

# D.V. Volkov Interview: To the 60th birthday

July 1985

- *Dmitry Vasilyevich, when did your interest to physics arise? Was it during your school years or later?*

- Before the war I finished only 8 classes, and at that time, of course, nothing could be said about serious interest, especially to physics. I remember my teachers: there were excellent teachers in mathematics, literature, history, chemistry, as for physics, I was unlucky: the teachers were not strong and, as a rule, our class did not absolutely listen to them.

There was an interest for mathematics, and quite big... but also school mathematics, of the 8th form... and for chemistry - I was fond of chemistry then and made various experiments. Mathematics was, of course, quite simple, but, nevertheless, it caused my interest even in those years.

During the war I also had no time for mathematics. But, there was the only case... After I was a wireless operator at the Karelian Front, I was sent to the reserve regiment for rising my qualification as a wireless operator. But I did not quite like the profession of wireless operator. First of all it demanded good ear, because it was connected with Morse alphabet - but at that time I had bad ear and, besides, I had to carry heavy radio set, which I did not like. At the same regiment there were the courses of artillery scouts. I began to look closely and say, that they make some calculations... and I wrote the service note to the regiment commander with the request to move me from wireless operators to the scouts group. Mathematics there was, of course, quite simple, there was no higher mathematics, but I managed to master it very quickly, and when the final examinations took place, I exceed all he norms and became the first. I was asked how I calculated and it turned out that I simply changed the program of calculations a bit and arranged intermediate computations in such a way, that there was nothing spare. And after I finished the courses, I was even asked to give the lecture to the regiment officers and to explain the way I do it. And then, but, it is somehow another topic for discussion, I was very glad with that transition, because the education of artillery scout gave me some civil speciality. When I returned from the Army, was demobilized and became a student every summer I could go and work as a topographer, which simultaneously gave me the rest. I worked every summer... and I can even enumerate where I worked: Baltic plant in Leningrad, then in Byelorussia... we measured the State farms, which had been formed then; then I worked at the building site of Kurgan Electro-station, Barabinskaya. Then, when I mastered some ground of physics we together with Yeugen Vasilyevich Inopin went to Karelia in search of radioactive elements, useful for our state.

- *What was your transition from military to civil life?*

- Of course, when the war was over, my main wish was... to continue study... But the difficulties were in the fact, that I... as I finished only 8 forms... could not enter the institute... and my first care was, of course, to pass the exams for school-leaving certificate... But the state at that time helped us, those, who were demobilized from the Army. Special groups were created... the so called preparatory departments... in some institutes. We got usual student allowance... groups consisted of people who had finished the 8th -9th form. And in half a year we learned the whole program... It was very strangely... because we forget everything... in particular, here on this photo... I am among the analogue group.

- *Dmitry Vasilyevich, did the war essentially influence your attitude to life?*

- Not really essentially, but absolutely formulated my attitude to life. The years of war... during these years we saw so much, that... modern generation, I think, will not see anything of the kind for decades. Speaking about those who inserted into my mind some characters... this

is a great row of people, more than that, most of them are... people of war years, with whom I met, with whom I had to fight.

- *So, you consider, that the war formed you...*

- Of course, it formed me... first of all, it brought up the care about our state in us. We understood, that the war is our mutual misfortune, and we understood, that our common goal - to win in this war... And after the war we carried this ideology... into our civil life. When you speak, for instance, about the choice of speciality... first of all the following questions comes to our mind... what can we do for our state. By the way it was the main question... not about ourselves... We did not think about ourselves... The war formulated all of us... meaning the human relation. Here... it is even difficult to say, what the war has given to us, because it was a difficult test for all of us, but it formulated all of us... those who remained alive, became stronger...

- *Tell us, please, about your student years in Leningrad.*

- Leningrad University produced a great impression on me. First of all, the first introductory lectures and the whole course of general physics were performed by Torichan Pavlovich Kravets. It was a very great scientist. He amazingly performed lectures... simultaneously both the physics laws in their development and realization and he could connect them with personal moments... So, he told much about his teacher Lebedev, gave interesting facts... He was an enthusiast who from the first days infected us with the deep love to science, to physics. More than that, I consider very important the moment, when he inspired us that physics is created by alive people, he showed, which people... and it made the science human.

- *Yes, and gave, of course, the feeling of succession of school...*

- Yes, there really was the succession of school... He was really an enthusiastic man. He can be considered my first teacher. Besides, in Leningrad there existed a very strong mathematical school. Vladimir Ivanovich Smirnov, whose lectured I attended, was a fine lecturer... You know his multi-volume work... which was especially dedicated to physics-theoretics, and in fact this course became the ground of our whole education. Many other mathematicians of his school gave us very much: Olga Alexandrovna Ladyzhenskaya, Maria Ivanovna Petrashen... In general, mathematical profile was very strong.

- *Till what course were you in Leningrad?*

- I finished four courses in Leningrad.

- *So you get the speciality in theoretical physics just there.*

- Yes, on the last course there was a theoretical specialization there. and in physics there were excellent teachers there: Lev Immanuilovich Gurevich and others.

- *Wasn't there Fock at that time?*

- There was Fock, but that's a pity, but I have never attended his lectures, because the streams did not coincide.

I was greatly impressed with philosophic seminars, which took place at physical department at that time. They were not carried out at the time, they are carried out now... comparatively calm, but at the same time, when there was a struggle of philosophers with the theory of relativity. All physics carried a life and death struggle, defending science. It was a great moral school. We had a large physical auditorium and it was usually full of students and we all listened with enthusiasm, maybe not always understanding all the nuances... but passions boiled! It taught us that science should be struggled for... but not only to be studied, but also we should be able to defend it. It should be mentioned, that we had quite a strong group... our constant communication with Inopin, Alexin, Stepanov, with Gribov - he also studied in our group - gave me very much... we spent the whole time in discussions.

- *And what about your own scientific interests, were they defined at that time?*

- At that time... mathematical side attracted me with more physical... and, of course, the beauty of such combinations as general theory of relativity, was felt by me at that time. The quantum field theory was just being started... And when I moved to Kharkov it was just an interesting moment. not really that I wanted to underline some difference between Leningrad and Kharkov schools, just on the contrary, at that very time physics itself sharply changed... it got sharp impulses. On one side quantum electrodynamics got so to say the second birth due to the theory of enumerations, on the other side, there appeared physics of new particles...  $\pi$ -meson was found at that time. Now it is a common notion -  $\pi$ -mesons, but at that time they were just being opened: in the 50th the neutral  $\pi$ -meson was opened, the discussions, experiments were carried out on the definition of spin in particular... it was, of course, a very deep moment in science. We were lucky - in Kharkov we found ourselves under the guardianship of Lipa Natanovich Rosentsveig, who carried out the main courses in our small group. It was a very enthusiastic man both in science and in that period in science. He understood, that something unusual was going on.. and often during the lectures... he came, for instance, to read some definite section of his course, but disaffirmed his performance and retold us with enthusiasm some new article from Physical Review. He even organized such a group..., where he gave us a possibility to work up ourselves new articles, dedicated to key moments of the birth of new elementary particles physics. This man played a great role in my raising the interest in elementary particles physics. He excellently performed lectures... he was notable for delicate wit and his enthusiasm couldn't but touch us. Then I entered the post-graduate course, and here my tutor was Alexander Ilyich Akhiezer... It was, as I have already mentioned, the period of quantum electrodynamics construction, also quite a new period... and Alexander Ilyich could organize a small group, which comprised Polovin, Fomin, Baryakhtar, Peletminsky, Alexin, me and we all friendly studied this new direction. It was especially important for me, because I remained working in this sphere, and the quantum electrodynamics is so to say the prototype of those theories, which I am working at now. Thus, there was two main influences: on one side it was elementary particles physics... and here Lipa Natanovich Rosentsveig played a great role, on the other side the fact, that Alexander Ilyich Akhiezer could give us his interest to quantum electrodynamics.

- *Dmitry Vasilyevich, moving to Kharkov, you, probably, had some impression about what awaited you in Kharkov?*

- In that time we knew the monograph by Akhiezer and Pomerantchuck "Some questions of the nucleus theory", it was a well-known monograph. That is why we awaited the meeting with Akhiezer... but in this relation we were unlucky: Alexander Ilyich did not perform lectures for us, though he was a legendary personality as for his art... about his performance. And in the post-graduate course I worked directly with Alexander Ilyich.

- *In what year did you enter the post-graduate course?*

- I entered the post-graduate course in 1953, i.e. I studied there since 1953 to 1956. I should mention about the birth of interests... I don't know why but I always was attracted by the group theory and symmetry. We had no lectures on the group theory in Kharkov, though in Leningrad we had a small course, but in Kharkov we had nothing of the kind... I don't know why, they thought, that we should never need it. But I has some instinctive interest, some instinctive thirst... When I was a student... Well, you know the student's life: you go to a canteen, sometimes stand in the row for twenty minutes sometimes... And I usually took the book by Pontryagin "Continuous groups" with me, though it didn't relate in any way to the subjects, which we were talking about at the lectures. Well, standing in the row, I read it step by step, of course, often returning to the read above material. I am so sorry now, that I worked up only three first chapters, though the most interesting material, as I understand it now, and

the most useful would be if I managed to work it up till the end. Though, it characterizes the interest I had then... Though, when I began to work, there were no strong theory-group methods in physics... So, it is surprisingly - there were not any in physics, but I had a traction to them. The first works, as I understand, were somehow connected with my work, they were dedicated to the following:

- I was always interested in connection between particles with equal spin. I wanted to understand somehow... here is a variety of particles... why is the spin different? Why is the statistics different? And if the works on quantum electrodynamics be excluded, my first works were just connected with general questions... about Pauli theorem, particles properties with higher spin. I want to underline, that the questions, which were included into supersymmetry interested me on the early stage of my work. What is the difference between the particles with different spin? Why bosons? Why fermions? These problems appeared for me very early... It continues to trouble me even now.

- *Who of Soviet and foreign physics impressed you most of all?*

- You mean those whom I met? Isaak Yakovlevich Pomeranchuk impressed me greatly. When I was in Moscow... that's a pity, but I seldom went there, but every time I came to Moscow I always met Isaak Yakovlevich and we liked to discuss problems... in the ideal plan. Our methods of work coincided... without any formulas, i.e. nothing was written on the paper. We simply discussed the development of new ideas, and this... I don't know about him - it is difficult to judge - but I had a great pleasure. It was a man greatly interested in science. Here is a prominent episode: in 1962 we together were at the conference in Geneva... it was a big conference... and I was lucky to live in the same room with him. We live in the same room; I remember, we returned from some discussion, went to bed... I could not fall asleep for a long time, thinking over some thought... About two o'clock at night I hushed him. He asked: "What's the matter?". And I say: "Here is the idea..." He forgot about sleeping... We were discussing this till four o'clock. It is also a characteristic feature of a person, that in any time of day and night he can discuss the questions which interests him!

I was also greatly impressed by the meetings with Dmitry Ivanovich Blokhintsev. We often spoke about science,, but, he struck me with the strength of his persuasions of a very high philosophical level. He was a rather versatile person, he was fond of art, of many philosophic questions, and all this was in harmony in him. But not only his points of view on various branches of science and culture were in harmony... All this was in harmony with his character, which to my mind was very wholehearted, he influenced me greatly. I found out many things about him just after his death, talking with his pupils... and I was sorry that I couldn't use all the possibilities of communication with him.

From foreign... In my trips abroad the meetings were rather short... I was greatly impressed by Gell-Mann... we worked much with him... at one and the same work together... And besides - Jiro Nambu - I considered him one of the greatest physicists... he gave me many central ideas of modern physics... I had a possibility to communicate with him a bit, he is a very shy person... and it was very pleasant to talk to him. Both with Gell-Mann and Nambu were the people with whom I talked on scientific themes... that it why it was difficult for me to give some definite personal characteristics. But in the scientific plan these men impressed me greatly, besides there was a possibility to discuss a number of problems with them.

- *Alexander Ilyich mentioned Gell-Mann with great delight...*

- Yes, in Gell-Mann... when I was in Geneva, we worked much... I was struck by the following: when we, theoretics, work, sometimes it happens that the way is divided into two different ways... or some possible variants appear. So, he could choose these ways, directly applying experimental data... the feeling of "real" physics was very big in him.

- *Can you characterize somehow some unitarian line, going through the main thing... the thing you are considering the main in your activity?*

- Well, of course, the main thing I consider... is still supersymmetry. I have already mentioned, that in fact in my first works I was interested in connections... of spin with statistics, i.e. fermions and bosons, parastatistics... I was always interested in it, it was a central point... the interest... I cannot say that I have always been thinking about it... but sometimes I returned to these questions... In particular... if the way leading to supersymmetry is mentioned... I remember, in particular, when I only found out about the group  $SU(3)$ , I was very surprised, even struck, that multiplets of this group simultaneously contained particles with integer and halfinteger isospin. I was struck with this and I tried to do something... changing isotopic spin into common spin, i.e. in fact it was the idea which became the basis of supersymmetry... In fact I had some attempts in this direction later... I returned to them... but in reality I could do nothing in this direction in those years.

The main thing... which led to the birth of just an idea of supersymmetry was, of course, the works of phenomenological langrangians, in which interaction of Goldstone particles under spontaneous violation of symmetry is practically simple... was described geometrically, by theoretico-group methods... I took an active part in working out of this direction, and it carried me alone... In that time there was such a situation... that there was just the whole class of particles, whose properties were simply defined according to group properties... and again to symmetry properties. At the same time there appeared... it appeared even earlier... but started to intrude actively into physics - it was the ideology of gauge fields... And there were two types... of particles, which were somehow defined completely by group properties, it can be said that practically simply. And then, again my old questions returned... and I was surprised, that all these particles - Goldstone and gauge fields, bosons, but fermions were not touched at all. I.e. here appeared some new inequality, I have always been looking after inequality, but here I noted, that for some reason one particles - bosons - are emphasized, but others - fermions - are not included into this group for some reason. It was the main key moment, as the thought itself about that the fermions can be Goldstone and gauge fields, this thought, by the way, contained simultaneously the answer, i.e. this thought became the key moment, because it is clear: if it was clear how to construct general scheme of Goldstone particles with general spin, then under transition to fermions it is simply necessary... to exchange corresponding operators with operators, which carry, first of all, half-spins, secondly, according to its fermion nature they are anticommutating... what was exactly done, and after it, as it has been done, we together with Akulov and Soroka, first consider the global supersymmetry theory properties, and only then their local properties. But the initial thought, as you see, was elementary: why is there the difference, and if it should be? Besides, one of initial moments was the fact, that there existed the works by Heisenberg, in which he mentioned, that neutrino can be a Goldstone particle. But then he could not register it and he considered that it is connected... with spontaneous violation of space integrity, but the following phrase... that neutrino can be a Goldstone particle, was in Heisenberg works... It turned out, though, that... the group nature of such Goldstone fermions, which we just suggested in the works with Akulov... was quite another and based on supergroups.

- *Dmitry Vasilyevich, what can you say about your disciples. How do you work with them?*

- About disciples... it is difficult to say... Only the disciple himself can say, who is his teacher, that is why I can say only about the style of work, I try to work more together with them... more than that, I try to discuss with them any idea on any, so to say raw level, if in a day or two I find out that the way was wrong, I try to explain them the problem... Well, I have such a method: to involve them to the sphere of my thoughts. How fruitful is my method?

Just the disciples can answer this question, including their works... More than that, years pass, and our roles change and I am becoming their disciple.

- *Dmitry Vasilyevich, when do you have a free time (admitting the theoretic has a free time). How do you spend it?*

- I have little free time, of course... First of all, I think that it is necessary to take care about the health... especially now I feel it, when the health is lost... And I consider, that any person, which dedicated himself to creative activity, must take care about it and to understand the regime of his work... the mechanisms of the work of brain, what mechanisms are turned on when the work is going on; how to turn oneself off the tension...

I... when I had time, used to read books, it was my practical interest... the question of health care as not only a hobby, but also as a necessity...

- *The preservation of the apparatus, so to say...*

- Yes, when I have free time I try to go for a walk, to be in nature... I like to go for a walk with my grand-daughter, with my family. I like nature and I think, that this is the best rest. I like to read most of all. But it happens seldom, too little time. I like to read books in history, I am interested in modern international life. The interests are wide. There are many things I would like to read, and to know, and to understand... in myself, in the surrounding world... But the time is limited as a rule...

- *Dmitry Vasilyevich! Thank you very much for a very interesting conversation. Let me on the name of the editorial staff and on myself personally congratulate you with your Anniversary and wish you, first of all, health and further success in your work!*

- Thank you.

*The conversation was carried out by P.O. Mchedlov-Petrosyan.*