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“To be a good mathematician, you need inner voice”

”ОгонёкЪ” met with Yakov Sinai, one of the world’s most renowned mathematicians.

As the new year begins, Russia intensifies the preparations for the International Congress of Mathematicians (ICM 2022), the main mathematical event of the near future. 1966 was the last time we welcomed the crème de la crème of mathematics in Moscow. “Огонёк” met with Yakov Sinai, one of the world’s top mathematicians who spoke at ICM more than once, and found out what he thinks about order and chaos in the modern world.[1]

Committed to science. Yakov Sinai's close-up.

One of the most eminent mathematicians of our time, Yakov Sinai has spent most of his life studying order and chaos, a research endeavor at the junction of probability theory, dynamical systems theory, and mathematical physics.

Born into a family of Moscow scientists on September 21, 1935, Yakov Sinai graduated from the department of Mechanics and Mathematics (‘Mekhmat’) of Moscow State University in 1957. Andrey Kolmogorov’s most famous student, Sinai contributed to a wealth of mathematical discoveries that bear his and his teacher’s names, such as Kolmogorov-Sinai entropy, Sinai’s billiards, Sinai’s random walk, and more.

From 1998 to 2002, he chaired the Fields Committee which awards one of the world’s most prestigious medals every four years.

Yakov Sinai is a winner of nearly all coveted mathematical distinctions: the Abel Prize (an equivalent of the Nobel Prize for mathematicians), the Kolmogorov Medal, the Moscow Mathematical Society Award, the Boltzmann Medal, the Dirac Medal, the Dannie Heineman Prize, the Wolf Prize, the Jürgen Moser Prize, the Henri Poincaré Prize, and more.

A professor at Princeton, Sinai lives in the United States but spends several months a year in Russia where he hosts a summer workshop at the Institute for Information Transmission Problems (IITP RAS), a go-to event for many mathematicians.

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[1] The original interview published in Russian by “ОгонёкЪ” (Ogonyok) on December 21, 2000, was conducted by Elena Kudryavtseva and Inessa Grigaliunene. ICM News thanks them, Natalia Maximova, and the Skoltech press office for their help in making the English version of the interview available to the ICM 2022 audience.

Y. Sinai speaking at the Steklov Institute in Moscow

S. Novikov, S. Natanzon (1948-2020), I. Krichever, and V. Buchstaber in the audience

— You got your first invitation to speak at the ICM in Stockholm in 1962 when you were only 27, and since then, you have spoken at this high-profile forum many times. Now that the ICM is going back to Russia for the first time since 1966, what does this mean for our country and what was the main reason for selecting St. Petersburg as the venue?

— It is difficult to say why exactly St. Petersburg. Each country presents a whole list of its strengths to the IMU and the venue is chosen much the same way as for the soccer World Cup or the Olympic Games, which also take place every four years. No wonder that Pyotr Kapitsa once suggested that mathematical congresses follow the same principles as sport competitions, with mathematicians grouped according to their research fields.

Hosting a congress of such standing means a lot to Russia and its mathematical community. It has been a while since Russian scholars received major mathematical awards, which may now find their winners in Russia. Besides, such seminal events give new impetus to scientific research and make it more appealing for younger generations.

— The ICM usually awards four prestigious prizes: the Fields Medal, the IMU Abacus Medal (formerly the Rolf Nevanlinna Prize), the Gauss Prize, and the Chern Medal. What is so special about them?

— Each is awarded in a specific area of mathematics. The Rolf Nevanlinna Prize is awarded in the mathematics of computation and the computer science, the Chern Prize in a variety of areas, and the Gauss Prize in applied mathematics. The Fields Medal is awarded in a wide range of areas but has an age eligibility limit.

— In 1954, the ICM began with a talk by John von Neumann and ended with a talk by your teacher, Academician Kolmogorov, and both were truly momentous presentations. Did the speakers ever discuss this?

— As for von Neumann, we should bear in mind that at the time he served on the U.S. Atomic Energy Commission and was privy to classified information, so he could hardly

communicate with anyone. Kolmogorov said that he put a copy of his paper in von Neumann's paper box but never got a reply. Needless to say, they never met in person.

— Have there been equally significant presentations at more recent congresses?

— I'm sure of that. Sometimes, it may take years before a talk will be seen as groundbreaking. Speaking of modern scientists, Witten likes to give powerful talks (*Edward Witten is an American mathematical and theoretical physicist, a Fields Medal winner, and one of the leading researchers in string theory. – "Ogonyok*").

There is no royal road to mathematics

— You said in an interview that you became a mathematician thanks to your grandfather, Veniamin Kagan, then a professor of mathematics at MSU. Did he teach you math?

— Rather, I should thank my elder brother for that... As for my grandfather, he decided he should teach me more math when I turned 14. He started with a two-hour lecture on the theory of quaternions (no less!). When he finished, he asked me to write down everything I understood from the lecture. He read my notes carefully and said, "You won't make a good mathematician." As a boy, my favorite pastimes were football and volleyball.

— Your brother, Grigory Barenblatt, was a prominent mathematician, too.

— My late brother worked at the Mekhmat. When the time came to decide what I should do after school, everyone in our big family had a say. My father insisted that the Oil and Gas Institute in Moscow ('Kerosinka') was the best choice in terms of eventual employment opportunities. Suddenly, my brother said, "No, he must be a mathematician. That's the only way." His firm point of view won over other opinions.

— Once a Mekhmat student, did you know right away what part of mathematics you would focus on?

— Not at all. We had an excellent professor in mechanics, Nikolay Chetaev, who had a teaching style of his own. At the exam, he would take the student's report card, put it aside and say, "Now let's talk mechanics." He would then ask an order of magnitude deeper questions about the whole scope of the course. During my first two years at Mekhmat, I immersed myself in mechanics...

— You graduated in 1957 when Mekhmat's faculty had a truly exceptional pleiad of great mathematicians, such as Kolmogorov, Gelfand, Petrovsky, Pontryagin, Novikov, and others. How did you first meet Kolmogorov?

— Andrei Nikolaevich was giving lectures at Mekhmat which I attended together with my fellow students. Everyone attended lectures by Kolmogorov, Rokhlin, Novikov, Gelfand, ... That's just the way things were. A lot was happening on the mathematical scene at the

time. Kolmogorov was also making presentations at the Moscow Mathematical Society meetings which we attended, too. I can't remember when exactly I met him for the first time.

— *What was it like to have Kolmogorov as your PhD advisor?*

— Andrei Nikolaevich lived at his dacha and all his students visited him there. We noticed that whenever milk was served, skiing would follow as a must-do item on the program. The next part was music, lots of it, and only after that, some math. This part was not Kolmogorov's favorite, as he wasn't too excited about what we had to say on the subject.

We always attended his seminar, where Kolmogorov posed great many interesting problems, but never assigned them to specific students. Each student was free to choose a problem and come up with a solution. Once, I solved a problem and showed my paper to Andrei Nikolaevich. He got back to me after a long while and said, "You know, I've already recommended your paper for publication." That is to say, he never even discussed it with me or said whether it was good or bad.

Or, I could mention some area of mathematics that I thought was promising, and he would advise agains pursuing it. But I would try and would be proven right.

— *You actually disobeyed? Didn't he get upset?*

— I remember an episode that did upset him. Kolmogorov was the leader of a mathematics boarding school where many of the teachers were his former students. He invited me to teach there too, but I said I'd rather not, because teaching kids was not quite my thing. After that episode, I felt a slight change in his attitude towards me.

— *Yet, you have co-authored many papers and even mathematical concepts, and some bear your names, such as the famous Kolmogorov-Sinai entropy.*

— Kolmogorov came up with the definition of the entropy back in the 1950s but put it aside for a while. In his paper, the entropy was determined for a specific class of dynamical systems. I did some more work and eventually offered a definition of the entropy that applies to any dynamical system. Kolmogorov's response was, "Well, finally you've done something good and now you can compete with my other students."

A problem worth a million

— *You are a winner of countless awards. Is a mathematical award worth it?*

— Why not?

— *Which of the awards is particularly dear to you?*

— I love and treasure them all, and each deserves a mention, for example, the Wolf Prize from Israel (*the prestigious Wolf Prize is awarded for "achievements in the interest of mankind*

and friendly relations among people" and handed out by the President of Israel. – "Ogonyok"). When my wife and I came to receive the prize, there were many familiar people, and the master of the ceremony was from Odessa, imparting a very special charm to the event.

— In 2014, you were awarded the Abel Prize, an equivalent of the Nobel Prize for mathematicians. How did you get the news of the award?

— I got a phone call at five in the morning. The organizers always call very early and, as odd as it may seem, we have to thank Leo Tolstoy for that. You know, he was awarded the Nobel Prize in literature, which he refused saying "Who are you to award me your prize?". This incident scared the prize committee so much that now they play it safe and call very early to have a sufficient time margin if something goes wrong. In my case, I didn't say 'no'. Actually, I believe that prizes should be given to people in good health who can survive all the hustle and travel that comes with the prize.

— You were awarded the Abel Prize for "discovering unexpected links between order and chaos through an extension to the theory of probability." What is the discovery about?

— Chaos and disorder are two different notions. Disorder means that various items in your room are not in their proper places. Chaos is more complex than that. Chaos is when particles around us move in all directions, each according to its own law. Our research focuses on chaos, but there is another area of science that studies disorder. For instance, the fact that if's impossible to predicting the weather for much longer than one day is a statement of chaos theory.

The guiding voice

— You wrote your first serious paper when you were 19. Is it typical for a mathematician to start so early? Do you think students have changed since then?

— Back then, there were a few cases when young mathematicians produced very good papers. This is neither typical, nor exceptional. It took me two years to write the paper that I published at 19, and I even remember a spot in the street where key idea dawned on me, after which everything fell into place.

Now, you find many good students, and some are very good indeed, perhaps even better than we were back then.

— What makes a good mathematician?

— Just listen to your inner voice. I still remember clearly how my grandmother intervened as my family was busy deciding my future. My grandmother came to me and said: "You can choose whatever you want, but remember that mathematicians think about mathematics 24 hours a day. Can you do that?" Her message meant a lot to me.

— Can you hear your inner voice?

— Sure. This is a supernatural thing, your inner mind that you cannot dispute. There are a lot of problems that I would not dare tackling until I get a firm inner understanding that I must work on them.

— At the ICM 1900 in Paris, David Hilbert proposed his famous list of problems for the new century. In 2000, the Clay Mathematics Institute published the list of seven Millennium Prize Problems, offering a US$ 1million prize for each. Which of them will be the first to be solved? What does your inner voice say in that regard?

— The first one on the list has already been solved by Grigori Perelman. Which will come next is hard to say. Right now, my students and I are working on another problem from the list. I am not sure it will be the next, but the problem is a good one.

— What is it about?

— It is about the Navier-Stokes equation, studied earlier by Olga Ladyzhenskaya and others and quite similar to the tsunami problems investigated by Zakharov, who is a physicist and not a mathematician. I have been working on this topic together with my friends and students, including one student in Italy, one in China, and one in Russia.

— Do you expect to solve it soon?

— I don't think so. Even if we don't find a solution, it's fine. Some problems are worth working on for their own sake.

At a conference in honor of Y. Sinai and G. Margulis in Moscow in 2016