

Everything About Kolmogorov Was Unusual . . .

A. N. Shiryaev (Translated by Andrew L. Rukhin; additional editorial work by Paul Shaman)

Andrei Nikolaevich Kolmogorov belonged to a select group of people who left one with the feeling of having touched someone unusual, someone great and extraordinary, the feeling of having met a wonder.

Everything about Kolmogorov was unusual: his entire life, his school and college years, his pioneering discoveries in many areas of mathematics and also in other disciplines, meteorology, hydrodynamics, history, linguistics and pedagogy. His interests were unusually diverse, including music, architecture, poetry and travel. His erudition was unusual; it seemed as if he had an educated opinion about everything.

His manner of talking was unusual, somewhat blurred; his walk was unusual.

One's feelings after meeting Kolmogorov, after a simple conversation with him, were unusual. One sensed that he had continuously intensive brain activity.

Kolmogorov's circle of students was unusually large. His letters to his students and friends were unusual. They contained unusual ideas and unexpected twists; they were models of letter writing.

Kolmogorov's childhood was unusual. He grew up without a mother; his mother died in childbirth. When he was five years old Kolmogorov made his first mathematical discovery: $1 = 1^2$, $1 + 3 = 2^2$, $1 + 3 + 5 = 3^2$, He used to offer various logical and arithmetic problems to his playmates. For example, what is the number of different ways to sew on a button with four holes? These problems appeared in the house magazine *Spring Swallows*, published by Kolmogorov's aunts, who took care of his upbringing and who ran a small school for him and his friends. Kolmogorov recalled that a standard problem about the meeting point of two travelers moving at different speeds was "uninteresting from a logical point of view."

A. N. Shiryaev is a professor at the Steklov Mathematical Institute, Vavilova str. 42, GSP-I, 117966 Moscow, USSR.

This article is based on a talk given August 18, 1990, at the Second World Congress of the Bernoulli Society, Uppsala, Sweden.



Fig. 1. Kolmogorov at age 5 with his aunt, Vera Yakovlevna.

His schoolfellows stated that as a student Kolmogorov was forever thinking about something. In later years he participated in some pranks. To the delight of his schoolmates and the frustration of his young physics teacher, he announced several times that he had invented a perpetual motion machine. Each time he described his device in such a sophisticated manner that it was difficult to find the error. The teacher tried to respond but her arguments were easily overturned.

As a student Kolmogorov's circle of interests was extremely wide. He was seriously interested in biology. He later wrote that "my first strong impression of the power and significance of scientific study was imparted by K. A. Timiriazev's *The Life of Plants*. At 14 he learned higher mathematics from the encyclopedia of Brokhaus and Efron by filling in the gaps in all the proofs. He was captivated by the game of chess. He attended chess competitions, but soon abandoned the game forever. He took a fancy to history and sociology, dreamed about a just system of government and wrote a utopian



FIG. 2. Kolmogorov and P. S. Aleksandrov in Göttingen, 1930.



FIG. 3. Kolmogorov with A. Rényi.

constitution of his ideal state. In fact, he wanted to become a forester.

Kolmogorov decided to take his final examinations for secondary school before his schooling was scheduled to end. When he so informed his teachers they asked him to come after lunch. He went for a walk and returned after lunch. The examination board gave him his certificate without testing him. He recalled this incident as one of the greatest disappointments of his life.

Almost immediately after entering Moscow University he found a job as a teacher in a secondary school to earn extra money. He played an active role in the everyday activities of the school, serving on its council. He was more proud of this work than of his awards and honors.

In graduate school Kolmogorov was a student of N. N. Luzin. At the time it was customary to

complete 14 different mathematics courses. It was possible to substitute an independent project in the field for any of the course examinations. Kolmogorov later recalled that he never took an examination. Instead, he wrote 14 papers on the various subjects with original results in each of them. "One of these results turned out to be false, but I realized it only later."

Kolmogorov's opinions about scientific research, particularly his own, were unusual. He admitted that he was never able to think fully about a mathematical problem for more than two weeks. He claimed that any result could be stated in the four pages allowed for a short note in *Comptes Rendus*. "The human brain is incapable of creating anything which is really complex," he wrote.

According to his own words, Kolmogorov had a lively interest in a problem only until it became clear what the answer should be. As soon as the picture became clear he tried to avoid writing down the results and proofs; he would look for someone else to take over.

According to Kolmogorov one should distinguish three stages in the development of every scientific area. The first, the pioneering one, is a breakthrough in a new area, an unexpected and striking discovery which often refutes the traditional point of view. This is followed by a technical stage, which can be difficult and long. At this stage the theory is enriched by details, becomes cumbersome and inaccessible, but embraces more and more applications. At the third and last stage, a new, more general approach appears. Connections with other issues, possibly rather remote, are understood, and this permits another breakthrough in a new field.

Kolmogorov's mathematical work is characterized by a pioneering approach which sometimes

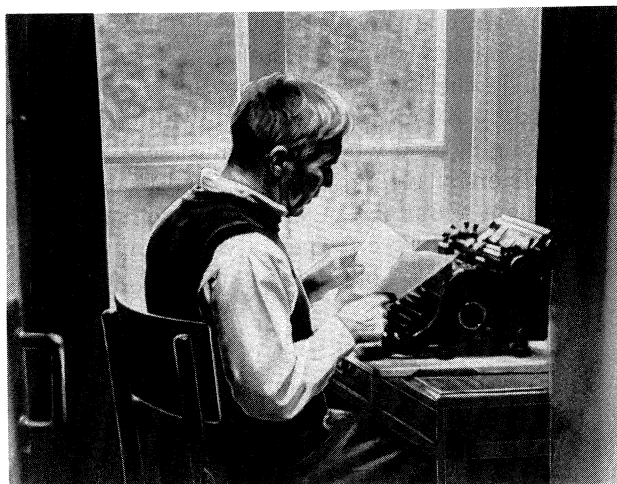


FIG. 4. Kolmogorov at Komarovka, his country house.

allowed him to solve problems which had remained open for two hundred years. He tried to avoid technical work in order to enrich the theory. However, at the third stage where one has to understand the results obtained and envision new perspectives in the creation of fundamentally new general theories, Kolmogorov made remarkable contributions. An example of such a breakthrough in a new field is his work in topology published in four short notes in *Comptes Rendus* in 1936.

In 1953, at the time of Kolmogorov's 50th birthday, P. S. Aleksandrov said, "I have known Andrei Nikolaevich since 1923, longer than many others.

He was working then under A. K. Vlasov in the field of projective geometry and was taking a course from P. S. Urysohn. Once in the fall he came to me and brought with him a paper on descriptive set theory." And later Aleksandrov noticed that in this classic Kolmogorov work, as well as in his work on divergent Fourier series, one can see the characteristic features of the mathematician Kolmogorov: extraordinary simplicity, the generality of his ideas and startling technical power.

A. Ya. Khinchin, who spoke after Aleksandrov, began his talk with the following words: "Andrei Nikolaevich and I entered the theory of probability through the same door. Neither of us had the intention of working in this theory, but both of us noticed the similarity between probability theory and



FIG. 5. Skiing.



FIG. 6. In India, 1962, with Mrs. P. C. Mahalanobis, C. R. Rao and P. C. Mahalanobis.

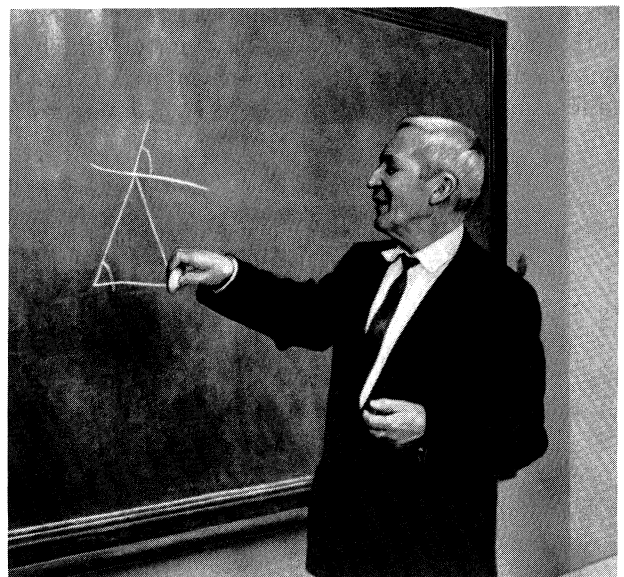


FIG. 7. Lecture at the Mathematical Boarding School, now named "Kolmogorov Boarding School."

the metric theory of sets and functions. Here Andrei Nikolaevich realized the unsatisfactory state of probability theory. Kolmogorov's monograph, *The Foundations of Probability Theory*, did the same thing for probability that Hilbert's treatise did for geometry."

Further, Khinchin noted that Kolmogorov had the rare gift of being able to combine talent for highly abstract mathematics with an interest in applied problems. "The most important and most fascinating feature of Andrei Nikolaevich as a mathematician is the wealth of his ideas. Each sentence of his about any work could become the basis for a Ph.D. dissertation. Many papers which do not have Kolmogorov as a coauthor were really written under his strong influence, inspired by him." Khinchin continued, "I wrote the book *Asymptotic Laws of Probability Theory*, which contains methods due to I. G. Petrovskii. But Petrovskii and I know that the real source of this work is Andrei Nikolaevich."

I. M. Gel'fand, who was the next speaker, said, among other things, "The fact that mathematics is viewed as a unified discipline is due to a large extent to Kolmogorov."

In conclusion, Aleksandrov made the following statement: "Kolmogorov belongs to a group of mathematicians whose any single work in any area leads to a complete reevaluation. It is difficult to find a mathematician in recent years with not only such broad interests, but also such an influence on mathematical style and on the development of mathematics . . . Hardy took him for a specialist in trigonometric series, and von Karman took him for a specialist in mechanics. Gödel once said that the gist of human genius is in the longevity of one's youth. Youth has several traits, one of which is excitement. Excitement with mathematics is one of the features of Kolmogorov's genius. Kolmogorov's

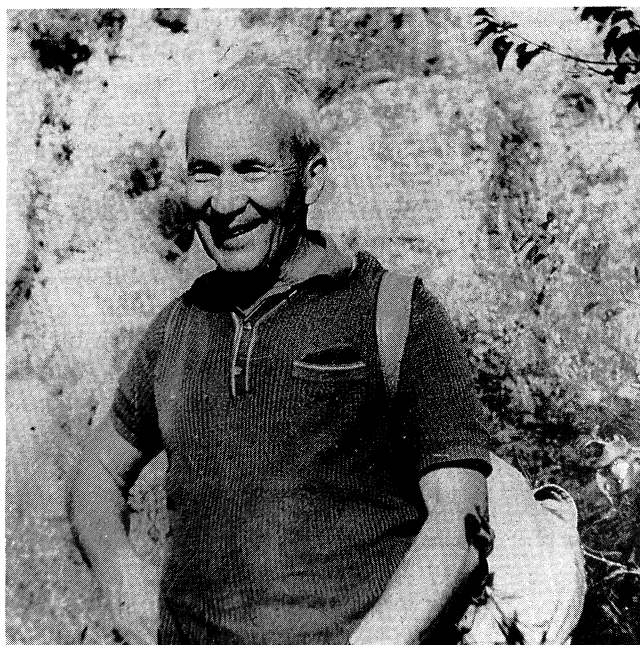


FIG. 9. *In the mountains.*

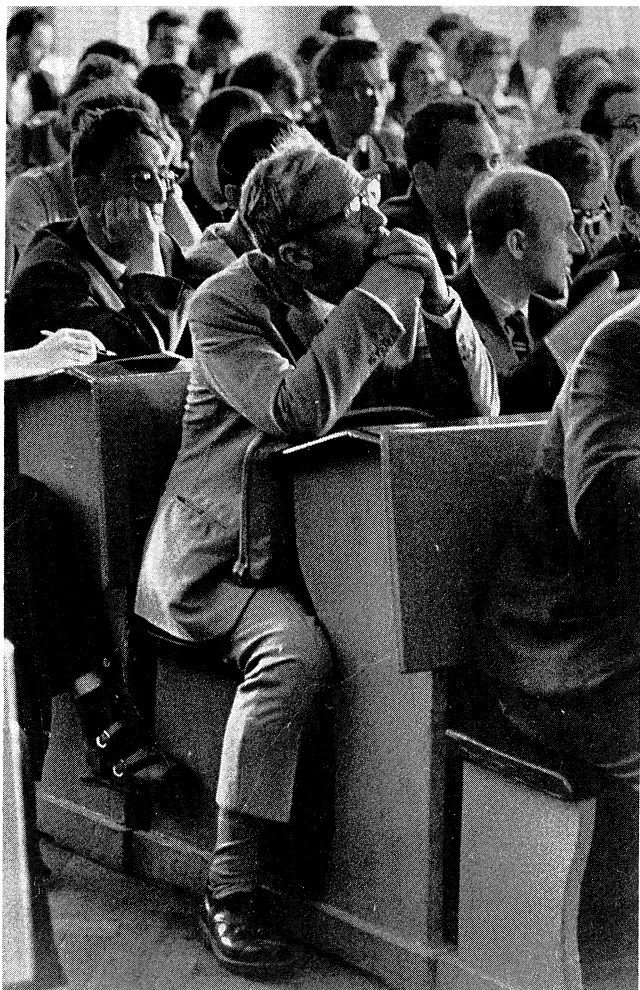


FIG. 10. *At a probability meeting.*

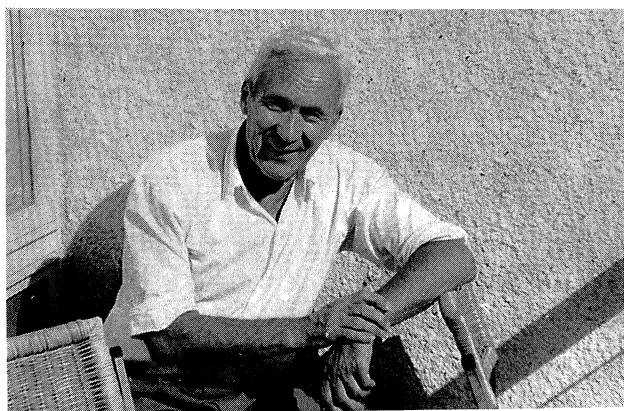


FIG. 8. *A. N. Kolmogorov.*



FIG. 11. Kolmogorov with schoolboys.

excitement is in his creative work, in his articles in the *Large Soviet Encyclopedia*, in his development of the Ph.D. program. And this is just one side of him. The other is his dedicated labor."

Students of Kolmogorov, and they are numerous indeed, stated on several occasions how lucky they were to be his pupils. However, they always added that it also was a huge responsibility. There was constant pressure to get as much as possible done so that during the next meeting with Kolmogorov they would be able to tell him about their progress. One of my friends characterized his attitude about Kolmogorov as "panicked respect."

Here is one relevant story. Once, the wife of a well-known professor at Moscow University, known for her sophistication, learned that Kolmogorov would be stopping by during the evening and became very excited. She started to clean the apartment and to cook dinner, pushing her housemaid away. In view of all this commotion the housemaid asked who was coming. "How can I explain it to you," was the answer, "just imagine that you will be getting a visit from the tsar himself!"

Kolmogorov was fond of jokes. Here is an anecdote he tells about Hadamard. (I learned this story from V. I. Arnol'd.) Hadamard was an avid collector of ferns. When he came to Moscow Kolmogorov and Aleksandrov took him for a boat ride. All of a sudden, Hadamard noticed something on the river bank and requested that the boat stop. He moved to the bow and, when the boat came closer to the bank, leaned over and fell over into the water. As it turned out, he had found an unusual fern he had been searching for for many years. Hadamard was thrilled. However, he had to attend an official reception at the Academy of Sciences that same day. His hosts had to lend him Aleksandrov's clothing, and this was noticeable since Hadamard was considerably taller. At the reception Hadamard was

asked about the incident. "They say you fell into the river." Hadmard responded, "Why do you think that a French professor may not have other adventures?"

In 1963 Kolmogorov received the International Prize in Mathematics from the Balzan Fund. The

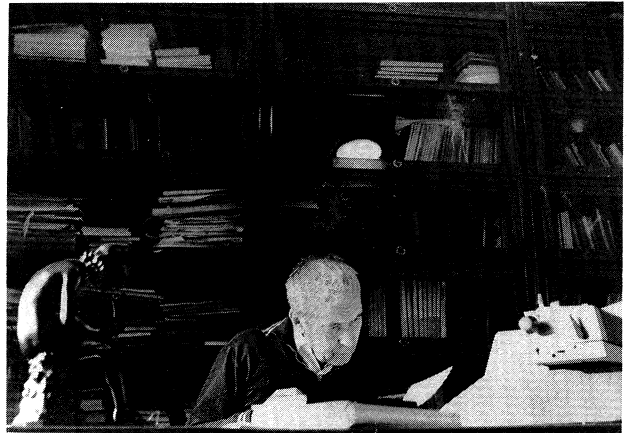


FIG. 12. Kolmogorov in his Moscow flat.



FIG. 13. Kolmogorov and his wife on his 70th birthday (April 25, 1973).



FIG. 14. Kolmogorov on his 80th birthday (April 25, 1983).

prize for "peace and humanism" was awarded the same year to Pope John XXIII. After the prizes were presented Kolmogorov spoke in French with the Pope about the general trend toward peace in the world.

Kolmogorov knew the history of the Vatican and of the popes. I learned from him that Pope John XXIII was really the 261st pope, and that the present pope, John Paul II, is the 264th. Kolmogorov told me that, according to his observation, in the 19th century fat popes were followed by thin popes, that one of these popes was a mountaineer and took celebrated photographs of mountains and that Pope John Paul II, the former Cardinal Wojtyla from Poland, who is an ardent lover of skiing, asked after his arrival at the Vatican what percentage of Roman cardinals ski. When he learned that this percentage was zero, he disclosed that the corresponding percentage in Poland was 40 percent. When asked how this was possible, since there were only two Polish cardinals, Wojtyla answered that the senior cardinal, Wyszynski, counts for 60 percent.

Here is another story. Once on the beach Kolmogorov heard my 10-year-old son tell a girl that she had lied. Kolmogorov retorted, "One cannot address ladies like that. You should have said, 'It seems to me that you have deviated from the truth.'"

Everything about Kolmogorov was unusual. He was one of those incomparable geniuses who enhance life by the mere fact of their existence.













