Boris Zilber

Ton Yeh

Boris Zilber is a retired Professor of Mathematical Logic and Fellow of Merton College. What follows is the interview that I had with him in July 2018, with my questions in boldface.

What recollections did you have of mathematics in the Soviet Union when you were at school?

It was one of the subjects properly supported. There was great enthusiasm for physics and mathematics. It was 'romanticised': there were films showing how physicists sacrificed their lives for the purpose of science, e.g. with nuclear reactors, for the sake of experiments. Rather like Marie Curie, sacrificing her life for radiation. Similar films were made that had a strong effect on the younger generation. There still remained very strong infrastructure, schools and the system of olympiads – the latter was always supported by the state – but the system of schools with special emphasis on mathematics and physics was a bit more controversial, being considered elitist. I was in one of those schools, in Tashkent where I was born. Up to the time I left school, I was in Tashkent. I took part in those olympiads. I was reasonably successful. This decided my fate. In fact, I first tried the olympiads as a student in a basic school in some old district of Tashkent. It was hardly a special school, very ordinary, where children beat each other. I found myself succeeding in these olympiads. I met students from other schools who joined the olympiads. It is from them that I learnt about the existence of such elite schools. My parents had no role in it. So I went to that school, for which one had to pass exams and some tests, where they test you on very serious problems. One is given a problem to think about for 20 minutes: then, if you can do this problem, can you then do a more difficult one? The harshest test that I had ever had! But the school was really good.

Two things affected this mathematical system in the Soviet Union. The social structure was such that very few careers made one feel independent. If you love history, or economics, or jurisprudence, you cannot be independent of ideology. One must repeat the nonsense about the values of communist teaching and follow the dogma. In physics and in mathematics, you can be really independent. This is what drove many young people into those subjects. Also, after certain shifts in the understanding of the value of physical and mathematical sciences, the Soviet bureaucracy realised their importance. It was the years of the nuclear bomb, etc. They had better not interfere with science, with bureaucratic political ideas. Their military capacity depended on the success of science. Mathematics was thriving – even pure mathematics. Applied mathematics was alright, linked of course to physical and nuclear things. But the downside of people who engaged in applied maths was to be kept in secret facilities, not to be allowed to talk about their research. Pure mathematics had minimal impediments and was free creative activity.

There were a couple of influential monthly mathematical magazines for schoolchildren, with stories about mathematics, and problems to test yourself with – a lot of literature of this sort. I myself first joined this activity at the age of about 12. I was talking to my elder cousins and their friends, who were looking at a newspaper specially for children. In that particular issue, the initial stage of the countrywide olympiad was announced. On a full page, they published problems for 11 or 12-year-olds, through age groups right up to the 17-year-olds. One was invited to try to solve the problems, then to send the solution to a certain address. If the solutions are checked and found to be okay, one would be invited to the next stage. There is no guarantee of independent and proper work at the initial stage, but it was just to check that one could pass to the next stage, which was far more serious. This is how I learnt about the olympiads. I saw the elder children try these problems, and I did so too. I was quite successful, I managed to solve problems for my age group, but also helped my cousins with their problems, and they were 2 or 3 years older than me. You've probably heard that some people who left the Soviet Union for the States started a similar system. It does exist in the US but not on this scale. They still publish a magazine for children, and they opened several schools. Friends of mine have told me that there is one in New York, but because it is based on private initiative, it is terribly expensive. Many parents want to put their children into those schools. So successful was it that it became expensive.

How about university?

I went to Novosibirsk State University, in SW Siberia, about 1500 miles from Tashkent. Still closer than Moscow, which was 2000 miles from Tashkent. One crossed the Kazakhstani steppes by train. It was a really good university, and newly started. The whole project was a step towards democratisation of the Soviet academic system. It was structured with an university campus together with a research institute. Traditionally in the Soviet Union, and still in Russia, research is mainly done in the Academy of Sciences. Universities were mainly for education, with some research facilities, but financially less well-off the Academy. Novosibirsk University, which I joined in 1966, had a new atmosphere politically. They were good years, and I benefited a lot from being there! It wasn't at the same level as Moscow State University: some aspects of mathematical education were missing in Novosibirsk compared to Moscow. But at Novosibirsk, the student fellowship was very strong, there was a competitive atmosphere. Almost everyone wanted to become a research mathematician. They thus had strong commitments to mathematics. When I was an undergraduate, almost all of us slept in student hostel accommodation. We would come after the classes and share the problems from homework, which were different in different classes. We competed with each other to solve them. We'd say 'the one from such-and-such room solved it!' And we'd know. That was the atmosphere. (In later years, this atmosphere was marred by political interference, and everything went a little differently.) Our classes were competitive too. Our tutors were graduate students, not experienced professors. They'd come in and say 'Here is a routine problem, please solve it. But I wonder if any of you can solve this problem, which is the real one'. Among the 12 students, there might be 2 or 3 top students who really competed among themselves. Our exams differed markedly with those in the British educational system. The advantage of the British exams is that they are fair. But they are also very formal. In Russia, it was the opposite. The main difference is that most exams were oral exams. Actually, not quite: for a class of 20-something students, with two subgroups of 10 each, they would announce that the exams were to begin on a certain day at 9 in the morning. This does not mean that all the students had to start writing at 9! It means instead that a lecturer and his assistants – also tutors for these classes – are inside and call out the first five students. The students go in and get what in Russian is called a ticket, a kind of lottery system in which from 30 or 50 questions from a list in advance, the ticket showed which ones were to be prepared. You would be there with 5 or 10 other people in the same room, at different desks, each preparing his/her own ticket. This ticket has questions discussed in lectures, but also some open questions, some problems. You are given 40 minutes or an hour to prepare this. One of the examiners would say, 'I am free now, who's next? You are ready now,' and then he goes over to talk to you. Of course, it can be un-objective, because you are completely in his power, he can simply say that he is not satisfied. Of course you can argue with him, and in mathematics it is more objective than other areas. In good universities like the one in Novosibirsk, after you answer the standard questions, typically they would say, if you were at a sufficient but mediocre level, 'Good, I will give you a good mark', sometimes even an excellent mark. But if they see potential in the student: 'Now I will give you a real question.' So they give question after question, and some good students can stay there for 4-5 hours. The great thing is that this is a moment of truth for the student, who starts to understand what real mathematics is about. Routine questions are done and reported on, but real mathematics shows original thinking. The system allows this, but it is time-consuming, and easily abused. If the student-lecturer relationship is for some reason bad, then there is nothing the student can do about it.

I did my doctorate in Novosibirsk. But there was also my habilitation, and in Russia it is very important if you want to become a full professor. The status of full professor was high at that time.

When did you come to the UK?

1999. Many people left the Soviet Union in the 80s and early 90s. I didn't plan to leave. But the situation was not very good. Also, my wife and I had two grown-up sons, who left home for university, one in Moscow, the other in Novosibirsk. She was insisting that we should move out of his town. We had spent 23 years there, in Keremovo University, where I taught after my doctoral studies. It was obligatory, in order to go into graduate studies, to sign a contract agreeing to a distribution of young specialists, and there I was sent. I tried to negotiate a position in Novosibirsk or Moscow or other central places, but I had zero prospects for a job there. Partly for political reasons, partly because the system was ill-adapted to hiring people who are not in close relations to those who control these places. There was not proper competition like that in most Western countries. So I thought, why not apply to somewhere in the West. A friend of mine told me that two positions were open at Oxford: one at All Souls', one at Merton. At the time I had good connections with Western mathematicians, and the previous Chair of Mathematical Logic at Merton, Angus MacIntyre, who is now in Edinburgh, had resigned a few years back. I applied to both, not having many hopes of getting either.

During a visit to Israel, I received an invitation via email to attend an interview at All Souls'. It scared me to death because the letter said that I was to bring my evening jacket and black tie, because after the interview, I would be invited to a formal dinner. Later I realise that this confused a lot of candidates. Within the traditional British system, this was expected, and one was prepared for it. But for me, this was a bit of a shock, and I wondered how to reply. Two days later, I received communication about the position at Merton. It was offered to me without interview. Later I found out that this was an exceptional situation. Of course, for many people, the committee knows in advance that they want these people, the interview being but a formality, but in my case, the committee realised that it was complicated for me to come for an interview, with visa issues etc. I was so happy that I accepted immediately. Mainly happy that the problem of evening jacket was resolved.

Let's talk about model theory.

I'm happy that I started and finished my career with model theory. Also, the next problem I looked at was a continuation of the problem I looked at before, so I never had to think, 'let me try something else'. The subject thus proved to be deep, and had huge potential on its own. The subject itself leads you to many other things. The essence of model theory is an attempt – speaking in more general or philosophical terms – to interpret mathematics as a whole, analysing the language and the logic of it. You don't attack problems on its own, say in linear algebra, after looking at all the formulas in it, but from a general point of view. You first ask yourself what formalism you use or what language you speak in this area. By asking this question, you see that in practical mathematics, people do not care and they mix many different levels of the language. It is useful and productive to be specific about what language you use when you talk of this or that aspect of linear algebra. You approach every mathematical area or problem, in number theory, in real or complex analysis, even in physics, and ask what is the adequate language and accordingly adequate formalism for this specific area. It might be that a specific problem requires a specific formalism. Then when you identify this formalism, you can approach it as a study of general patterns of formal theories. There is, in the roughly 100 years of the history of model theory, a deep classification theory of various formalisms or formal theories. You can say that the type of formalism for this problem in number theory is exactly like the theory of differential equations. Subject-wise they discuss different universes, but the formalisms are like each other. Asking questions about what are the formal statements of this theory, e.g. classifying statements by imposing that the only quantifier is 'for every'. This is probably the case in physics: 'for every position, momentum, etc., this and this is this'. Or there are more complicated kinds: 'for every such-and-such, there exists such-and-such'. And so on. This is not the most common analysis, but is one possible kind. Two great advantages: one, it helps develop a universal language for mathematics that exhibits links between two branches of mathematics. The unity of mathematics is very much the unity of the underlying logical system. For instance, what is common between number theory and mathematical physics is that both are based on rigorous mathematical principles. Perhaps there is no common axiom, except perhaps commutativity of addition or suchlike. Connected with it, you have not only the unity of mathematics, but with classification, you find deep underlying principles, that are only seen at a general logical level. Certain success was enjoyed in discovering the logical principles, and this is in particular my business in model theory. The main thing is what is technically called category theory. The definition: formalism allows you to describe the structure under analysis, uniquely up to isomorphism. A description fixes an object, which would be desirable for physicists, because if a description allows many interpretations, then people would start wondering which is the one. Nowadays this has become acceptable, and philosophers discuss the meaning of it. But in the age of Einstein, Dirac, Heisenberg, they still thought in terms of categorical description. Categoricity, independently of the physicists who might have thought about it, is a classical subject in model theory. If a formal theory describes, e.g. groups, by saying that the structure describes such-and-such, one may ask whether the description gives a unique object. Of course, if we only have the axioms of groups, then of course, there are many groups. But one may then specify, say, a group of 2-by-2 matrices. Is this unique? Can it be described uniquely in group-theoretic terms? Yes, provided you add that the size of the group is of cardinality continuum. The dividing line between categoricity and non-categoricity is sharp and bears with it very strong classification principles.