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# A Conversation With Yuri Vasilyevich Prokhorov

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# A Conversation With Yuri Vasilyevich Prokhorov

## **Abstract**

Yuri Vasilyevich Prokhorov was born on December 15, 1929. He graduated from Moscow University in 1949 and worked at the Mathematical Institute of the Academy of Sciences from 1952, and as a Professor on the faculty of Moscow University since 1957. He became a corresponding member of the Academy in 1966 and an Academician in 1972. He received the Lenin Prize in 1970. The basic directions of his research are the theory of probability and mathematical methods in theoretical physics. He developed asymptotic methods in the theory of probability. In the area of the classical limit theorems, he studied the conditions of applicability of the strong law of large numbers and the so-called local limit theorems for sums of independent random variables. He proposed new methods for studying limit theorems for random processes; these methods were based on studying the convergence of measures in function space. He applied these methods to establish the limiting transition from discrete processes to continuous ones. He found (in 1953 and 1956) necessary and sufficient conditions for weak convergence in function space. He has several papers on mathematical statistics, on queuing theory and also on the theory of stochastic control. This conversation took place at the Steklov Institute in early September 1990. It was taped in Russian and translated by Abram Kagan. The final version was edited by Ingram Olkin.

## **Disciplines**

Statistics and Probability

# A Conversation with Yuri Vasilyevich Prokhorov

Larry Shepp

*Abstract.* Yuri Vasilyevich Prokhorov was born on December 15, 1929. He graduated from Moscow University in 1949 and worked at the Mathematical Institute of the Academy of Sciences from 1952, and as a Professor on the faculty of Moscow University since 1957. He became a corresponding member of the Academy in 1966 and an Academician in 1972. He received the Lenin Prize in 1970. The basic directions of his research are the theory of probability and mathematical methods in theoretical physics. He developed asymptotic methods in the theory of probability. In the area of the classical limit theorems, he studied the conditions of applicability of the strong law of large numbers and the so-called local limit theorems for sums of independent random variables. He proposed new methods for studying limit theorems for random processes; these methods were based on studying the convergence of measures in function space. He applied these methods to establish the limiting transition from discrete processes to continuous ones. He found (in 1953 and 1956) necessary and sufficient conditions for weak convergence in function spaces. He has several papers on mathematical statistics, on queuing theory and also on the theory of stochastic control. This conversation took place at the Steklov Institute in early September 1990. It was taped in Russian and translated by Abram Kagan. The final version was edited by Ingram Olkin.

## THE EARLY YEARS

**Shepp:** Yuri Vasilyevich, you are the only full member (Academician) of the USSR Academy of Sciences whose field is probability and statistics. Please draw the main lines of your biography, talking about the main events in your life since your birth. I know that you are a member of the Scientific Council of Steklov Mathematical Institute. What are the other positions at the Academy you kept in the past and keep now?

**Prokhorov:** I was born in Moscow on December 15, 1929. My parents also lived in Moscow, and it seems that earlier ancestors were also Moscovites. I went to school, and in the summer of 1941 when the war began the family was evacuated to a small town of Chistopol on the Volga River (about 300 miles east of Moscow), not far from Kazan. We

lived there for two years, and in 1943 came back to Moscow.

When we left for Chistopol, I finished four years of school. While in evacuation I had much time, and in two years studied the curriculum of four years so that I came to Moscow as a student of the eighth year. Also, in Moscow, I finished the two-year curriculum in one year, and in 1944 graduated from high school.

Like my father, I wanted to become an engineer, and I first entered the Higher Technical College named after Bauman (actually, a Technical University). There, I took a class in mathematical analysis of Professor Adolph Pavlovich Yuškevič, renowned in particular by his works in the history of mathematics. Pretty soon I understood that my primary interests were in mathematics. I began taking classes at Moscow University, first as an external student and in the next year transferred to the university. My main interests at the time were in analysis and number theory, and the first seminar I attended was that of Professor Alexander Gel'fond in elementary number theory, without any theory of analytic functions.

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But in the fall of 1946 Kolmogorov started, for the first time at Moscow University, a course entitled "Supplementary Chapter of Analysis." Actually, the course contained foundations of functional analysis, measure theory and theory of orthogonal series. It was a big and serious course. When I took this course—and I attended all the classes and took notes—I decided at once that it would be my field.

**Shepp:** Was there any special subject in Kolmogorov's course you liked most?

**Prokhorov:** Yes, measure theory. Simultaneously with this course, Kolmogorov began another one in probability, along the line of his book "Basic Concepts of Probability Theory." The next year Kolmogorov had a seminar in probability that I attended. Thus, my fate turned out to be tied to probability theory. Kolmogorov saw that I knew analysis and had an interest in set theoretical problems.

**Shepp:** What year was this?

**Prokhorov:** It was the fall of 1946 and spring of 1947. I was in my third and fourth years at the university.

**Shepp:** Where were you during the war?

**Prokhorov:** During the war? In 1944 I entered Bauman College and in the spring of 1945, when the war was approaching its end, I transferred to the university. I was only 16 at the time. This was the way I came to Kolmogorov's seminar. The seminar was very small at that time. Its participants were A. M. Obukhov, A. S. Monin, E. B. Dynkin and B. A. Sevastyanov, who was already working in the theory of branching processes. It was a small group and the seminar increased significantly later, in a few years, about the time when V. M. Zolotarev, R. L. Dobrušin and A. A. Yuškevič (junior) were finishing their studies at the university.

**Shepp:** And afterwards you got a Candidate of Science (Ph.D) degree?

**Prokhorov:** My first paper on the strong law of large numbers was a success. It was my diploma (M.Sc.) work. My Candidate of Science work dealt with local limit theorems.

**Shepp:** When did all this happen?

**Prokhorov:** I got my Candidate degree in 1952 and at the same time changed the topic of my research. Again, under Kolmogorov's influence, I began to study distributions in functional spaces. In 1956, I wrote a dissertation on this subject for a Doctor of Science degree.

**Shepp:** Oh, it is your very well-known work!

**Prokhorov:** Yes, a larger part of it was published in our journal, *Probability Theory and Its Applications*, but a part has never been published.

**Shepp:** The paper was also a great success in the

West. And afterwards? Please describe your career in general lines. What positions have you had?

**Prokhorov:** As to formal positions, in 1966 I was elected a corresponding member, and in 1972 an Academician of the USSR Academy. For many years I was a Vice-Secretary of the Mathematics Department of the Academy. This was from 1966 through 1989.

**Shepp:** A very long period.

**Prokhorov:** Such positions at the Academy were permanent at that time. Now it is different. Recently, changes have been voted for, and since the end of 1989 N. N. Bogoljubov is no longer the Academician Secretary of the Mathematics Department. Other people at the Academy were replaced as well. For 18 years I was also a Deputy Director of the Steklov Institute.

**Shepp:** What positions do you hold now?

**Prokhorov:** Now, within the Academy, I am only a member of the Bureau of the Mathematics Department. It is a relatively small position; I hold no other positions.

**Shepp:** Aren't you a member of the Academy Presidium?

**Prokhorov:** I have never been one. I used to attend meetings of the Presidium and take part in its activities in my capacity as Bogolyubov's Deputy. Bogolyubov, then Academician Secretary of the Mathematics Department, was often out of Moscow, and on those occasions I took part in the Presidium's activities. I also held some positions related to international mathematical bodies. Of them, the most significant was that of Vice-President of the International Mathematical Union that I occupied from 1978 to 1982.

## INTERNATIONAL CONTACTS

**Shepp:** Yuri Vasilyevich, you and your colleagues here, in the Soviet Union, have had for many years contacts with probabilists from abroad. I shall go through the list with several names and ask you to share with me and future readers your personal reflections on meetings and talks to these people. I shall begin with Joe Doob.

**Prokhorov:** I have known him personally since his visit to Moscow. I think it happened in the fall of 1963 when Doob spent a few days here, and almost all of those days we spent together. I had known his work long before; as a student I had studied his papers that later became a part of his monograph on stochastic processes.

**Shepp:** On martingales?

**Prokhorov:** Yes. I had very good relations with Doob, and after 1963 we corresponded for some time. However, we did not meet any more.

**Shepp:** Other probabilists? Maybe you can tell something about their relations with you or other Soviet colleagues.

**Prokhorov:** I remember that such people as Will Feller were vividly interested in our results.

**Shepp:** Probably you know that Feller was my teacher. Go on, please.

**Prokhorov:** The first time I met Feller was at the International Congress of Mathematicians in Edinburgh in 1958. I made a closer acquaintance with him during the Fifth Berkeley Symposium in 1965 when I had an opportunity to spend a long time with him. He came to give a talk and afterwards we had a long walk together. Besides his original results, I highly appreciated his excellent two volumes on probability. Together with my students, we prepared the Russian translation of the second edition of the books. In the foreword, I had an opportunity to express my gratitude to both the author and his remarkable book. I think that for many more years to come it will be highly useful for all those who work in probability.

**Shepp:** I completely agree with you. What about Mark Kac?

**Prokhorov:** I have known him as well. The first time I met him was in Edinburgh, and later in Berkeley we again met each other, and probably elsewhere. I remember that we got along rather well. I took the initiative to translate into Russian his small, but very well-written book on statistical independence.

**Shepp:** May I ask you to compare his style and achievements with those of people mentioned previously? I am trying to get a general idea of how you personally estimate different achievements. Certainly, you do not have to answer the question.

**Prokhorov:** In his work, other aspects were more important. (Thinks.) I can tell you that I read with interest the papers of Kac and found them very useful.

**Shepp:** Maybe, his approach was different? More concrete?

**Prokhorov:** Yes, more concrete, if you like. It is difficult to find the proper words.

**Shepp:** How about Harald Cramér?

**Prokhorov:** Cramér was well known in our country for his two books: the small book *Random Variables and Probability Distributions* from Cambridge Tracts and his larger work *Mathematical Methods of Statistics*. These were translated into Russian on Kolmogorov's initiative. By the way, the translation of the latter gave an impetus to creating Russian statistical terminology. At that time, many English statistical terms had no Russian analogs. Kolmogorov should be credited for changing this.

Cramér came to the Soviet Union in 1963 to attend the All-Union Conference on Probability and Statistics, in Tbilisi, near the Turkish border. Yu. V. Linnik and I met him in Moscow, and we spent much time together in Tbilisi. Actually, I saw Cramér before when he visited the USSR in 1955 or 1956 (this was his first visit to our country), as he remembered. But, at that time, I had not been introduced to him.

**Shepp:** Did Cramér have close contacts with some of your colleagues?

**Prokhorov:** Judging from his recollections, *Fifty Years in Probability*, published in the *Annals of Statistics*, he was closer in scientific interests to Kolmogorov, A. M. Yaglom and J. A. Rozanov, since they all worked in the field of random processes.

**Shepp:** Carl-Gustav Esséen?

**Prokhorov:** I should say that his memoir of 1945 was studied here by practically everyone who works in the field of limit theorems. By the way, it is now on my desk, and I am rereading it. A significant part of the memoir, its main theorems, were included into the well-known monograph by B. V. Gnedenko and A. N. Kolmogorov. His subsequent papers, although shorter, were always noted here with great interest.

**Shepp:** Paul Lévy?

**Prokhorov:** As far back as in Kolmogorov's seminar, I began to study Lévy's monograph *Théorie de l'Addition des Variables Aléatoires* and many times returned to it. I have never met Paul Lévy; however, for a short time, we corresponded. Once, I asked him to recommend my paper for publication in *Comptes Rendus*. His monograph and the later *Concrete Problems of Functional Analysis* were very useful.

**Shepp:** May I ask if you know about Kolmogorov's relations with his colleagues, especially with Paul Lévy?

**Prokhorov:** What I know for sure is that Kolmogorov corresponded with Paul Lévy, and some of Kolmogorov's theorems were contained in his letters to Lévy.

**Shepp:** Kyosi Itô?

**Prokhorov:** I have met him, in particular, at the Soviet-Japanese symposia on probability and statistics. I never went to Japan, but Itô came here.

**Shepp:** I think there were many Soviet-Japanese symposia.

**Prokhorov:** Yes, we have had many. It seems that the first time I met Itô was in Berkeley around 1965. That visit to Berkeley was extremely useful, since during the eighteen or twenty days that we spent there we met with many colleagues. It was an exceptional opportunity.

**Prokhorov:** Norbert Wiener?

**Shepp:** I have never met him.

**Prokhorov:** Maybe you can say something about Kolmogorov's meetings with Wiener?

**Shepp:** I have to say that during Wiener's visit to the Soviet Union, it was after WWII (I think Wiener visited the Soviet Union only once), Kolmogorov and Wiener did not meet. However, one can read Kolmogorov's article in the *Soviet Encyclopedia* entitled "Norbert Wiener" and will find it very interesting. Kolmogorov liked writing biographical articles. He was very proud of his article about Hilbert in the same *Soviet Encyclopedia*; it is a short article, but Kolmogorov prepared it for a long period. He also wrote about Wiener. I have heard that there was a discussion among mathematicians, at least, of the priority question relating to their work on stationary processes. I think that everything Kolmogorov wanted to say about the subject he said in the article "Norbert Wiener."

**Shepp:** Monroe Donsker?

**Prokhorov:** I have met him. We were working independently in almost parallel ways on the invariance principle. I began with studying the well-known paper by Paul Erdős and Mark Kac related to the invariance principle. It contained a special case of it. Donsker and I were advancing on almost parallel courses, although by different methods.

**Shepp:** Henry McKean?

**Prokhorov:** I have never been acquainted with him.

**Shepp:** Frank Spitzer?

**Prokhorov:** I became acquainted with Spitzer in 1965, when I visited Cornell University on my way back from Berkeley to Moscow. In Ithaca we rode a canoe and almost immediately I fell into the water. Later, Spitzer visited the Soviet Union. I liked his book *Principles of Random Walk* very much and suggested a Russian translation of it; my students later translated it. Afterwards, I did not meet Spitzer any more, unfortunately, but always followed his work.

**Shepp:** Jerzy Neyman?

**Prokhorov:** (Laughs.)

**Shepp:** Why are you laughing?

**Prokhorov:** The thing is that I probably met Jerzy Neyman more often than the other people you mentioned. We met the first time in Berkeley in 1965 and then during his multiple visits to Moscow. Practically every time he came to Moscow, I had opportunities for long talks with him and attended his seminars. He was always very interested in Soviet life, both scientific and everyday. He knew Russian culture and spoke fluent Rus-

sian. By the way, he supported me when I was nominated to the Soviet Academy.

**Shepp:** He was a foreign member of the Soviet Academy, wasn't he?

**Prokhorov:** No, he wasn't, but he wrote a personal letter on my behalf when I was nominated as a corresponding member. I know that he was discussing my nomination with Sergei Natanovitch Bernstein and supported me.

**Shepp:** Did Neyman meet with your colleagues?

**Prokhorov:** Neyman used to spend much time with Kolmogorov. In particular, Neyman's works on rain stimulation were continued in Kolmogorov's laboratory at Moscow University. Some of Neyman's other work was continued at the Mathematical Institute. Neyman had good connections with many people here.

**Shepp:** Has anyone in the Soviet Union had any contacts with Karl or Egon Pearson?

**Prokhorov:** To the best of my knowledge, no.

**Shepp:** Ronald Fisher?

**Prokhorov:** It is possible that some of the older generation here could have corresponded with him, but I don't know about it.

**Shepp:** Kendall?

**Prokhorov:** Maurice Kendall?

**Shepp:** Both Maurice and David.

**Prokhorov:** Maurice Kendall's books were translated into Russian, as well as R. A. Fisher's. The monograph *Statistical Methods for Researchers* was published here several times. There was a paper by S. N. Bernstein containing a discussion of Fisher's viewpoint on confidence probabilities. Kolmogorov highly praised Fisher's works on mathematical genetics, and the last time he quoted them was in 1969 in Oberwolfach at a small conference on branching processes. Kendall's multi-volume book was translated into Russian on Kolmogorov's suggestion, who praised it.

As for David Kendall, Kolmogorov knew him personally and, on a number of occasions, praised his works. David Kendall was one of those foreign scholars who, like Cramér, attended the All-Union Conference on Probability in Statistics held in Tbilisi in 1963. Actually, it was our first conference attended by our colleagues from abroad: Harald Cramér, David Kendall, Murray Rosenblatt and Jack Wolfowitz. Maybe, I forgot some; there were not that many foreigners there, but they were renowned scholars.

**Shepp:** Were there other scholars from abroad who had good contacts with you or other Soviet colleagues?

**Prokhorov:** I think we have talked about most

of them, although I may have forgotten a few names.

### SCIENTIFIC WORK

**Shepp:** May I ask you what you consider your main scientific or administrative achievements? I know that you have contributed much, and I ask you to describe in a few words what you consider most important.

**Prokhorov:** Certainly, my most successful work was on the applications of functional-analytic methods to limit theorems.

**Shepp:** Yes, no doubt. That paper of 1956 has been a tremendous success!

**Prokhorov:** In the years that followed, I returned to the subject, although in shorter papers. This is my principal contribution if we speak about mathematics. As for the administrative sphere, my greatest success may well be the organization of the 1st Congress of the Bernoulli Society in Tashkent. It required a lot of effort, and I made maximum use of all the positions I had at the Academy at the time to arrange many things related to the Congress.

**Shepp:** I heard that the Congress was a success, although I could not attend it.

**Prokhorov:** It was mainly organizational, administrative work, and I did use all my administrative possibilities in order for the Congress to take place.

### STATISTICS IN THE SOVIET UNION

**Shepp:** My next question is why mathematical statistics in the Soviet Union has developed so slowly if you agree with such an assessment of the situation with statistics.

**Prokhorov:** Yes, I do. Both we and our colleagues from abroad see this situation. After the Tashkent Congress, when we were discussing its scientific results, David Kendall noticed a backwardness of statistics in the Soviet Union. I think the explanation is that here there has not existed a demand for serious statistical research compared with, say, those in the U.S. or England. After we learned about Abraham Wald's work and became interested in statistical acceptance control, Kolmogorov—with his students—began to work in the field and wrote a few papers. But the thing is that statistical acceptance quality control is aimed at the well-organized manufacturer, and very often the need here was not in implementing statistical control but in arranging the elementary order. Now, I think we are approaching the time when the government or its institutions have become inter-

ested in reliable statistics, and it will result in a demand for statistical researchers. As for the present situation in the Soviet Union, there is not a single statistics department. All the statisticians at universities, if there are any, come from mathematics departments.

**Shepp:** I think I have seen somewhere here the sign on a door, "Department of Statistics."

**Prokhorov:** It means a chair and not a department in your understanding of the word. Usually, it is a small unit, maybe five persons.

**Shepp:** Do you think glasnost will eventually help in developing statistics here?

**Prokhorov:** I think it may help. For example, our weekly *Arguments and Facts*, with its huge circulation, publishes in almost every issue statistical data, such as survey results. Readers are gradually becoming accustomed to statistical data.

**Shepp:** I think that now it is possible to describe everyday life through statistical data, certainly in newspapers. Changing direction a bit, may I ask you to describe changes at Steklov Institute after Vinogradov's death, if there are any.

**Prokhorov:** I can tell you that since Bogolyubov has become the Director, the Institute has hired some people who did not work here before, as for example, V. I. Arnol'd.

**Shepp:** I believe these changes are for the better. Is the process going on?

**Prokhorov:** I think so, yes.

### ELECTRONIC MAIL

**Shepp:** What do you think about the offer, now under discussion, to provide the Steklov Institute with the equipment for electronic mail correspondence?

**Prokhorov:** It will make postal connections with other countries easier and should be welcome.

**Shepp:** This offer came in a package along with the idea that the equipment (computer, modem, etc.) for E-mail correspondence be allowed for use also by mathematicians and not affiliated with the Steklov Institute, say, by members of the Moscow Mathematical Society. What is your opinion about the free access to the E-mail terminal installed at the Institute?

**Prokhorov:** The following is an example. The Institute has a very good mathematical library, and many mathematicians working at the university prefer to use our library for borrowing books and journals, since our library receives them earlier, and some journals can be found only at the institute's library. As a rule they are not refused. I think that if we can get something else that we can

share with our colleagues working elsewhere, we shall do it.

### ON DISCRIMINATION

**Shepp:** I think it will also be good. Now I would like to pursue another direction and ask you to tell us the story about the group of students at Moscow University to which you belonged. I have heard about it from many people, but maybe you would like to add details.

**Prokhorov:** Yes. The story lasted for a short time, but was very instructional like many similar stories that happened at the time. Let us hope now that the times have changed and such stories are no longer possible.

**Shepp:** But what happened at that old time? Can you and do you want to tell us the story? I am sure that practically none of the readers of *Statistical Science* have ever heard about it.

**Prokhorov:** The story was very simple. A group of students, some of them war veterans and serious people, met at participants' homes.

**Shepp:** And discussed...?

**Prokhorov:** As I understand, there was nothing criminal there, from the participants' viewpoint. Among the participants there were serious people, war veterans and party members. Maybe, on some occasions, we showed thoughtlessness. For example, we promised each other to be together in the years to come and never be separated. But once in the form of a joke, all of these wishes were written down as a document. At that time, those things should not have been done, and even the most experienced members of the group did not understand it. This resulted in a rather severe punishment: participants were expelled from the university, and also the party members from the party. Similar things used to happen in later times, for example, in 1956 when comparatively innocent—according to present-day standards—students' actions were promptly and severely condemned. Such an incident happened at the Mathematics Department in 1956, I think.

**Shepp:** Why did the KGB act so promptly and uncompromisingly?

**Prokhorov:** The story of our group developed as follows. It was openly discussed within the party and Komsomol (young communist league) organizations. The investigation lasted for several days. A big meeting of students of the Mathematics Department took place, and professors also attended the meeting. A general accusation aimed at all members of the group was that they had formed an organization opposed to Komsomol. The accusation was based on the discovery of the origins of an

organization in the meeting's record. It was a general accusation against all. Moreover, an additional accusation not directly connected, was charged against Jewish members of the group, namely because of Jewish nationalism.

**Shepp:** I didn't know about the second accusation, although I heard that members of the group were Jews.

**Prokhorov:** Yes, there were. They were accused also of Jewish nationalism.

**Shepp:** (Joking) You weren't among them were you?

**Prokhorov:** I don't know how serious these accusations were, but the words "Jewish nationalism" were spoken at the meeting. Recall the time, it was 1949. It was the time when any nationalism, Jewish in particular, was persecuted.

**Shepp:** Thanks for this clarification. I guess that Soviet science is falling behind. I cannot judge Soviet sciences as a whole, nor the whole of mathematics, so I am speaking mainly about probability. It seems to me that the Soviet school of probability, which under Kolmogorov and even earlier (before the revolution, and later in the twenties, thirties and forties) was a world leader, is gradually falling behind. I would like to know if at this point you agree with me, that this falling behind has resulted, to a certain degree, from discrimination. I appreciate that you already mentioned the discrimination based on the fifth paragraph. (In standard Soviet questionnaires, the fifth paragraph asks for the nationality, e.g., Russian, Ukrainian, Jewish, etc.) Certainly, there also existed discrimination based on political grounds and on some other grounds that I don't know. In any case, it was part of the academician I. M. Vinogradov's policy. Do you think some energetic actions should be taken in order to correct the situation inherited from Vinogradov?

**Prokhorov:** Your question turned out very long, actually consisting of two parts. The first concerns the falling behind of the Soviet probability, although relative. When I came to the Institute, the head of its Probability Department was Kolmogorov. Bernstein worked here, although in another department, and Khinchin (A. Ya. Hinčin) and N. V. Smirnov worked in Kolmogorov's department. Earlier, Slutsky (E. E. Slukii) also worked in the department, but by the time I came to the Institute, he had passed away. Certainly now the department, however good, has not reached that level. It is a small piece of the overall picture, but it reveals the general situation. We are facing the serious problem of how not to lose what we have inherited from our predecessors but to preserve and multiply it. A similar problem is faced by the son



who inherited his father's business. He has to behave properly to push the business upward, not let it go down.

The second part of your question concerns the Mathematical Institute. One should distinguish different periods of its activities. If you address the prewar or even World War I years and look for discrimination on the basis of nationality, you will see that one of the most active researchers was Lazar Aronovitch Lusternick, for example, and the scientific secretary of the institute (i.e., actually the closest aid of Vinogradov was Alexander Lvovitch Seigel). Thus, up to a certain period, the situation looked normal.

**Shepp:** There was no discrimination?

**Prokhorov:** In any case, it was impossible to detect it. If we try to detect discrimination by statistical methods, it could be found in the postwar period.

**Shepp:** How do you think the situation should be changed?

**Prokhorov:** I think the events are now developing in such a way that the problem will be resolved automatically.

**Shepp:** I think we owe much to the Russian and Soviet schools of probability and have to help it in overcoming its lagging position. Personally, I am trying to provide the Mathematical Institute with the equipment for E-mail correspondence. As I have understood you, you support the idea of getting the equipment and even installing it in your department. I am glad to see that you support the idea of getting the E-mail equipment for the Institute and look to the future with optimism.

**Prokhorov:** The final decision will be made by the director. The scientific council also votes.

**Shepp:** Maybe you want to add something else concerning other topics of the interview.

**Prokhorov:** Yes, I would like to add the name of C. R. Rao to the list of foreign colleagues who collaborated with us. I've met him several times, was his guest in India and hosted him during his visits to our country.

**Shepp:** Do you collaborate with India now?

**Prokhorov:** Yes, in particular, there is an agreement including probability and statistics.

**Shepp:** Certainly, I have known of Rao's close ties to Soviet colleagues but somehow missed his name. I'm extremely glad that you recalled Rao's significant contribution to strengthening the cooperation of Soviet and foreign scholars. Do you want to make other comments?

**Prokhorov:** I would like to add that the now arising opportunities for personal contacts, visits to and from other countries that have become by and large more free than before will contribute much to

the advancement of mathematical science and especially to the progress of younger mathematicians. Imagine that there was time after WWII when even correspondence was practically prohibited. I remember that Kolmogorov neither wrote nor received letters from abroad, and it was in a sharp contrast to the intensive correspondence before the war. Here, as probably in other countries, we face the problem of selecting able young students and directing them to probability and especially mathematical statistics. The problem is not simple at all, since at mathematics departments there is a strong competition for capable students and the probability is high that they will choose other fields of mathematics, more modern, in a sense. If an able student enters a mathematics department, the odds are high that the student chooses modern algebra or geometry rather than probability. When Kolmogorov was alive, his personality alone attracted many strong students.

**Shepp:** Maybe a part of the problem is also in that probability in the Soviet Union is falling behind?

**Prokhorov:** One more reason is evident, but somehow we have not mentioned it. All the great Russian and Soviet probabilists, starting with Chebyshev, Markov, Lyapunov and then Bernstein, Kolmogorov, Khinchin, Linnik, were all mathematicians of broad profiles. They were not only probabilists, but knew much more. We are losing this feature of breadth and together with it connections of probability with other areas of mathematics are being lost. Maybe a similar picture can be seen elsewhere, but certainly probability does not benefit from it. We are in a difficult situation. On one side, we have to understand applications, in particular, of statistics since nobody else will do it. For example, the first papers by A. N. Širjaev on disadjustment were directed toward practical applications (by the way, the very first paper was joint with Kolmogorov). Some very good papers on statistical quality control were written by Kolmogorov. Those and similar research are a probabilist's task. On the other hand, probabilists here have to keep the level of their science of probability sufficiently high. In a sense, they are carrying a double burden.

**Shepp:** I am glad you mentioned Shiryaev's papers on change-points. I have read them with interest and found them extremely useful.

**Prokhorov:** Yes, they were very good. After WWII, some papers by Kolmogorov on fire control were published in the *Proceedings of Steklov Institute*. Probably, they were written during the war, but like some papers by Wald, were not published at that time. Certainly, applications are important,

and we have to deal with them. But look, we have fewer people working in probability and statistics than the United States.

**Shepp:** This happens despite the fact that probability and statistics are important for applications?

**Prokhorov:** Yes. When we are looking for speakers at congresses, conferences, etc., we often find this task difficult, and time and again choose the same people.

**Shepp:** We also have problems. Yuri Vasilyevich, thank you very much for a pleasant conversation. I wish you all good wishes in everything. We have known each other for many years, and I was

glad to have this opportunity to interview you for *Statistical Science*.

**Prokhorov:** Thank you very much for the opportunity to give an interview for *Statistical Science*. It is a rare opportunity. Actually, it is the first interview in my life, and I ask you and future readers to excuse me in advance for all its shortcomings. Maybe, on working together on the final text, we'll be able to improve it and make it interesting and pleasant reading.

**Shepp:** For me, it is also the first experience as an interviewer. Thank you very much.