FROM THE HISTORY OF PHYSICS

SKETCHES FOR A PORTRAIT OF S. I. VAVILOV

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S. I. VAVILOV: RECOLLECTIONS OF PHYSICISTS

The name of Sergeĭ Ivanovich Vavilov, scientist and social activist, is a familiar one. The years have not diminished this familiarity, despite the fact that more than two decades have passed since his death (January 25, 1951). Most readers of "Uspekhi Fizicheskikh Nauk" probably embarked on their scientific careers after that date. Although they could not have known Vavilov, they have perhaps read his work and almost certainly have heard of him from others.

Vavilov's works are indeed read even today, and by representatives of various specialties. Physicists working in optics and its applications continue the development of Vavilov's ideas to one degree or another. They have become acquainted with them either in the original or through their teachers. Scientific historians not only study Vavilov's activity, but also hold his own works on the history of physics in high esteem. They have not only become classics, but are also highly popular. Many of us are no doubt familiar with his book on Newton. Those concerned with problems of philosophy have no doubt read or are reading Vavilov's papers, notably his lecture on "Lenin and Modern Physics." Finally, many generations of those interested in physics have read his popular books. The excellent volume "The Eye and the Sun" went through several editions during Vavilov's life, and is still being reprinted. Add to this the fact that we know of Vavilov's record as President of the USSR Academy of Sciences during the difficult postwar years, and we begin to understand clearly both the many-faceted nature of his talent and his contribution to the development of science and culture.

The wish to relate the sort of man that Vavilov was during his life is therefore natural. A man with such outstanding intellect and talent cannot, of course, fail to attract attention. Every scientist invariably ventures outside of his personal field in some measure. He influences his students and the scientific environment in which he works. This influence is extremely individual and inseparable from the human qualities of the scientist. But few create scientific schools in the true sense of the term, even though they may have successors and students, sometimes in considerable numbers. Why is this so? No answer to this question can be found simply by reading the output of the scientist (even though much will be found there that is inseparable from his personality). Only those who knew the scientist well and themselves came under his influence can tell us of this aspect of his activity. Remembering S. I. Vavilov, we understand clearly how strongly he influenced us. So collossal a figure was he that we feel his presence even today, two decades after his death. This poses with special insistence the question as to what sort of a man he was in his life and in his dealings with those around him.

The idea of a book on Vavilov has been around for some time and was originally quite ambitious. It was first suggested that his scientific and organizational activity be recounted, and that a considerable portion of the book be devoted to personal remembrances of him. I do not know what of Vavilov's students or friends first suggested this book, but the prominent scientist and Academician Aleksandr Nikolayevich Terenin took upon himself the by no means easy task of assembling the materials for it.

He succeeded in acquiring most interesting material, and a number of excellent remembrances of Vavilov were written at his request. However, Terenin wanted articles from a number of additional authors. Repeatedly and insistently, he sent out letters with requests for contribution of an article for the collection. I admit with sorrow that I was among those whose debt went unpaid. As for the scientific part of the collection, no preparations for it had been undertaken. Terenin apparently assumed this would be the less difficult part of the work. Years passed, and Terenin with them (he died on January 17, 1967). Among the authors who submitted to Terenin the manuscripts that we are publishing today, the prominent scientist Aleksei Vasil'evich Shubnikov, Boris Alekseevich Vvedenskiĭ, and Vladimir Iosifovich

Veksler are no longer with us. Time is implacable, and the circle of persons who knew Vavilov is shrinking steadily. After Terenin's death, some time passed before the "Nauka" publishing house of the USSR Academy of Sciences sent to me, in 1969, a file with the materials that he had collected. I was asked to supervise and continue the work toward compilation of the book. The materials proved to be quite varied. It was not a very simple matter to organize them into the form of a single book without revision. And among them, unfortunately, there is nothing written by Terenin himself. Perhaps he had started and not finished an article, perhaps he had set it aside until such time as the inspiration for the book crystallized. As his unwilling heir, I found myself in a difficult position and still had not the vaguest idea of how to complete the labor that he had started. At the same time, it appeared incumbent upon me to publish at least part of the available material.

Speaking of the book, I have become more and more convinced that there is no particular point in combining purely scientific articles on Vavilov's work with recollections of him. And perhaps there is no particular need to do so. In my view, the principal concern of the book should be with the story of Vavilov himself. Then all of it, rather than individual parts, would of interest to a broad range of readers—whether physicists or not. As for the specialists, they will find much of interest in previously published and new materials (including archival material), which will no doubt be printed in the future.

The recollections of those who were closely acquainted with Vavilov are of special value for publication in a book, and we are indebted to Terenin for having assembled them. Only some of them are being published today.

Before going into greater detail on this matter, I should like to say a few words, in gratitude for the memory of Terenin, concerning his own first-hand recollections, the more so since he was directly associated with Vavilov. When we were physics students at the Moscow University, probably in 1929, I and my friend, the now departed Viktor L'vovich Ginzburg, were sent to Leningrad for a student-corporation course at the State Optical Institute. Vavilov, in whose laboratory I worked told us to "try to get into Terenin's class." And, as always, he not only said, but wrote, handing me a rather flattering letter of recommendation addressed to Terenin. I did not yet know that Vavilov was generous with letters of recommendation. He wrote them with pleasure and, in his benevolence, denied them to few.

In Leningrad, I began to look for Terenin on the premises of the Leningrad University Physics Institute, which still housed some of the SOI laboratories. When I managed to tear him away from his business for a minute, he apparently mistook me for a student who had not passed the term or had not done the class work. The latter is more likely, because I stammered something about the class. Clearly, he was trying to get away from me in one way or another. However, I stayed and waited for him long and stubbornly. At long last he reappeared, and everything changed instantly as soon as he read Vavilov's letter. He immediately invited me into the laboratory, although, as I was to learn later, he received students with little enthusiasm and then highly selectively. Thus I gained the first impression that these two scientists were joined by a bond of mutual confidence, sympathy, and respect. Later, in 1932, Terenin was one of those supporting the invitation of Vavilov to Leningrad to become the scientific chief of the State Optical Institute. D. S. Rozhdestvenskiĭ had been forced to leave his post as director of the Optical Institute, and a difficult situation had developed there.

When I became acquainted with Terenin, he was already widely known as a physicist, and Vavilov undoubtedly had high regard for his work. At that time, quantum mechanics had not only opened the way to study of the structure of atoms and molecules, but was also winning over the minds of physicists who had clung to the classical principles. Rozhdestvenskiĭ himself was among the converts to the quantum faith. His student Terenin was known for a paper that was correctly regarded as one of the pioneering studies toward a quantum interpretation of the interaction of light with molecules. He had discovered the optical dissociation of diatomic molecules in 1925. In this effect, the action of light on the vapor of such substances as thallium iodide or sodium iodide results in the appearance of a spectral emission line of the thallium or sodium atom. The appearance of the light-emitting atom indicated not only that the molecule had dissociated under the exposure to light, but also that the atom was in an excited state during the dissociation process. The ultraviolet quantum energy necessary for this was greater than the bonding energy of the atom in the molecule plus the energy of the quantum emitted by the atom. There was an obvious analogy between the quantum effect of atomic excitation by electrons in the celebrated experiment of James Frank and Gustav Hertz and excitation of atoms by light via interaction with the molecule. Research on the dissociation of molecules and related questions was being continued in Terenin's laboratory as I familiarized myself with it. As I recall it, a 1932 paper by B. V. Popov and Terenin demonstrated by a direct method the optical dissociation of thallium iodide into thallium and iodide ions. At the same time, James Franck in Germany was working on problems of molecular dissociation by light and analyzing results obtained by another method (light absorption). There was disagreement in certain points between the conclusions arrived at by Terenin and James Franck. When, on graduating from the University in 1931, I resumed my association with Terenin, this time as a colleague rather than a student, he instructed me to find the causes of these discrepancies. My first result appeared to indicate that Terenin was correct, and the first version of my paper stated as much. This business was joked about in the laboratory as "Frank versus Franck." I do not remember why, but, fortunately, publication of the paper was delayed, and during this time I found out that in fact, and as is often the case, the contradiction was only apparent, and Terenin and James Franck were equally correct. I am now unable to recall the essence of the disagreement, but this is immaterial. Later on. Terenin's activity took him farther and farther away from physics and into photochemistry and chemistry. As for myself, I remember gratefully my work in the laboratory with Terenin and recognize my debt to him. It was there that I was first exposed to complicated (for their time) experimental techniques (vacuum and spectroscopic). Also very dear to me now are the words that Terenin had for me at a meeting not long before his death—words that, even discounting for the

fondness of a teacher for his students, I regard as a high honor.

I should like to permit myself a few words on the recollections of Vavilov that Terenin collected as they are published. They were all written in 1966. First in order of appearance is a short article by Academician Alekseĭ Vasil'evich Shubnikov.[1] He begins his reminiscences with his childhood days. He studied at the Moscow Commercial School from which both Nikolaĭ and Sergeĭ Vavilov graduated, and attended one class with Nikolaĭ. There are also autobiographic notes of Sergeĭ himself, not yet published in their entirety, about his childhood and his days at the Commercial School. (Vavilov wrote them during the last years of his life, and we propose to include them in the book about him.) The breadth of Vavilov's interests even as a schoolboy and his attraction to the humanities are evident from his recollections. We recall, for example, that after a trip to Italy in his youth, Vavilov wrote and published now little-known articles on Italian Art. The foundations of Vavilov's thorough and unusually many-sided education were no doubt laid during his youth and expanded upon throughout his life. His family situation was, of course, of no small importance for his formative development. Vavilov writes of his father with deep respect: "He was clever, entirely self-taught, but he read and wrote a great deal and was beyond doubt an intelligent man .... under other circumstances, he might have become a good engineer or scientist." As for his mother, he dedicates lines full of admiration and tenderness to her: "Mother was remarkable, a rarity in her moral elevation... I have met few such women in my life," and, he adds in conclusion,"... Both families—my father's and my mother's—were talented and above-average." These traits of the family, which must be granted undisputed membership in the Russian democratic intelligentsia, could not fail to have their effects on the children. There is no doubt that they made it easier for the above-average and talented Vavilov brothers to begin their journey to the summit of science. Was this not why, many years later, Sergeĭ Vavilov began his article on "Lenin and Modern Physics" with words that ring not only with admiration, but also with pride: "Lenin was a Russian intellectual in the broadest and best sense of the word."

In his notes on his school days, Vavilov remembers in particular a home-made chemistry laboratory and his brother Nikolaĭ's attraction to chemistry. As for physics, Vavilov writes that although it was taught simply horribly in school, his interest in it was very high from the very beginning. He writes "At home, quite on my own, I read Malinin and Burenin from cover to cover and performed experiments." Later he tells us a little of his first independent experiments. However, he had not yet chosen his specialty:"... Before the university I vacillated between becoming a chemist or a physicist." What was it that directed Vavilov to physics? Perhaps the interest in philosophy and the fundamental problems of natural science that he had manifested at a very early age. Shubnikov relates an episode with an electrophorus machine that was made for Vavilov, but the latter does not mention it. However, there is no doubt that the device must have attracted Vavilov's attention. It is even natural to suppose that he used it in his first experiments. However, his interests at that time were probably so dispersed that the device itself had no important influence on his choice of career. Readers of the Uspekhi Fizicheskikh Nauk will no doubt also read with interest the article by Academician Vvedenskiĭ[2] that follows Shubnikov's article. This article is unusually informative, and when it comes to Vavilov, as Shubnikov himself correctly observes, readers and "his admirers will not be uninterested even in every day traits of character and idiosyncrasies of this element, complete, and at the same time surprisingly many-sided personality."

He recalls some of Vavilov's highly characteristic epigrams. Sometimes, incidentally, their lighthearted form concealed profound thoughts. Thus, Vvedenskiĭ mentions in passing that, in speaking of scientific planning, to whose development Vavilov contributed so much, he unexpectedly quoted A. K. Tolstoĭ:

> "The sprouts of science are not in our power
> We only sow the seeds."

These two lines were taken from a Tolstoĭ poem aimed at the Czar's censor, who had attempted to ban Darwin's works in Russia. I assume that the quotation came as a surprise to Vvedenskiĭ because the poem in question contains not only angry lines, but some language that is not even particularly decent. And, during our long years of association with Vavilov, none of us ever heard him use intemperate expressions, even in jest, not to mention the unmitigated profanity that is so fasionable, unfortunately, among certain officials. But Vavilov actually did like to quote the lines cited by Vvedenskiĭ when he attempted to explain the essentials of scientific planning. The plan must formulate a concrete problem and map out paths to its solution, i.e., the seeds that must be sown and how to sow them. But the answer that nature gives us to the question posed may be unexpected—"the sprouts of science are not in our power." In this context, one of Vavilov's favorite adages was: "Mighty Nature is full of wonders." Vvedenskiĭ's article does indeed give us many of Vavilov's characteristic human features. We see, for example, how delicately Vavilov could issue orders—sometimes with the aid of a joking reference, for example, to the Weber-Fechner law.[3] His own example was, of course, the chief ingredient of this influence. The reader will also appreciate the uncommon breadth of Vavilov's knowledge and his abiding interest in the problems of the history of science and civilization.

In the next article,[4] Academician Aleksandr L'vovich Mints constructs his story of Vavilov around a conversation that took place on the Moscow-to-Leningrad "Red Arrow" train. This is no mere literary device, but something quite typical of Vavilov. Whenever he was able to steal even half an hour of spare time, he liked to go into the laboratory and strike up a casual conversation. Although this was his way of relaxing, the talk was never idle chatter. The conversations were always uncommonly pithy and surprisingly interesting, I now regret very much that I never recorded any of them. Mints's story takes us back to a subject also written about by Vvedenskiĭ—the Newton festival. Actually, Vavilov's encyclopedic knowledge of everything having to do with Newton could not have escaped notice. It would have been astonishing even if Vavilov had never studied anything but Newton. However, I cannot think of a single question from the history of physics on which Vavilov could not have given an answer that was not only exhaustive, but extemporaneous. In

the conversation with Mints that the latter recalls, they discussed a problem that is still most important for present-day science—its industrialization. I believe that this subject is far from exhausted even now. Perhaps we now understand more clearly that this process is in many respects inevitable. But is it always necessary in science? What can be done in the face of elements that are foreign to science but are injected into it by industrialization? These questions lack definite answers even today.

In the last article published here, Academician Vladimir Iosifovich Veksler begins his story at the same time when he was beginning his work at the P. N. Lebedev Physics Institute in 1937. Like the authors of the preceding articles, he writes of Vavilov's exceptionally varied talents and breadth of knowledge, which must have been evident to everyone, and of his equally astonishing capacity for work. He also stresses something else—Vavilov's attitude toward people: simplicity of manner, helpfulness, and, at the same time, an exacting streak that was manifested in the question "What's new?", a question that is essentially unanswerable. Behind this question there was, in fact, a profound involvement in the success of the work and a remarkable scientific unselfishness and breadth of understanding.

Veksler remembers the construction of a scientific facility for which he was responsible. This was a synchrotron electron accelerator for energies over a hundred million electron volts. Veksler had conceived the idea and established the feasibility of this accelerator, and, as is typical at the birth of something fundamental new, it fell to him to overcome the barrier of difference and doubt.

However, when the project had been approved and generously funded, the celebrated principle known as Parkinson's law went into effect, and there were penny-pinching economies in areas where there was no need to economize. A vacant lot whose grassy borders Veksler remembers had been set aside for the construction. At that time, it was nearly outside the city limits (near the present Trade Unions Street, which did not yet exist), quite near the present Academy of Sciences Physics Institute (FIAN) Building.[5)] For some reason, the locality had come to be known as "Tree Farm," a name that it has, surprisingly enough, kept to this day, although anyone who remembers a nursery on this spot is long gone.

In the context of accelerator construction, of course, Veksler was acutely aware of Vavilov's attitude toward the industrialization of science. Veksler's work opened a path into relativistic nuclear physics, and Vavilov, who understood the importance of this for science, gave Veksler his unqualified support.

Veksler wrote his article (or, more precisely, dictated it to his wife) in April of 1966, during a brief remission after his first heart attack. At that time, he did not have long to live (he passed away on September 22, 1966). He told me at that time "You know, I dictated this article and wept; I read it, edited it, and wept again." I myself now reread all of the reminiscences published here only with agitation. This is, of course, partly because the papers stir up my own remembrances of Vavilov, which in many respects echo what has been written. I have no doubt that the unmistakable figure of Sergeĭ Ivanovich Vavilov will take form, if only in outline, even before those who did not know him as they read these articles.

WHAT MEMORY PRESERVES
A. V. Shubnikov

Unfortunately, all reminiscences must begin in the first person. I received my intermediate education at the Moscow Commercial School. I studied in the same class with Vavilov's older brother Nikolaĭ, who was to become a noted geneticist and breeder. The younger Vavilov was in one of the lower grades at our school, but, like all of the older pupils, I paid little attention to him. When I was in about the sixth grade, having been interested in physics from an early age, I built myself an electrophorus machine with great difficulty and at "considerable" expense. My annual "income" at the time was one ruble, consisting of two half-rubles received as gifts from my grandmother for the Christmas and Easter Holidays. I had no other financial resources at the time. My father had died, leaving six children, when I was two years old.

The machine that I built was of the Wimshurst type, but differed from the original in that only one glass disk rotated, while the other was fixed. The two disks were made without benefit of a glass cutter, as follows: wet newspaper was stuck to both sides of the glass, and tiny fragments were chipped away from the glass using flat-nosed pliers and a template. I suppose that, in addition to the glass disks, the machine had two Lyden jars and other components. But the original feature of my machine was a large thick-filament coil that was glued to the center of the rotating disk with "Syndetikon" cement. The coil was fitted onto an ordinary thick nail of the necessary diameter, which was positioned horizontally on an appropriate wooden support. The disc was set in rotation by a drive consisting of a crank handle, a wooden pulley, and an old sewing-machine belt.

I was very proud of the fact that my machine could produce a spark 5 centimeters long, and willingly demonstrated it to anyone who would watch: my schoolmates, my sister's schoolmates, and even the washerwoman Fedos'ya Ivanovna, who was enraptured: "One piece of iron faces another and strikes fire from it." Rumors of this machine filtered down to Sergĭ Vavilov. Soon thereafter, I received an order for the construction of a similar machine from Sergeĭ through one of my classmates who had entree at the Vavilov house. For expenses incurred in building the machine and for my labor, the Vavilovs paid me five rubles—more money than I had every seen. Two weeks later, the little future physicist became the owner of an electrophorus machine. I would not, of course, venture to say that this machine might have played a certain part in Vavilov's choice of his specialty.

In later years, I had frequent occasion to meet Sergeĭ Vavilov, took an interest in his scientific work, and witnessed all of the difficult and complex peripetia of his career.

I remember him as being constantly in attendance at the sessions of Lebedev's seminar, and met him frequently in the Shanyavskiĭ National University, where he worked in the laboratory of Academician P. P. Lazarev, who had studied directly under Lebedev. I may be in error, but I had the impression that it was

here, among the amiable "Lebedevians," many of whom were later famous Moscow Physicists, that Vavilov completed his first work in his specialty.

As I remember it, Vavilov was elected President of the USSR Academy of Sciences shortly after the tragic death of his brother Nikolaĭ. From that time on, I had quite frequent occasion to meet with Vavilov on various matters, some of them very involved.

Vavilov always remembered me and helped me in my work. He favored me with a number of commissions, including trips to the Sverdlovsk branch of the Adademy of Sciences and to the Armenian Academy of Sciences to gain first-hand familiarity with their work.

I can remember one instance only with gratitude. Unexpected orders had been received to transfer the Crystallography Laboratory, of which I was head at the time, from Moscow to Leningrad. It was clear to me that such a move would totally disrupt the work of the laboratory, which had been organized only recently. So I went to Vavilov, who consigned the transfer order to oblivion on his own responsibility, without regard to the displeasure that he might incur.

In conclusion, I cannot omit mention of an event that had a direct bearing on Vavilov's activity as President of the Academy. It happened that the Presidium of the Academy had been obliged to relieve one of our most famous academicians from his post as director of the Institute that he had founded. Despite the decree of the Presidium, Vavilov asked me to make things easier for this scientist by appointing him to the staff of the agency of which I was then director. Naturally, I could not refuse him this favor.

FROM MY MEMORIES OF SERGEĬ IVANOVICH VAVILOV

B. A. Vvedenskiĭ

One cannot count many examples of the complete and harmonious combination of rare charm with a monumental scientific and scientific-administrative career of national scope as was embodied in the unforgotten Sergeĭ Ivanovich Vavilov.

This volume contains more than a few articles devoted to specific aspects of Vavilov's exceptionally varied activity. It seems to me that his admirers will also be interested in everyday human traits and nuances of this lofty, complete, and, at the same time, surprisingly multifaceted personality. I have therefore set myself the modest goal of setting down such moments as I remember that are typical from precisely this point of view.

My earliest recollection of Vavilov dates from an occasion in either 1912 or 1913, on which he was reading his paper on photometry at a colloquium (the word "seminar" had not yet come into use) at the Shanyavskiĭ University on Miusskaya Square. But then a long chain of his excellent papers of much later years comes immediately to mind. Despite the enormous differences in both content and maturity of exposition, Vavilov retained to the end of his days the manner of speech and the gestures of his youth, with their telling effect on his listeners.

Vavilov was greatly assisted in this by a singular, gentle, unobtrusive, throwaway brand of humor that sometimes even crept into formal presentations. It would glimmer in a scarcely noticeable intonation, a pause, a hint of a gesture, and only rarely in a peculiar combination of words, an unexpected juxtaposition, a quotation.

I remember one brilliant paper on fluorescent lamps in which he compared the light of incandescent lamps to the light cast by the flames of a primitive wood fire; in another instance, during an argument over the planning of scientific research in which he wished to draw a line between planning of research and planning of discoveries, Vavilov unexpectedly quoted from A. K. Tolstoĭ:

> "The sprouts of science are not in our power,
> We only sow the seeds."

Vavilov's sense of humor had a special way of breaking out in quick catchwords, like his term "finger reading" for papers read from prepared manuscripts or his lapidary "Oho!" when, in the heat of a report, someone would state that "We readjusted and rotated through 360 (!) degrees;" or—on an incomparably more serious occasion, in response to being congratulated on his appointment to the post of President: "They don't congratulate you for this!" when he wished to express how deeply he felt the full weight of responsibility of his new job and to hint that congratulations were perhaps somewhat premature.

Nor did his humor abandon him in his remarks and reproofs to subordinates. I do not remember a single occasion on which Vavilov lost his temper: even comments delivered in a cutting tone were a rarity. He was usually able to make himself heard with a mild interjection, and, although he did not prohibit argument, he was still usually able to make his interlocutor (who was essentially "on the carpet") recognize his—the interlocutor's—error. But in most cases Vavilov managed to do this gently and without offending: if the other party went away angry, it was only with anger at himself. His strongest expletives included: "not good" (or even "not too good") and his famous "fie for shame". This last expression was near his limit of severity, and I dreaded it like fire.

Vavilov would relate certain facts from his own life with the same humor.

During the First World War, Vavilov had command of a "spark station" (something that would now be called a radio), which offered him the opportunity to investigate the then new technique of radio direction finding (another term that did not exist at the time). Vavilov introduced new twists into this method in accordance with the requirements of the tactical situation, determining not only the direction to the enemy transmitter being located, but also the strength of the received signal, which, with certain reservations, was equivalent to determining the distance to the station of interest. Vavilov submitted a report to his superiors in which he explained the triangulation principle with a simple drawing that indicated clearly the essentials of the proposed technique and dispensed with superfluous formulas. But his superiors were not pleased by this simplicity and demanded a "more solid" approach from Vavilov. "Well, why not? I wrote out the formulas of analytical geometry for the various circles and straight lines, used them to determine the points of intersection, and so forth. My superiors were satisfied."

Behind the light-heated form of the story, however,

one felt Vavilov's serious interest in problems of radio engineering. It is true that Vavilov was not clearly involved with radio after one more interesting paper on the frequency of the loaded antenna. Back in 1919, however, he was making serious plans for work on these problems, especially in connection with the electron tube or, as it was called, the cathode tube, which was just then appearing on our horizon and still quite a "novelty," and was about to go to work at the Military Radio Laboratory of the Main Military Engineering Directorate. But the physicist (or, more precisely, the optician) in Vavilov won out over the radio engineer (or radiophysicist) in Vavilov, and in the same year, 1919, he made a first decision to turn or, more properly, return to optics. Even then he had an acute sense of the proximity of optics and radio (which is now a truism, although the possibility of bridging the gap between the radio and optical spectra was still being disrupted at the time), perhaps influenced by the ideas of the Lebedev School, with which Vavilov was closely associated during his student years.

The reader will find the story of Vavilov's brilliant chain of works in optics in the appropriate articles in this volume. As for radio, Vavilov's interest in it and related problems remained strong throughout his life. It was responsible in great measure for his vigorous support of L. L. Mandel'shtam's promotion to head the department at Moscow State University and his cordial (and even friendly) relationships with N. D. Papaleksi, M. A. Bonch-Bruevich, and various other scientists, some now dead and others living, who were close to radioelectronics, and also, for example, his active participation in the marking of the Fiftieth Anniversary of Radio in 1945 and the fact that he included problems of radio engineering in the courses that he taught.

Vavilov had a good command of foreign languages, including Latin, which he studied privately during his years in intermediate school. He would occasionally show a fondness for folk and Old Russian words and phrases, such as his "fie for shame." He had a strong interest in the history of the Academy of Sciences. This subject was somehow organically interwoven with his love for Leningrad (which owed much of it to his extremely close creative association with the State Optical Institute), although he was himself a native of Moscow. The Leningrad memorials pertaining to the St. Petersburg period of the Academy of Sciences received Vavilov's love and attention. Thus, he restored the old emblem of the Academy of Sciences, which now appears, for example, on Academic publications and represents the Academy Building on the Neva (formerly the Kunstkammer building); in preparation for the 1945 Academic Festivals, Vavilov gave much effort to the job of making the old Academy of Sciences buildings and the Pushkin memorials presentable in the aftermath of the fascist invasion. He was most active in the Pushkin festivities of 1949.

The fact that Vavilov had a good command of Latin even though he received his secondary education at a school far removed from "classicism" comes as something of a surprise. It was in harmony with his interest in such works as the philosophical poem of Lucretius Carus "De Rerum Natura" and others, and in the history of natural science in general and in Russia in particular. His knowledge of Latin enabled him to familiarize himself closely and fully with, for example, the works of Newton, of which he produced a complete translation considerably superior to any that had existed previously.

He prepared a paper on Newton for the London Newton Festival of 1946 with meticulous care (the same care that he devoted to everything that he wrote, including his numerous public addresses, which were, incidentally, always his personal handiwork). He was unable to deliver this paper in person, and quite upset over the fact that it was to be presented in his absence; it was delivered successfully by Professor Andrade of London, who had recently been in Moscow.

This paper was carried to London by the delegation of the Academy of Sciences, which was headed by Academician A. E. Arbuzov. Vavilov gave us very thorough instructions before the trip, anticipating various difficulties that might be encountered, as he did in all similar cases, for example at the departure (in 1950) of our delegation to Berlin for the 250-th Anniversary Celebration of the German Academy of Sciences, at which, after a considerable lapse of time, the inaugural address was also to be given in German. Vavilov went into minute detail in discussing the German translation of this address with us, with a critical appraisal of Germain neologisms that were just then coming into use.

Vavilov was also interested in other scientists—Galileo, Euler, and, for example, Monge and his work to equip the revolutionary army during the French Revolution in 1789. He wrote a very interesting paper on Monge, replete with historical facts taken, by Vavilov's own accounting, directly from French periodical literature of the day ("Moniteur" and others), which he, Vavilov, had found in the Library of the Academy of Sciences (LAN).

Hardly anyone (and least of all Vavilov himself) could ever give an exact count of the total number of burdens that he carried simultaneously (here we refer only to the workload for which he received no supplementary salary). His own attitude toward this question was stoical and humorous as usual. When someone complained to him about additional work, he would reply "What difference does it make to you whether you have a hundred jobs or a hundred and one? ", refer to the famous Weber-Fechner law, and hear no objections, although, to be sure, like the Weber-Fechner law, this reply would hold up only as long as all of the numerous jobs were advancing smoothly. For "rocky" cases, Vavilov himself would contrive to steal time from the night hours, of which there were not so many left by the notion of the working day that prevailed at that time.

I remember how Vavilov spoke of the ten-hour "day" as something on the order of a vacation, because he himself worked considerably more than ten hours a day. This was his pattern not only during the Second World War, when he worked at both the Physics Institute (FIAN) (Kazan') and the State Optical Institute (GOI) (Ioshkar-Ola), with regular journeys from one city to the other, something that was not exactly easy for him considering the wartime conditions and the state of his health.

When it comes to Vavilov's concern for his beloved FIAN, the colleagues of that institute can, of course, produce a much better account than I. I mention only that Vavilov was exceptionally attentive to the blueprints, planning, internal layout, and furnishings of the Institute, as he was, incidentally, in regard to the other

academic institutes that were built during his day. He was very particular about the vacation spots to which members of the Academy were sent, placing his prime emphasis on beauty of the natural surroundings rather than accessibility. Thus, he was very fond of Batiliman (near Balaklava) despite the difficulty of the road leading to it.

However, Vavilov himself had a rather unique interpretation of the term "vacation:" during his vacation, he would usually write papers and books or prepare new editions. This was evidently what moved him to declare on one ocassion that the Academic "dacha" villages formed in 1948 were not only for relaxation, but also for creative work.

In addition to his extremely tight regular scientific and administrative schedule, Vavilov found time and energy not only to serve as the opening speaker at numerous festive gatherings, such as anniversary observances of various major events and personalities, but also to become involved most actively in the work, for example, of the Society for the Dissemination of Political and Scientific Knowledge and to work actively on the Great Soviet Encyclopedia (GSE) as editor of its Second Edition (unfortunately, he had time to review only seven volumes). As the Editor-in-Chief of the GSE, he not only chaired regular conferences of the main editorial staff, but also read attentively though the material, made numerous comments, and even wrote some articles himself (on the USSR Academy of Sciences, the Bouguer-Lambert-Beer law). As he signed piles of papers and manuscripts, he would remark with his usual humor: "Which one of these is 'To the oblivious dog'?" (this was the title under which there appeared in one of the volumes of Brockhaus and Efron's Encyclopedic Dictionary a very short but strongly insulting notice directed at the editor-in-chief of the Dictionary, who signed it without reading it along with a number of others). That Vavilov was joking was clear to everyone: he always read very carefully everything that he signed.

* * *

Wherever Vavilov worked, he has been remembered as an exceptionally kindly and considerate chief and comrade. To himself, however, he was totally merciless. At work, he would literally burn himself out. All promises to spare himself, even on orders from above, were forgotten as soon as they were given.

Even when he was quite ill (as eyewitnesses tell it), he would apologize touchingly to his doctors for having alarmed them with his illness, assuring them that all was well with him.

And now Sergeĭ Ivanovich is no more. A beautiful life, but one so prematurely ended!

The poet wrote:

> "Say not in anguish that they're gone,
> Be grateful that they lived!"

Should not this comfort all of us who loved him deeply but could perhaps have cared for him more?

A CONVERSATION IN THE NIGHT
A. L. Mints

In the fall of 1956, the P. N. Lebedev Physics Institute of the USSR Academy of Sciences was ordered to go ahead with the development of a 680-MeV synchrocyclotron that was to be the largest in existence at that time. A new laboratory, supervision of which was entrusted to the author of these lines, was organized for this purpose in the Physics Institute of the Academy of Sciences (FIAN).

Sergeĭ Ivanovich Vavilov, then the President of the USSR Academy of Sciences, had stayed on as director of the Physics Institute, and showed great concern for the development of our laboratory's projects. He was highly interested in the progress of the design work on the synchrocyclotron.

I had rather frequent occasion to bring Vavilov up to date on design considerations relating to this giant accelerator. From time to time he would heave a sigh as he listened to these reports, and, although he approved our plans and elaborations, the feeling nevertheless persisted that he was to some extent worried about the high cost and complexity of the synchrocyclotron. However, as though not to discourage those of us who had the job of developing the accelerator, he never once said anything to that effect.

During 1946–1947, the author made frequent trips to Leningrad and the "Elektrosila" plant, which was building most of the equipment for the project, construction of which had started at Dubna (at what is now the Joint Institute of Nuclear Research).

Ambitious for its day, this accelerator was a complex of electrical and electronic equipment, vacuum systems, and a multitude of other devices for observing the performance of the synchrocyclotron, for automatic control of its circuits, etc.

Early in 1947, business brought me together with Vavilov in a car on a train from Moscow to Leningrad. We found ourselves in adjacent compartments. Vavilov was alone and invited me to join him. Over tea, we spoke of the destiny of experimental physics far into the night. Whenever it seemed to Vavilov that he held the upper hand in the argument, the compartment would be filled with his characteristic deep-voiced laughter. He took the position that modern experimental physics too often digresses into the construction of extremely complex and very expensive facilities. But the genuinely talented experimental physicist can choose another path—that of the subtle and elegant experiment in which the creative flight of imagination is supplemented by the skill personally to create simple instruments and still obtain results of fundamental importance. As an example, he cited the classical works of the celebrated Russian Physicist Petr Nikolaevich Lebedev, who used his own hands to build his famous instruments for light-pressure experiments, to reproduce the experiments of Hertz in the millimeter band, and so forth.

Vavilov was also intrigued by the outstanding experiments of the American Physicist Robert Wood, who used extremely simple apparatus of his own making to perform a number of classical investigations in optics and acoustics. I would not yield, and observed that we were getting farther and farther away from the epoch of Newton, when, according to legend, all that was necessary to discover the law of gravity was ingenuity and an apple orchard. Vavilov burst out laughing and replied that to obtain the genius of Newton was not such a simple matter. As always when Newton's name came up, Vavilov shifted the conversation to him, and could not pass up the chance to express his unbounded admiration for the genius of the great Englishman.

Vavilov was our greatest expert on the scientific heritage of Newton. He did not content himself with reading Newton's works in translation, but studied them in the original Latin. Although Vavilov had not received a classical education and had not studied Latin in secondary school, he had had to pass a Latin examination to enter the Moscow University. With his remarkable memory and exceptional ability, Vavilov was not satisfied with passing a course merely to overcome a formal barrier posed by the University admission rules of the day, and became a genuine Latin scholar with a feeling for all of the subtleties of the language and admiration for the impeccable logic of its syntax and the beauty of the poems of Ovid and Virgil, many of which he knew by heart.

With his massive knowledge of his subject, Vavilov spoke not only on the scientific side of Newton's works, but also on peculiarities of the language in which they were recorded. As always when the conversation came around to Newton, Vavilov took special note of his "Philosophiae Naturalis Principia Mathematica." Later, at the festivities in England dedicated to the 300-th anniversary of Newton's birth, Academician B. A. Vvedenskiĭ read for the absent Vavilov the latter's famous address on Newton and his creativity. This piece made a tremendous impression in Newton's homeland and was met with the highest praise, and Vavilov was recognized as the greatest living Newtonian. Relating our evening visit over that cold tea, I cannot omit the tremendous impression that Vavilov's words in tribute to Newton left with me. I sensed a direct link to the ideas of Newton, who seemed to have passed his scientific torch over the centuries to his Russian admirer and follower.

The romantic turn of mind of the experimental physicist made Vavilov feel closer to works whose chief distinctions were subtlety in statement of the problem and cleverness in the design of the experiment.

He did, of course, acknowledge the importance of "industrialization" of the physical experiment (this phrase, which gives very precise expression to the involvement of engineering thought and industrial plants, originated with Academician L. A. Artsimovich), but his tastes and personal inclinations were in sympathy with such magician-experimentors as Lebedev and Wood.

Although it is now a widely endorsed position that progress in modern physics would be difficult without extremely complex and expensive hardware, remarkable papers appear from time to time to describe the use of relatively simple apparatus to acquire results of fundamental importance with far-reaching consequences for the development of physics and engineering. As an example, we might note the outstanding work that led to the discovery of the Mossbauer effect, which would have pleased the eye and tickled the scientific palate of the departed (how difficult it is to write that word) Sergeĭ Ivanovich Vavilov.

S. I. VAVILOV AT THE FIAN[6)]

V. I. Veksler

I have been asked to write my reminiscences of S. I. Vavilov. And I have attempted to do this, but I shall not and cannot do justice to the importance of Vavilov's scientific works, to his tremendous "enlightening," if I may use the word, and social activity, or, finally, to the influence of Vavilov's personality on the development of science in our country during the years when he was President of the Academy. Each of these subjects should be a topic of serious research. Vavilov's record is clearly so deeply etched in so many fields of activity that only a collective effort on the part of many persons could produce the appraisal merited by Vavilov's importance in the development of culture and science in our country. Thus the statement that follows will be concerned only with Vavilov's personal human qualities.

My acquaintance with Academician Vavilov dated from 1936. At that time, I was working at the All-Union Electrical Engineering Institute (VÉI) as Chief of the x-ray Laboratory. I occupied this post nearly by default, since the laboratory staff were either quite young—persons of my own age--or, if older, essentially practical engineers or mechanics. The group of young physicists that were then at work in the FIAN (I. M. Frank, P. A. Cerenkov, L. V. Groshev, and others) know of some of my studies, which were concerned with methods applicable in nuclear physics. Vavilov was then director of the FIAN Laboratory and D. V. Skobel'tsyn was a scientific consultant who traveled once a week from Leningrad to Moscow. Frank asked me to present a report of my work at a small laboratory seminar, and after hearing it they apparently consulted with one another and then asked me whether I should like to discuss with Vavilov the possibility of my being transferred from the VÉI to the FIAN. At that time, such notable scientists as L. I. Mandel'shtam and N. D. Papaleksi, with their group of outstanding theoreticians, I. E. Tamm, G. S. Landsberg, and many others, were employed at the FIAN. Therefore, I could, of course, only dream of becoming a part of such a remarkable scientific group.

I remember how, on the appointed day, Frank met me in the building on Miusskaya Square that formerly housed the FIAN and took me directly into Vavilov's office. Its furniture included a large, ancient writing table and a glass cabinet in which various instruments were stored, some of them made by Levedev. A tall man, still very young and handsome, advanced toward me. This was Vavilov.

Naturally, I was quite nervous over being introduced to Academician Vavilov, and had no idea of how I should address myself to this famous scientist. But the first overriding impression was made by Vavilov's uncommonly kind and unassuming demeanor. He chatted with me and from the very start of the conversation literally put me totally at ease. So attentive was Vavilov that he even remembered to ask whether I would suffer financially if I transferred to a job at the Physics Institute and suggested a way of arranging for my transfer and even of doing this in such a way that I would be no worse off. He proposed that I transfer to the FIAN to study for a doctorate, and said he was willing to be my scientific sponsor. This was the only way I could have gotten out of the VÉI, since nothing had priority over doctorate studies. Vavilov's simplicity of manner left a lifelong impression upon me. I was later to reaffirm time and again that Vavilov's simplicity in his dealings with all persons, irrespective of rank, scientific accomplishments, or age—his unfailing benevolence to everyone—was his most attractive trait as a man.

After I had begun to work at the FIAN (starting in September 1937), I naturally saw Vavilov very often. He always came into the laboratory in the morning and conferred with his closest collaborators, Frank and Cerenkov, on the experiments in which the new famous Cerenkov effect had been discovered. His role in this discovery is well known and, of course, those immediately involved—Cerenkov and Frank—can assess Vavilov's part in it much more completely and exhaustively than I. Our part in these morning conversations consisted essentially of reporting to Vavilov on our work; everyone in the laboratory participated. During these visits, in addition to Vavilov's excellent memory and erudition in widely diverse branches of science, yet another characteristic trait of his came clearly to the fore: his exceptional interest in any progress, no matter how small, in the work of each of us. This ability of Vavilov to be genuinely interested and pleased by progress in a study even if it was quite remote from his own scientific interests made his personality uncommonly attractive to everyone who worked with him. For example, he discussed with equal and unfeigned interest the "purely nuclear" projects of our laboratory and, at the same time, took a lively interest in research being done in the acoustic laboratory by our junior colleague Sukharevskiĭ

Vavilov was modest in the highest degree. When he walked into the Institute, he would shake the hand of everyone he met, whether janitor, technician, or professor, greeting everyone by his first name and patronymic. Vavilov used the familiar form of address with Rogovtsev, a technician who had worked with him for a very long time, since before the 1914 War. It is recorded that back when Vavilov was director of the Leningrad Optical Institute, he worked for some time with one of the junior laboratory assistants. This assistant, E. M. Brumberg, helped Vavilov in his personal work. When they published scientific papers, Vavilov's name always came second: Brumberg and Vavilov, since this was the alphabetical order. Obviously, Vavilov was to be credited with the basic contribution to the article. Later, Brumberg became an investigator in his own right, thanks in no small measure to Vavilov's support. Vavilov's modesty is pointed up by another trivial but telling episode. During the Second World War, Vavilov was located with the Optical Institute at Ioshkar-Ola, and traveled once a week to Kazan' University, where the FIAN was at that time. He was ill quite frequently during this period. His son was in Leningrad, which was under siege, and when Vavilov took seriously ill it was suggested to him that he call for his son, taking advantage of his perquisites as an academician and as the scientific director of the Institute. Vavilov rejected this suggestion and categorically forbade anyone to request his son's evacuation. Vavilov helped many people out of his own personal material resources, but he knew how to do this without hurting anyone's pride and generally went to great lengths to keep such matters private.

Sergeĭ Vavilov had an exceptionally high regard for the talent of his older brother, and I heard him many times and on various occasions speak in praise of Nikolaĭ's gifts and of his place in science. It was a very difficult time for him when Nikolaĭ was unjustly sentenced, and he made no effort to conceal it, maintaining, to me among others, that he could not even entertain the idea that his brother might be guilty of crimes against the people. So great was his love for his brother that the sentencing very seriously affected his own state of mind and health for the rest of his days.

During the war years, and especially during the last years of the Second World War, an enormous range of new responsibilities fell on Vavilov's shoulders. His capacity for work was astonishing. He would regularly make his appearance at the Institute at 10 o'clock in the morning and often finished his working day at 3 or 4 A.M., taking part in the deliverations of various governmental organs, which were then meeting at night. Sometimes he had to pick his way through the dark streets of Moscow as the antiaircraft batteries were pounding away at attacking fascist airplanes.

Vavilov was elected President of the Academy of Sciences in 1945. By this time his health was noticeably impaired. Still he never refused a responsibility. An encyclopedically educated man, he managed to read an enormous amount of literature, obviously by working at night, since there was no opportunity for this during the day. His breadth of vision and interests always astonished those near him. Publication of books on the history of physics, translations of Galileo's works, problems of philosophy and natural science, optics, wide popularization of science--by some miracle he succeeded in all of these accomplishments. Throughout this gigantic work he remained at all times calm and affable. He was always fair in his dealings with people, even when he was overburdened with work. In all the years during which I knew Vavilov, and I was his deputy for the FIAN after the War, I saw him lose his temper only once. The situation was as follows. I had had occasion to advise Vavilov of plans for the construction of a scientific facility for which I was responsible. I had tried to make the project as economical as possible, since I felt that complications might arise during the hearing before the commission whose approval was required for the project. I had deleted the greenery around the installation, but during the discussion Vavilov insisted that it be restored, as was indeed reasonable and expedient. During the hearing, as I had expected, one prominent member of the commission criticized precisely this item of the plan in a bantering tone of voice. Then for the first time I saw Vavilov in a rage. He turned livid, jumped to his feet, pounded on the table with his fist, and screamed: "Devil take it! I had that part put in!" Vavilov's performance was so unusual that the caviller turned pale himself and began to mumble incoherent apologies, while the rest of us surrounded Vavilov and quieted him down.

His active interest in a broad circle of problems, including those of the history of science and philosophy, resulted in Vavilov's being consulted on projects of widely varying nature that invariably received his support, even though they were remote from his chosen field. He was a man without an axe to grind, and always proceeded from the single premise that new ideas, exchanges of ideas, and arguments were necessary for the development of science. At the time, however, this sometimes created difficult situations for those who went into print with new ideas of a general nature: thus, for example, Corresponding Member of the USSR Academy of Science M. A. Markov (now Academician—I. F.), who was working at the Physics Institute, had a long-standing interest in the philosophical problems of physics. Knowing this, Vavilov recommended to Mar-

kov that he write a paper on the problems of quantum mechanics. Markov felt that his paper, in which he discussed the viewpoint of Bohr and the Copenhagen School on quantum mechanics, would become a target of malicious criticism for the conservative faction of philosophers specializing in the philosophy of natural science. Vavilov had great respect for Markov's originality and profundity of thought, and kept insisting that the latter publish his paper. When the article was published, Markov's fears became a reality. Things went so far that complications arose in the High Degree Commission concerning Markov's nomination for the rank of professor, even though he was already a well-known scientist. Vavilov became highly agitated and concerned for Markov, understanding that he had unwittingly been the instigator of the situation. The attacks on Markov eventually stopped, but only thanks to the most resolute intervention of Vavilov.

One characteristic trait of Vavilov that I found particularly striking very early during my time at the FIAN was his urge to achieve the simple but profound experiment with a minimum of technical outlay. When we young physicists wanted to build a complex apparatus for an experiment, he would always point to a multitude of examples from the history of science to demonstate that the great discoveries were made it as a result of intense brainwork rather than by the construction of complex apparatus. Only after the war, when physics was becoming industrialized, did Vavilov himself take part enthusiastically in the development of an industrial base for physics in our country. It seems to me that he must have gone through an internal struggle and perhaps not quite completely overcome his own private skepticism. His tremendous part in the development of postwar physics is known to everyone. The above observation is intended only to underscore the great good that always came of his gentle skepticism and stubborn insistence that physicists who think clearly are more important than enormous expensive machines.

In his conversations with subordinates and especially with the younger ones, Vavilov would often draw upon his excellent memory to relate one of his repertoire of curiosities from the field of physics. I remember one case in particular. During the First World War, Vavilov was in the army, where he was fated to take over the property of a field radio station of the primitive type then in use. An inventory that had been prepared most conscientiously by an anonymous clerk and contained a list of the equipment included the following entry after number so-and-so: "unknown in a jar." Naturally, this aroused Vavilov's curiosity, and he established that the clerk had applied this "original" designation to a coherer, a device well known to all physicists. The term "unknown in a jar" grew to be highly popular among physicists and became for all practical purposes an appellative.

Needless to say, the isolated anecdotes given above cannot pretend in any measure to constitute a thorough characterization of Vavilov. I am certain that many people who came into contact with Vavilov at one time or another could expand significantly on my contribution as to Vavilov's character and turn of mind. But I do hope that even the brief reminiscences given above have provided the reader with an authentic impression of that remarkable man.

[1)]It is dated August 1, 1966.
[2)]Dated March 11, 1966.
[3)]It will be recalled that the Weber-Fechner law is a physiological law. It states that the smallest increment in an external stimulus that can be sensed by sense organs requires that the stimulus change by an amount ΔI proportional to the stimulus I itself, i.e., that $\Delta I/I$ is constant.
[4)]Dated March 31, 1966.
[5)]The FIAN Laboratory directed by Academician P. A. Cerenkov is now located there.
[6)]Veksler's original manuscript carried no title.—Ed.

Translated by R. W. Bowers