When Stalin unexpectedly proposed in 1945 that Sergeĭ Ivanovich should become the President of the Academy of Sciences (his beloved brother had died of starvation in prison two and a half years before that), he perceived this proposal with horror. He realized that at the new post he would have to speak terrible ritual words and participate in criminal arrangements at Stalin's directions (it later turned out that there came a suppression of entire sciences). But rejecting Stalin's proposal (no one could run the risk at that time) might involve terrible consequences. Sergei Ivanovich's consent was by no means a manifestation of spinelessness. Moreover, he knew that should he escape the presidency, Stalin would appoint one of his favorites who would ruin our science completely. We now know that Stalin initially wanted to appoint Vyshinskiĭ, not even Lysenko, to be the President of the Academy. But the Academy Vice-President I P Bardin, who replaced in fact the sick, virtually in marasmus, President Komarov and expressed the opinion of several leading academicians, managed to make Stalin change his mind, giving his consent to their choice of S I's candidature. Once again — this time tragically — his fate became interwoven with the time he lived in...

Sergeĭ Ivanovich made up for this humiliation by his gigantic-in-scale, exceptionally fruitful activity to support and advance the sciences in our country. That which he managed to accomplish during the five years of his presidency astonishes by its scale, careful consideration, successfulness, and prodigiousness of accomplishments. But it involved such a physical effort and moral feelings on his part that it resulted in his untimely decease. Look at this photograph. It was made by L V Sukhov, a FIAN staff member, only a few days before S I's decease. At this moment S I was in his laboratory and unaware of being photographed. It would suffice to compare this photo with the previous ones (see, for instance, the photo on p. 1017) to make sure that S I was on the verge of death.

Like many others, I believe that Sergeĭ Ivanovich consciously sacrificed himself to our science, and we must gratefully bend our heads before his deed.

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## Sergeĭ Ivanovich Vavilov in my life

## A M Bonch-Bruevich

Much has been written and said about Sergeĭ Ivanovich, who has been portrayed so clearly and thoroughly that hardly anything remains to be added to his image. Nevertheless, I dare say a few words because I am much obliged to Sergeĭ Ivanovich. It is not unusual that the personal recollections of a collaborator or a student of his teacher and supervisor are to a large extent a story of himself. While contemplating what I can say about Sergeĭ Ivanovich, I recognized the inevitable recourse to the circumstances of my life, which led me, I would say, to the happy meetings with Sergeĭ Ivanovich and the work in his laboratory, when I was working for a doctor's degree under his scientific leadership. I shall try not to abuse my position and, figuratively speaking, punctuate these circumstances with a dotted line.

I first met Sergeĭ Ivanovich in winter, a few months before the war broke out, at the end of 1940 or in early 1941. In 1939, I graduated from the Leningrad Polytechnic Institute and began my post-graduate study at Fiztekh (the Physicotechnical Institute) in Leningrad. That year, a universal military obligation law was issued in the USSR. I was therewith called up for military service in the Red Army. Initially I found myself in a military unit near Moscow to be later transferred as a private soldier to a technical training company attached to the Leningrad Military Electrotechnical Academy of Communications. At that time, the attitude to higher education was much more respectful than nowadays, and a Red Army soldier with such an education attracted considerable attention from his senior officers. That is why I was allowed, during my off-duty hours, to participate in the work of the Physics Chair of the Academy, which was chaired by D N Nasledov. I was engaged in the preparation of demonstrations for lectures. It occurred to me that it would be a good idea to demonstrate the effect of luminescence to the audience and draw a picture in fluorescent paints to make the demonstration more spectacular. One of my friends, a young painter, enthusiastically undertook to paint the picture. As for the phosphors, I decided to get them from the State Optical Institute (GOI), one of whose staff members was P P Feofilov, who later became a Corresponding Member of the USSR Academy of Sciences. We had been studying in the same group in the Polytechnic Institute. Unlike me, he had not been called up for army service and was then working in Sergeĭ Ivanovich's laboratory. When Petr Petrovich and I were selecting phosphor powders under UV lamp illumination, Sergeĭ Ivanovich entered the room and Petr Petrovich introduced me to him.

Sergeĭ Ivanovich asked me if I was the son of Mikhail Aleksandrovich Bonch-Bruevich who had died about a year ago. They — Sergeĭ Ivanovich and my father Mikhail Aleksandrovich — had known each other well. My father was a professional radio engineer and a radiophysicist, whereas Sergeĭ Ivanovich, as is well known, served in radio troops during the First World War and in 1919 published his paper "Oscillation frequency of a loaded antenna" [1] written in field conditions. Both of them were elected Corresponding Members of the Academy of Sciences in the same year of 1931, and more than once my father had made mention of Sergeĭ Ivanovich.

Sergeĭ Ivanovich regarded with interest my intention to do a painting with the use of phosphors. In a very benevolent manner and without any haste he inquired of me what kind of picture it would be. The painting was conceived as one and the same view of a blue sea, a yellow sandy seashore, a schooner with sails drawn down, and a fire with several people sitting about it: either on a sunny day with patches of sunlight on the water (under natural illumination), or on a moonlit night with a moonlight path on the sea (under UV irradiation). It seemed to me that Sergeĭ Ivanovich appreciated this conception.

I memorized this first meeting with Sergeĭ Ivanovich very clearly. The kind image of Sergeĭ Ivanovich has remained in my memory so as he appears, though at an older age, in the well-known photograph reproduced, in particular, on the dust-cover of the book about Sergeĭ Ivanovich edited by I M Frank [2]. This photograph in portrait format hangs now in my study in GOI.

The next time I met Sergeï Ivanovich after the war. This meeting largely determined my subsequent fortune. Not without trouble, in 1946 I got demobilized, now as an officer. Immediately after that, the First Main Directorate sent me on a relatively long mission, on nonarmy business trip, to the Soviet occupation zone in Germany. On my return, I pursued a winding path to eventually find myself in Moscow in a closed (classified) institution, under the supervision of A I Leĭpunskiĭ and D I Blokhintsev. I combined jobs and was an assistant professor at the Moscow Mechanical Institute (MMI), which later evolved into the Moscow Institute of Engineering Physics (MIFI). I K Kikoin, S É Khaĭkin, M A Leontovich, and other prominent physicists lectured at this institute at that time. While still in the army, already being an officer and a lecturer of one of the Chairs of the Military Electrotechnical Academy, in 1944 I defended my candidate thesis on pulse technology and acquired a background in pulse radio engineering circuits. I took advantage of this background as applied to the recording of nuclear radiation and delivered a lecture course in measurement radio engineering for physicists in the MMI. So far as I know, this was the first course of lectures in this field.

For some time, I retained access to the devices and materials brought from Germany, which were kept in storehouse at Obninsk. This enabled me to pursue the recording of scintillations in the MMI, employing trophy photomultipliers and compact high-voltage power supplies. But in reality this work was not satisfying, and I wanted to come back to Leningrad to my family and commence physics research. However, this was hardly possible to accomplish, bearing in mind my primary responsibilities and the general situation. One day I discussed this issue with M A Leontovich and he advised me to apply to Sergeĭ Ivanovich, who already was the President of the Academy of Sciences. This seemed to be a difficult task to me. What helped was that N A Tolstoĭ, a friend of mine, was working for a doctor's degree under Sergeĭ Ivanovich's supervision. And so I found myself in Sergeĭ Ivanovich's study in FIAN in Miusskava Square. Sergeĭ Ivanovich gets up from his big table, makes several steps to me, shakes my hand, and with his kind smile already familiar to me suggests that I should tell him of my problems. This was a conversation with an extraordinarily benevolent person sincerely wishing to help me rather than a reception by the Academy President of a relatively young man who had served in the army for seven years and had accomplished nothing in science. Later on I would read and hear much of Sergeĭ Ivanovich's benevolence and unaffected manners, but reading or hearing is one thing and experiencing by oneself is quite another. I was lucky to experience this.

Probably to make it easier for me to overcome my reservedness and accept the confiding character of conversation, Sergeĭ Ivanovich asked me whether the picture I had spoken of had been drawn and how it looked. It amazed me to hear that he remembered my visit to GOI in 1941, and I started somewhat enthusiastically telling him of the painting and of what I had been doing during the past years. Sergeĭ Ivanovich was surprised to hear that I had managed to pursue research work and defend a thesis for candidate of sciences while in army service. To my regret he regarded with skepticism my attempts to get engaged in scintillation counters. I had been looking for his interest in them before the meeting. By contrast, he favored my intention to write a monograph on the application of electron tubes in experimental physics. Running slightly ahead, I will mention that the manuscript of the book was completed in 1949, and Sergeĭ Ivanovich wrote a recommendation letter to Gostekhizdat (that existed prior to the inception of the 'Nauka' publishing house), which undoubtedly promoted its publishing [3]. This book, and especially its subsequent editions, was benevolently accepted by physicists, and from then I would gratefully remember Sergeĭ Ivanovich who, I would say, trustfully supported my work on the book. More recently, when I was a staff member of his laboratory, he approved my lectureship (the course had greatly expanded), this time not in the MMI, but at the Chair of B P Konstantinov of the Leningrad Polytechnic Institute. This undoubtedly moderated the completion of my dissertation work, but such was Sergeĭ Ivanovich — he always readily encouraged scientific research or work beneficial to science, even though this activity might not lie within the field of his direct interests.

During this first post-war conversation with me, Sergeĭ Ivanovich told me he could help me by making me his doctoral candidate. He immediately told me he had long wanted to stage a first-order relativistic experiment in the quantity v/c in order to directly observe in laboratory experiments that the velocity of light is independent of the velocity of motion of the radiation source. In the view of Sergeĭ Ivanovich, a relativistic experiment of this kind could well underlie the work for a doctor's degree. I regarded Sergeĭ Ivanovich's words about the doctorate with concealed joy. I had learned from M A Leontovich that a doctorate was nearly the only possibility to quit a classified institution, because according to law there was no escape from letting a doctoral candidate leave. A work for a doctor's degree under the supervision of the Academy President would make this opportunity a reality. I left Sergei Ivanovich in euphoria, taking with me his book Experimental Foundations of the Theory of Relativity [4].

While on my way to the meeting with Sergeĭ Ivanovich, who knew little of me, I could hardly expect a proposal of a thesis for doctorate without preliminary work, for instance, in one of the FIAN laboratories. My joy was therefore quite natural, but I should admit that the relativistic experiment filled me with some dismay.

Reverting mentally to the conversation with Sergei Ivanovich, I appreciated his wisdom. I had not performed any investigations that could make me known to physicists in some realm of physics and could underlie the work for a doctor's degree. At the same time, the accomplishment of a relatively complex classical work of general physical significance could justify such pretensions. That was good, but I feared that the scientific community might suspect that I doubted the special theory of relativity. I shared my apprehension with Sergeĭ Ivanovich on my next visit to him in FIAN. I memorized his reply well. "I believe", he said, "that every significant statement, the more so a basic physical postulate, should be directly confirmed by experiment. The absence of such an experiment and reference to corollaries instead, no matter how numerous they may be, may raise doubt in not-too-well educated people. These doubts retard the advancement of science, and we have to spend time and effort to combat them. Herein lies the importance of any reliable experiment staged to directly confirm the second postulate". Sergeĭ Ivanovich repeatedly reaffirmed this viewpoint of his concerning the significance of direct experiments in physics, and I would inevitably recollect it when encountering papers that cast doubt on the second postulate of the special theory of relativity.

Furthermore, Sergeĭ Ivanovich emphasized once again that the experiment he had conceived was a first-order relativistic experiment, which had never been staged. The experiment proposed by Sergeĭ Ivanovich was truly convincing as well as elegant. I outline it in a paper published in the journal *Optika i Spektroskopiya* in 1956 [5]. That is why I will not describe it in detail, but will only say a few words about its idea. Measurements of the velocity of light were not proposed in the experiment. The intention was to compare the time a light signal takes to travel through a relatively short (within a laboratory) fixed distance for different, while high, velocities of the radiation source. Excited atoms moving with a velocity not-too-small in comparison with the velocity of light should fulfil the function of the radiation source. These atoms can be obtained by charge exchange of ions accelerated to these velocities. By varying the potential difference that accelerates the ions, it was possible to modify the velocity of the radiation source. By changing the ion-beam intensity for a constant ion velocity, it was possible to modulate the intensity of optical emission without the interaction of emitting atoms with any material medium.

As for the time the light takes to propagate the base distance, a decision was made in the course of work to fix it employing the phase technique. Then, for a harmonic modulation of the radiation intensity, the experiment itself reduced to recording the phase of this modulation at the base end relative to the modulation phase of the source. This phase shift should remain invariable under variations of the voltage accelerating the ions, i.e. under variations of the velocity of motion of the radiation source. Remarkably, if no recourse is made to the focusing optics to direct the radiation through the base, the radiation interaction with the material medium is completely eliminated, beginning with its emission to the moment it strikes the photodetector. Running ahead, I will say with great regret that I failed to stage the experiment formulated in this way.

Sergeĭ Ivanovich was apparently satisfied by our contacts and a short time later I was taken on as his doctoral candidate. I knew from A I Leĭpunskiĭ that this was not easy. Therefore, Sergeĭ Ivanovich did a good deed for me and his efforts predestined the course of my life for many years to come. Subsequent contacts with him convinced me that doing good deeds was inherent in him, like in any good person. This was, so to say, his way of living.

On becoming a doctoral candidate of FIAN, I was attached to Sergei Ivanovich's laboratory in GOI. As noted above, my family lived in Leningrad. Much has been said of Sergeĭ Ivanovich's work in GOI by his students - staff members of this laboratory. It only remains for me to once again confirm what they have said rather than to add some new material. The attention Sergeĭ Ivanovich devoted to the work of every collaborator and his memory were striking. He regularly, once a month, came from Moscow to Leningrad for a week to spend about half of this time in GOI. In this case, he primarily communicated not with the Board of Directors of the institute, but with the staff members of his and other laboratories, who wanted to tell him something interesting, from their viewpoint, or applied to him with numerous requests. Sergeĭ Ivanovich was very democratic and practically accessible to all, but he conducted it his first business to make the round of the rooms of his laboratory to inquire of new advances. In doing this he remembered perfectly well the state of affairs a month ago.

The result of work could be of one kind or another — confirming the expectations that existed when the work was formulated or, conversely, quite unexpected or even seemingly inexplicable and requiring confirmation. But an important point was that the result had to be reliable and the work done, as Sergeĭ Ivanovich put it, 'lege artis'<sup>1</sup>. This 'lege artis', though truncated to 'lege', came to be a proverb with us, laboratory staff members, as our own internal estimate of the level of current work.

It is well known that Sergeĭ Ivanovich was not an emotional person, but he was highly appreciative of both successes and of making no headway. He was always sincerely pleased to hear of the former, while the latter upset him, and upsetting Sergeĭ Ivanovich was a highly unpleasant thing to do. That is why everybody in the laboratory sought to demonstrate their, while slow, advancements in research, which referred primarily to different aspects of luminescence. If no progress was made over several of Sergeĭ Ivanovich's visits, he went into the details of the work, trying to elucidate what was holding matters. In this case, he found out whether he could be helpful in some way and never hurried anybody.

Sergeĭ Ivanovich's arrival was always followed by a seminar during which he not only participated in the discussion of the paper reported, but quite often spoke of what he believed to be interesting. Among the seminar participants were sometimes FIAN staff members who had arrived together with Sergeĭ Ivanovich. When essentially new results were reported in a paper, Sergeĭ Ivanovich invited the author to come to FIAN and present the outcomes there. Such an invitation was an indication that Sergeĭ Ivanovich had appreciated the work. A report made by a GOI staff member in FIAN, as well as that made by a FIAN staff member in GOI, united the interests of the Moscow and Leningrad laboratories of Sergeĭ Ivanovich.

We were all amazed at Sergeĭ Ivanovich's capacity for work. I recollect how surprised we were when Sergeĭ Ivanovich, on coming to us in the fall of 1950, told us with some pride that he had written the book *Microstructure of Light* [6] during his holidays spent in the country. It amazed us because we were aware of his unbelievable work-load, whereas we ourselves spent our holidays not in productive work, but far from it.

If, in the view of the author, a significant result was obtained over some period, which called for writing a paper, it was common practice in the laboratory to time the manuscript of the paper with Sergeĭ Ivanovich's arrival and present it to him. Sergei Ivanovich returned the manuscript the next morning with his notes. When he agreed with the authors and the paper was liable to be published in the journal Doklady Akademii Nauk SSSR, he returned it with an accompanying letter of recommendation. Conversely, if the paper required revision and perhaps the research itself needed completion in the view of Sergeĭ Ivanovich, not only did he return the manuscript with his comments, but he also conversed with its authors. Only on very rare occasions did he take the manuscript away to Moscow, but several days later the paper was back in GOI. Sergeĭ Ivanovich spoke that the delay in sending back the article, referee comments or review demonstrates the lack of respect to the authors. And the respectful attitude of Sergeĭ Ivanovich to anybody who addressed to him - be it an academician, a researcher or a metalworker --- was never doubted.

It was common knowledge that Sergeĭ Ivanovich was a kind and responsive person, and he willingly helped those who applied to him with requests of not only scientific nature, but also of any nonscientific kind — personal or concerning the everyday necessities of life, or of any other kind. Of course, this does not mean that he fulfilled all of them, the more so as the requests of GOI staff members were innumerable: we are dealing with the first post-war years, when the conditions of people's lives were unsettled. It was a matter of general experience that Sergeĭ Ivanovich was able to find words of consolation for anyone and if he was able to help — write or sign a letter, telephone somebody, intercede for somebody, etc. — he would do it. Sometimes Sergeĭ Ivanovich's favorable attitude was not manifested immedi-

<sup>&</sup>lt;sup>1</sup> According to the rules of the art (*Lat.*). — *Translator's comment*.

ately. I repeatedly witnessed a request being set forth in a conversation with him and Sergeĭ Ivanovich refusing it with a grumble, whereas the next day he called the applicant to tell him with a similar grumble: "Yesterday you spoke of your..." — next followed the heart of the problem of everyday life. — "So, I have...", it was then said that he had either telephoned somebody or had signed a letter or had done something else to help the applicant. In my view, such episodes show that Sergeĭ Ivanovich's help was not 'his soul's noble impulses'; rather they testify that he laid to heart people's needs and problems and constantly thought of them. I wonder how he selected those deserving his help, but his responsiveness was famed in legends.

I will make an absolutely trivial statement that the image of a person (just the image and not the appearance) is determined by his behavior, and the behavior by his human nature. I would recall the well-known words of O'Henry from his magnificent story *The roads we take*: "It ain't the roads we take; it's what's inside of us that makes us turn out the way we do". All the kind and humane actions daily taken by Sergeĭ Ivanovich were the road he pursued, a manifestation of his nature as a remarkable personality. It is likely that there is good reason for me to come to a stop here, but I will allow myself to add a few words about the work entrusted to me by Sergeĭ Ivanovich.

In the laboratory in GOI, where they treated me benevolently, among the staff members there were also my friends. It may be that I concerned myself with the two main units of the future facility — the radiation source and the phase meter — with inadequate energy and concentration. At that time L A Tummerman and M D Galanin in FIAN constructed a device for investigating fast luminescence processes — a phase fluorometer. Its phase-measuring part was well suited for my work. We (I and my two new collaborators) assembled a fluorometer only slightly different from that of Tummerman and Galanin. Its limiting resolving power was determined both by the intrinsic (noise) instability of phase reading and by the signal level. This imposed constraints on the velocity of the radiation source and the base length, and also on the intensity of emission from the moving atoms. Here, the situation was much worse. The initial crude experiments with a capillary arc-discharge source of hydrogen ions, which I staged, and the subsequent estimates made with the help of staff members of the Leningrad Physicotechnical Institute and taking into account charge exchange cross sections and the plausibly attainable number density of excited atoms demonstrated that we were orders of magnitude below the values required. To accomplish the task, we needed something like a proton generator with a charge exchange chamber. Only experts could produce this generator, and that by no means quickly. We discussed this situation with Sergei Ivanovich several times, both in the GOI and FIAN. I was eager to arrive at a decision as to what should be done next, so as not to appear an unskilful fellow in the eyes of Sergeĭ Ivanovich. The termination of the work for a doctor's degree was already approaching, but Sergei Ivanovich was unwilling to cease this work. He believed that it was possible to find a way to quickly solve the problem of the source of fast excited atoms and, if necessary, to prolong working on the thesis.

In January 1951, Sergeĭ Ivanovich passed away. Naturally, my doctoral study therewith came to an end. I was taken on the GOI staff as a senior researcher, and they set me completely different tasks. The institute was ready to provide me with the possibility to complete the dissertation work, but there was no hope of producing the requisite radiation source of sufficiently high intensity. What is more, I started to suspect anew that physicists might misapprehend the very fact of staging the relativistic experiment which had previously been under the protection of Sergeĭ Ivanovich's authority. I turned for advice to S É Khaĭkin, M A Leontovich, G S Landsberg, who all were posted as to my work, and additionally to A F Ioffe. They voted unanimously that I continue the work. G S Landsberg, aware of the difficulties encountered in producing the requisite fast-atom source, proposed the use of the left and right solar limbs as the moving radiation sources with a tangential velocity difference of 3.9 km s<sup>-1</sup> and, accordingly, of a longer base. This proposition deprived the experiment of its original elegance, but was probably the only real possibility to bring it to completion, though in a strongly modified form.

I took advantage of G S Landsberg's advice. The corresponding facility was made with the assistance of the GOI and the staff members of the Pulkovo Observatory, and the experiment was staged. The thesis for doctorate of sciences was defended, the opponents being A F Ioffe, S É Khaĭkin, and V L Levshin. This work was outlined in G S Landsberg's book *Optics* [7]. I list these names only to show that Sergeĭ Ivanovich's idea of a first-order relativistic experiment, even though it was realized in a strongly truncated form, was adopted by physicists.

And now quite a particular remark. I dislike this work and make infrequent mentions of it, because I retain the sensation of not having justified the hopes of Sergeĭ Ivanovich. Meanwhile, subsequently, even after Sergeĭ Ivanovich's decease, again and again there appeared papers whose authors sought to experimentally confirm the second postulate of the special theory of relativity and to prove the inconsistency of the ballistic Ritz hypothesis. These included discussions about the apparent trajectories of binary stars, the angular distribution of synchrotron radiation, estimates of the radiation propagation velocity in nuclear processes... But a direct laboratory experiment, as was conceived by Sergeĭ Ivanovich Vavilov, has never been staged.

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