leningrad State University. In 1936 V. R. Bursian's scientific and organizational work was tragically terminated—he was arrested and died in prison (he was completely rehabilitated posthumously).

V. R. Bursian began his scientific career while he was still a student. In 1907 he made a report entitled "On the anomalous dispersion in sodium vapor." He performed an experiment and demonstrated it "at a meeting of the Physics Division of the 1st Mendeleev conference." This was his only experimental work. His remaining work, not counting his work in geophysics, was devoted to theoretical physics.

V. R. Bursian is best known for his work on thermal electron emission and passage of current through a vacuum. He studied this problem, which was important at the dawn of radioelectronics, several times, starting in 1919. The effect of a volume charge on the current was first analyzed by Langmuir. Langmuir, however, assumed that the starting energies of all the electrons equalled zero. In this case the curve obviously started at the origin. V. R. Bursian took into account the distribution of the starting velocities of the electrons and obtained a curve with a retardation potential in agreement with experiment. This rigorous solution of the problem still forms the basis of emission electronics, especially in cases of low accelerating or retarding potentials. Further research on the measurement of the velocities of photoelectrons in the external photoeffect (spherical capacitor method of Lukirskiĭ and Prilezhaev) was conducted based on this work and with the direct participation of V. R. Bursian.

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In 1923, while discussing an experiment by V. I. Pavlov, V. R. Bursian solved another interesting problem regarding the effect of space charge on the current in electric vacuum devices. He discovered the first instability in the history of the physics of electron beams. When a sufficiently dense electron beam passes through a cylinder with equipotential walls a sharp disruption of the current occurs. The effect now carries V. R. Bursian's name. This effect is always encountered when accelerators and other electronic devices are being built.

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In 1928 V. R. Bursian proposed, in a discussion of the well-known works of Richardson, Dushman, and Bridgman, his own variant of the derivation of the Richardson-Dushman formula, obtaining, as did Dushman, the factor T^2 rather than the factor $T^{1/2}$ obtained by Richardson, in the coefficient multiplying the exponential. This gave rise to an interesting discussion, in which Ya. I. Frenkel', P. I. Lukirskiĭ, A. N. Frumkin, I. E. Tamm, and A. Rebinder participated.

Another series of investigations by V. R. Bursian was devoted to the theory of dispersion and gyration. The microscopic theory at that time was just being developed (investigations of M. Born). In 1926 V. R. Bursian showed, in collaboration with A. V. Timoreva, that Born's theory required significant supplementation. Born neglected the magnetic moment of molecules, which, as Bursian showed, cannot be neglected under any circumstances. Thus important corrections were made in the final formulas for the angle of rotation of the polarization plane in an optically active medium. This work was based on a microscopic, but still classical (nonquantum) approach. Later V. R. Bursian undertook the analysis of the quantum theory of dispersion. His last large work on gyration, performed in 1936, remained unpublished.

A new method for calculating the average values of the charge and current densities (necessary for making the transition from the microscopic equations to Maxwell's equations) was proposed in a paper entitled "On the calculation of average values in Lorentz's electron theory." The idea involves the introduction of a small parameter (ratio of micromolecular dimensions to the macroscopic lengths) and the expansion of all quantities in a Lagrange series in terms of this parameter.

In 1913 V. R. Bursian became interested in the problem of the interference of x rays. He solved the problem of the transformation of the energy of x rays and of the effect of the strain of a crystal on the intensity of maxima in the Laue diffraction pattern. V. R. Bursian's 1919–1922 work "On the distribution of the intensity of x rays transmitted through a system of oriented atoms and molecules" was further developed. As is well known, this problem was solved for systems of unoriented particles in 1915 by P. S. Ehrenfest and P. Debue. V. R. Bursian showed how the appearance of order in the direct space (orientation) leads to singularities in the reciprocal space (screen with the powder pattern) and gives formulas for calculating the interference pattern exactly. He later collaborated with V. A. Fok on a paper on the same theme. The results are still being utilized today, though in a different form and without reference to the early papers of Bursian and Fok.

The paper "On the determination of the world line of an electron from the variational principle" is devoted to the determination of the relativistically invariant equation of motion of an electron in an external field by the variational method. As is well known, the variational principle is predicted on the existence of a special action integral of the Lagrangian function, and the line on which this integral is minimized is sought. The correct expression for the Lagrangian function, which is now employed in all textbooks, was first given by Bursian.

A series of papers by Bursian is devoted to the nature of the forces of chemical affinity. Continuing the well-known investigations of Born, Landé, Kossel, and Madelung, he resolved the then so-called Sutherland's paradox.

V. R. Bursian's work on the theory of chain reactions (the first work was performed together with V. Sorokin; the second remained unpublished) played a definite role in the development of the physics of combustion and explosions (work of N. N. Semenov) and, naturally, in nuclear physics (I. V. Kurchatov), which at that time was still in an embryonic state. In the first work it was shown that the use of partial differential equations for diffusion is a convenient method for discussing the course of a chain reaction. The relations obtained mainly confirmed the earlier results of Semenov, obtained by an elementary method (Semenov employed a formula from the theory of Brownian motion). Bursian and Sorokin constructed a mathematically exact theory of chain reactions, including branching chains. Expressions were derived for the steady-state finite reaction rate and for the rise time of the rate. Reactors, bounded by two infinite walls, cylindrical and spherical surfaces, were studied.

A series of investigations by V. R. Bursian is devoted to thermodynamics, statistics, and the use of the intereference of light for comparing standards of length. He became a member of the Atomic Commission at the State Optics Institute chaired by D. S. Rozhdestvenskiĭ, which first met on January 21, 1920. At the 1st Conference of the Russian Association of Physicists in September of 1920 in Moscow V. R. Bursian reported on the work of the Petrograd Atomic Commission.

V. R. Bursian was a physicist-theoretician, a typical "cabinet scientist," However, when physicists were called upon to participate in the economic expansion in the 1920s, he responded in his characteristic manner—with full attention and with all his strength. He participated on committees for the evaluation of inventions of the first electronic television systems in the USSR. His main work, however, was his participation in the prospecting for mineral ores in the USSR.

On an assignment from the Geological Committee, Bursian, who had extensive experience in research work, was able to select and organize quickly a team and to create a Department of Electrical Prospecting at the Scientific-Research Institute of Physics at Leningrad State University. Research on the development of the theoretical foundations of prospecting for mineral ores as well as the deveopment of instrumentation for prospecting was conducted at the same time, and field work was undertaken on a large scale. V. R. Bursian was able to attract his colleagues V. A. Fok and V. K. Frederiks to this work. Methods for electrical prospecting using alternating current were developed: methods of "equipotential lines," "intensity," and "induction." Crews, working under the direction of V. R. Bursian, discovered with the help of the method of equipotential lines large copper-pyrite deposits in the Urals—the Elektricheskaya, Levikh IX, and other lenses.

Since 1926 the intensity method has become one of the leading methods of prospecting for ore. The first typical domestic geophysical apparatus—detection loops and tube-based voltmeters, employed in the devices developed for this method—was developed at the Physico-technical Institute. The induction method, developed by I. G. Mikhaĭlov under the direction of V. R. Bursian, went into operation in the

1930s. Prospecting methods based on direct current were developed for petroleum.

V. R. Bursian participated in expeditions to the Urals, the region of Astrakhan-Gur'ev, Sverdlovsh and Nizhniĭ Tagil, Baku, and Kuzbass; he even personally led some of them, which was physically difficult for him because of ill health.

V. R. Burian played a large role in the organization of higher education in geophysics and preparation of young specialists at institutes of higher learning. He participated actively in the determination of the types of and the first programs in geophysical specialities.

Because of the premature termination of his scientific career V. R. Bursian's contributions to theoretical physics are not as great as those of his colleagues. In the memory of most leading Soviet physicists, however, he has remained an educator of the first rank. His main trait was kindness, both as a person and as a scientist. He was not so much concerned with his own personal results in theoretical physics as with attracting to this science young and capable scientists and introducing them to the latest revolutionary and difficult to accept events occurring at that time in physics. It is enough to mention only a few of the subjects (and dates!) of his lectures, reports, and papers:

1909—"Michelson's experiment and its significance for the theory of optical phenomena";

1911—"New research in the region of long wavelengths";

1913—"Interference of x rays";

1919—"Obtaining x-ray spectra";

1927—"Schrödinger's wave mechanics".

The clear and rigorous exposition transformed the new elements of physics from vague ideas into a firm foundation for direct applications. Bursian prepared himself so thoroughly for these reports that a report which was meant to be a review became an independent theoretical study of the question.

In her recollections A. V. Timoreva writes: "Viktor Robertovich's role at scientific conferences, gatherings, and seminars was very large. In the course of a meeting he exuded an indifferent, not very attentive demeanor during the presentation of the reports. However, at the end of a report or when some question arose Viktor Robertovich stood up and discussed the points that were unclear or evaluated the results. His comments were usually exhaustive."

V. R. Bursian's lectures were distinguished by their rigor. He never permitted sloppiness in the notation, definition of concepts, or conclusions, which is sometimes pretended to add "liveliness" to presentation. His courses on the electromagnetic theory of light, electrodynamics, thermodynamics, and the theory of radiation played a significant role in the preparation of specialists in the 1920s–1930s and in the creation of the Soviet textbooks of the 1940s–1950s.

Contemporaries of V. R. Bursian consider his participation in the creation of the school of theoretical physics in the USSR as one of his most important achievements. Many future well-known theoreticians were his students. L. D. Landau, as a student, wrote his dissertation under the direction of V. R. Bursian at Leningrad State University. Well-known physicists and geophysicists have considered and still consider themselves his students: L. É. Gurevich, A. N. Terenin, S. V. Izmaĭlov, A. S. Semenov, and many others. Academician V. A. Fok considered himself to be a student of V. R. Bursian, though, of course, it is more correct to say that these two physicists influenced each other deeply, they were sympathetic to one another, and they collaborated with each other. V. R. Bursian collaborated just as closely with V. K. Frederiks and Yu. A. Krutkov.

In 1972 the Nedra publishing house reprinted V. R. Bursian's last book entitled "The Theory of Electromagnetic Fields Employed in Electrical Prospecting," which still has not lost any of its value for geophysics. In January 1987 V. R. Bursian's 100th birthday was celebrated at Leningrad State University and at the A. F. Ioffe Physico-technical Institute in Leningrad.

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