COROLLARY 3. *Suppose that $K \subset R^n$ is compact, and $a \in K$ is such that every two-dimensional plane containing a intersects K in an acyclic set. Then K is star-shaped relative to a.*

COROLLARY 4. *Suppose that $K \subset R^n$ is a compact set such that every two-dimensional plane intersects K in an acyclic set. Then K is convex.*

The last corollary is a theorem of Aumann [9].

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PAGES FROM AN AUTOBIOGRAPHY

P. S. Aleksandrov

In these notes the events and encounters of my long life are described, as it were, from the inside, so that they form a subjective account; more like psychologically coloured pages of a journal than an epic objective description of the author's life in the context of a given society and a given era.

On the other hand, it is just its subjective-psychological character that makes my notes a human document, which to the question "What might the life of a man of a given occupation and a given era be like?" gives the answer "In this particular case, just as it is described here". My notes are not, and are not intended to form, anything but one such human document, among the possible ones.

PART ONE

My memory goes back to my fourth year. My first recollection is of a conversation between my mother and the person who had been engaged as my German nursery governess. The conversation took place in German, which my mother spoke well (as she did French). My mother told Olga Petrovna (that was the name of her questioner) that I would be four in two (or three) weeks, from which it follows that this conversation must have taken place during the second half of April 1900.

I remember the dining room of our Smolensk house, which was brightly lit by the spring sunshine, as it had two windows (or, to be more precise, a window and a glass door) overlooking the garden. The room was on the ground floor of a large wooden two-storey house in the grounds of the Smolensk Provincial Hospital, at which my father was principal, or, as the position was then called, senior doctor. This house was let to my father, in virtue of his post. As I remember, my mother told Olga Petrovna what her duties would be. The conversation came to a successful conclusion.

Olga Petrovna lived with us, as a member of the family, for somewhat over four years, and she and I got on extremely well. As far as I can picture her, she was about 30, from Riga, probably Latvian by nationality, and she spoke German well, with the same distinctive Baltic accent, which, many years later, I heard in Hilbert's German speech, and with which Kant is known to have spoken, who, like Hilbert, came from East Prussia.

Olga Petrovna read many German fairy tales to me, mainly from Grimm and

Hauff, and also Andersen's fairy tales in a German translation. We often went for walks in the country, which was very easy because the Smolensk Hospital, and therefore our house, were on the very edge of the town, beyond which lay picturesque, hilly country with beautiful groves.

The German language and German fairy tales, which played such a large part in my earliest childhood impressions, undoubtedly exerted a considerable influence on the subsequent formation of my personality and were the origin of the strong link with German culture, which has been a striking feature of my character throughout my life. German was, indeed, my second native language.

One particular feature of my childhood was the almost total absence of toys and amusements in the usual sense, or rather, the extreme simplicity of these, and other, things. One of my toys, for example, was a "balloon", cut out of cardboard, which was supposed to represent the balloon of the Montgolfier brothers, a picture of which had been shown to me, with an appopriate brief explanation. To this "balloon" I attached a string, hooking it with a nail or a fishhook, which I hammered into the wall, so that, by pulling it in a suitable way, I could get the balloon to rise or fall. My imagination added the rest. Another of my toys was a ship with masts and sails, which my brother Ivan made out of a birch log and which, with his assistance, I "put to sea", early in the spring, on a small pond (or, rather, a large puddle), not far from our house. The masts and sails, admittedly, were chiefly of a decorative nature, we usually had to set the boat in motion by giving it a push, and it often fell on its side, which, however, was treated as a shipwreck and provided its own interest. The only trouble was that these shipwrecks were very frequent and were, so to speak, the normal condition of life on my ship, rather than disasters. Probably this was the reason why the ship did not last long – only for a single spring. But my favourite amusement, at the age of four or five, apart, of course, from walks and being read aloud to, was my whales, which I made by gluing newspaper sheets together. From a few sheets I could get huge whales, which stretched along the floor from one room to another. The whales came into being as follows. My uncle Mikhail Akimovich Zdanovskii (about whom I will say a lot later on) gave me a well-illustrated edition of Brehm's ten-volume "Tierleben", and I, though I did not yet know how to read, very much liked looking at the pictures, while my mother told me or read to me the necessary text. I was chiefly attracted to the large animals, elephants, hippopotami, boa constrictors, and, among the birds, condors and albatrosses, and I always asked to be given precise facts about their measurements, the length of the hippopotamus, the wing-span of the albatross, and so on. Of course, I was also interested in the ways of life of the animals that I liked. All in all, I learned a great deal from my Brehm. Of the land animals, I was especially interested in hippopotami and elephants; for monkeys I felt a pronounced aversion, provoked by I know not what. But, most of all, I took a fancy to whales, and so I glued newspapers together to make them. I knew many kinds of whales, Greenland whales, sperm-whales, etc. I have had, from that time on, a lifelong aversion to the whaling industry. When I was in London in 1958, at the age of 62, and found myself at the British Museum, I immediately went to the special pavilion, where an enormous stuffed Greenland whale, and, next to it, its skeleton, are kept. Looking at these exhibits, I was carried back to my early childhood.

My grandmother, Varvara Vasil'evna, who lived for the last twenty years or so of her life in Paris with her husband Duval came to visit us in Smolensk sometime in the early 1900's and brought me, as a present from Paris, a locomotive with unusually perfect and therefore elaborate equipment. In addition to this engine there were railway lines and two carriages, so that one could set the whole train in motion, with whistles and other attributes of a real railway. I did not, however, have this elaborate equipment for long; after two days the locomotive broke down and we did not have in Smolensk the craftsmen and the spare parts that would have been needed to mend the complicated Parisian toy. It ceased to exist, and I went back to my whales and my cardboard balloon. I have warm memories of these; the toys and amusements of my childhood were, perhaps, excessively primitive, but I certainly do not regret this, and I am glad that I did not experience that surfeiting of children with elaborate technical toys, which causes me to shudder, which nowadays is almost the custom, and which, together with the still more dreadful surfeit of television, presents in my opinion a serious threat to the child's psyche. This same simplicity and lack of sophistication of amusements and holidays attended my upbringing during the subsequent years of my childhood, and the early years of my adolescence. I was not taken to any health resorts, and I did not even see the sea for the first time until the age of 27. My parents considered the best holiday for us children to be a stay at Mikheev (see below) with bathing, walks, boating, and participation, within our ability, in farm work.

An even more important feature of my childhood and early adolescence than the primitive nature of my toys and the extreme simplicity of my amusements was the absence of friends of my own age. I made my first such friend in the autumn of 1912, in the last year of the gymnasium, when I was sixteen and a half years old.

My social circle as a child consisted of my mother, my German nursery-governess, and later my older sister Tat'yana Sergeevna, who was in reality my closest friend during the years 1907–1912, until her death on June 14, 1912; her death was the first real sorrow I experienced. During the years 1910 and 1911 my friendship with Tat'yana took on a "symmetrical" character, because my sister, despite the difference of nine years between our ages, no longer regarded me as a "little boy", but shared the experiences and excitements of her life with me, as with an equal.

My first knowledge of literature was due to my mother, who read aloud to me first Russian fairy tales and some of the poems of Zhukovskii and Pushkin, and, later on, the Russian classics, and also Schiller and Shakespeare (in Russian

translations). I was very young when I began to read the popular science books that were comprehensible at my age. These were above all Rubakin's excellent books, mainly of a geographical and ethnographical character having a good moral tendency, which the author formulated in the words "The love of nature and of freedom".

Through books dealing with Africa and South America I developed a deep sympathy with the peoples inhabiting these countries, and my indignation was aroused against their oppression by colonialists. This feeling played a large part in my psychological make-up as a child. My interest in geography went hand in hand with an enthusiasm to draw maps. Among proper children's adventure stories I only read Jules Verne's "The Children of Captain Grant", and I very soon moved on to more serious books on geography. These were the so-called "geographical collections" (*geografischeskie sborniki*) published under the editorship of four authors, Kruber, Grigor'ev, Barkov, and Chefranov.

Taken together, these books made up an outstandingly well-written voluminous geographical chrestomathy. I also read, with great interest, E. N. Vodovozov's three-volume "Life of the European Peoples", which was by that time already somewhat out-of-date, but which I found nevertheless quite absorbing.

Then my interests switched to geology. I read serious (but nonetheless popular) books, such as Peters' "What Stones Say", Hutchinson's "Extinct Monsters", and lastly, Neumayerr's "History of the Earth", quite a serious work in two big volumes, of which I read one-and-a-half, skipping only the last half of the second volume, which dealt with useful fossils.

I should mention a peculiarity of my character, already noticeable then, which was that I always preferred the most theoretical concepts of a general nature to isolated concrete facts and applications. This feature, probably deeply rooted in my subconscious, has shown itself particularly strongly in my mathematical interests and the direction of my mathematical work.

My interest in geology was succeeded by an even greater interest in astronomy. I read some good books about this subject, of various degrees of difficulty, ending with Laplace's "Exposition of the System of the World", which I understood well enough to become very interested in celestial mechanics.

Before I enrolled in the gymnasium, the following interlude took place. In the summer of 1908 my older brother Mikhail Sergeevich (1885–1965), who later became an eminent doctor, made up his mind firmly to become a medical student, after several years of wavering between a musical and a medical career, and was during that summer occupied with preparations for the examination in inorganic chemistry. Somehow I happened to show interest in the subject, and we began together to study A. N. Reformatskii's textbook conscientiously.

In the summer of 1902 a big event occurred in my life: my mother took me bathing in the Dniepr and began to teach me to swim. From that day on she systematically took me bathing, not letting a day slip by if at all possible. I soon learned to swim, and bathing became my favourite pastime and remained so throughout my life.

The following summer my parents rented a *dacha* on an estate (Pasovo), about three miles from Smolensk, in very picturesque surroundings. There was a beautiful lake, and daily bathing became an established custom of each member of our family. My older brothers loved to swim across the lake, but I was not allowed to do this. In 1904 my parents acquired the small estate of Mikheevo (370 acres) with means supplied by P. P. Voronin (see below), a few miles away from Yartsev in the province of Smolensk. From 1904 to 1918 our family spent every summer at Mikheev.

My father was known in the province of Smolensk as an outstanding doctor and a public figure in medicine. Immediately after the October Revolution he was offered the chance of becoming the head of the medical subdivision of the Provincial Department of Public Health, while still keeping his post as principal doctor at the hospital. In the summer of 1918 the district representatives of the Soviet government not only did not evict us from Mikheev, but persistently asked my father to settle there and to give medical assistance to the local population. But my father was too closely attached to the Smolensk Hospital to agree to this offer, and it was, of course, not practicable. In any case, the summer of 1918 was the last that I spent at Mikheev, and I have never been there since.

But now it is time for me to say some words about my parents. My upbringing as a child was almost entirely in the hands of my mother. My father exerted a very great influence on my development, but later, during my years of growing up and especially during my adolescence. I shall therefore write first about my mother. She was Tsezariya Akimovna Zdanovskaya, of the noble Polish family of Zdanovskii, which has to this day (so my Polish colleagues tell me) its representatives in Poland. My mother's branch of this family had a genealogy that could be traced back without interruption to before the 16th century. But by the middle of the 19th century the very impoverished representatives of this branch were small landowners in the province of Podol'sk and took more part in hunting than in productive agriculture.

In the sixties of the last century, after the birth of my mother (1861–1946), my grandfather Akim Ignat'evich Zdanovskii had troubles in connection with a Polish insurrection which compelled him to move in a hurry from the Podol'sk to the Tula province, and to seek refuge there, entering the service of a Russian landowner as the manager of his estate, which was at that time the customary occupation of Polish gentlemen who had fallen on hard times. Of my grandfather's subsequent fate I know from his eldest son, my uncle Mikhail Akimovich Zdanovskii, only that Akim Ignat'evich died in extreme poverty somewhere in the province of Tula of inflammation of the lungs. This uncle, Mikhail Akimovich, was very dear to our whole family. He was a doctor at the district hospital in Tula and a man of rare mental qualities, without any greed

for money, to whom medicine meant only carrying out his duty to help suffering people. And he gave assistance to everyone whom he could help, completely free of charge. Having a large family and living on the modest salary of a country doctor, he had difficulty making ends meet and was often hard-up. Twice a year he came to spend a few days with us in Smolensk, and this was always a festive occasion for us: we were all very fond of him. He was a man who had thought a lot about life's most important questions, and we retained in our memories the long and animated conversations that my father and my uncle had on topics that stirred them both. I only understood fragments of these conversations, but I realized that they concerned serious and important subjects. I was very fond of Uncle Misha, and I felt deeply my last parting with him before his death in October, 1915. He died of cancer, a few weeks before his 69th birthday, in the Tula hospital where he had worked for most of his life.

My mother received a classical education in S. N. Fischer's gymnasium for girls, which was well known at the end of the last and the beginning of the present century. She attended it from its foundation. My sisters, Tat'yana and Varvara, also graduated from this gymnasium. The feature that distinguished this school from other educational establishments of the time was that its curriculum was exactly the same as the curriculum in boys' schools, in particular, that mathematics, physics and the ancient languages were taught there. In the last year of the Fischer gymnasium's existence, during the winter of 1917–18, when Fischer had already died, I taught mathematics there, just after my graduation from the University of Moscow.

The parents of my father Sergei Aleksandrovich Aleksandrov (1958–1920) were Pavel Petrovich Voronin, a rich Moscow merchant, and a simple peasant girl from the province of Vladimir, whom in time I knew as Grandmother Varvara Vasil'evna. A few years after the birth of her son Varvara Vasil'evna, with the assistance of Pavel Petrovich Voronin, got married to J. Duval, a Frenchman and a barber by occupation. At the appropriate time my father was, through Pavel Petrovich's support, enrolled in the first class of the First Gymnasium at Kazan', where he completed his studies successfully and in good time; after leaving school he enrolled in the faculty of medicine at the University of Moscow. My father took a great interest in his studies at the university and was a good student throughout the course. When the time drew near for him to graduate, my father, like A.P. Gubarev, who took the same course at the same time and was later a notable professor in the faculty of medicine, was offered the chance of staying on at the university, which corresponds to present-day postgraduate work. But in his fifth and last year my father began to get involved with illegal student political groups and took a great interest in this new activity. Who knows how it might have ended? As a consequence my father was threatened not only with expulsion from the university, but also with banishment from Moscow. Sof'ya Nikolaevna Fischer, who knew the then all-powerful M.N. Katkov well, became involved in the

matter. When she learned from my mother about the danger threatening my father, she appealed to Katkov to remove the husband of one of her favourite pupils from this danger. Katkov heeded her plea, and the matter ended with my father being permitted to graduate from the university and to become a Zemstvo doctor in the district, a remote corner near Mologa in the Province of Yaroslavl, where his predecessor had just died of typhus. This was my father's first post as a doctor. After working there for some years, my father became first the doctor at the Gorodishchensk textile factory of the Chetverikovs, in the District of Bogorodsk in the Province of Moscow, and then the senior doctor at the Bogorodsk District Zemstvo Hospital. I was born in Bogorodsk in 1896. Finally, in 1897, my father was offered the post of senior doctor at the Smolensk Provincial Zemstvo Hospital. He remained in this position permanently until he died of typhus at his post in the hospital, on December 2, 1920.

My father was an exceptional doctor, an exceptional public figure, and an exceptional person. Having seen, during my life, many outstanding people in various professions, I can say with certainty that my father was one of the most outstanding among them, one of the most gifted, clearest-thinking, and brightest of all the human personalities I have known. He was a specialist in what is now called surgical gynaecology. The result of his creative work in this field was a new surgical operation, which he proposed (see the article "The Aleksandrov-Wertheim operation" in the second edition of the Great Soviet Medical Encyclopaedia). Articles about the operation were published in specialist journals, both in Russia and abroad, and won fame for my father. One of the ways in which this fame showed itself was that when the International Congress of Gynaecologists and Obstetricians took place in St. Petersburg in 1911, my father, who did not even have the title of professor, was elected Vice-President of this Congress.

My father's outstanding organizational abilities were shown in the high standard to which he raised the Smolensk General Hospital, starting right from the moment when he became its director, and which he succeeded in maintaining over the nearly twenty-five years that he was in charge of the hospital. From the very beginning, Sergei Ivanovich Spasokukotskii, one of the most eminent surgeons of his time, was drawn to my father, as head of the department of surgery. He worked at the Smolensk Hospital for a decade and later wrote to my father saying that those ten years had made him the surgeon that he had become.

My father was not only an outstanding specialist in his field, he was also a widely educated, versatile doctor, such as Russian medicine, as he saw it, required. In particular, he had an excellent knowledge of internal and infectious diseases, and his exceptional general medical, in particular, diagnostic, intuition contributed to his being constantly enlisted as a consultant to different departments of the hospital and to other medical establishments.

My father's influence on my personal development was very great. While

still a young teenager I heard his words, which I adopted as a precept for my whole life, that you should love the work you do, and that you should love it disinterestedly, and do it because you love it, and not because you expect personal success, or any sort of profit for yourself from it. If you do your work for the sake of personal success, and not for its own sake, then you will have neither satisfaction from the activity itself, nor personal success in it. And even if there is personal success, it is only a supplement, so to speak, to a detached interest in one's work.

In essence, what my father told me was what Stanislavskii, having in mind people working in the arts, expressed in his famous formula "Love art in yourself, and not yourself in art". But I heard the similar precept from my father when I was still very young, almost still a child, and as applied to science, to which I was already dreaming of devoting my life. But about this see below, where I tell about my entering university.

My father also taught me respect for work, for all honest work, as one of the fundamentally valuable things in life. He taught me respect for study, which was in his eyes a basic way of seeking truth. He taught me to despise wealth and to regard money as a necessary evil in modern society, and by no means something to be striven for as valuable in itself.

As far as I conceive of it, my father's world outlook, during the period of my youth, was the "naive" materialism of natural science, which at that time was shared by many representatives of the Russian, especially the medical, intelligentsia. But he was never a strictly consistent materialist. He admitted the existence, both in nature and in man, of things inaccessible to reason, beyond the grasp of the mind. While not (at least, at that time) a religious man, he could respect a religious world outlook in others, for example, in Mikhail Akimovich Zdanovskii and in Sof'ya Nikolaevna Fischer.

Now it is time, at last, to resume the basic thread of my story, which has been interrupted by so many digressions. It has taken us up to my enrolment in the gymnasium in the spring of 1909. In the autumn of that year I became a pupil in the fourth class of N.P. Evnevich's private gymnasium for boys. The teachers at this school were very good. V. M. Bogolepov's ancient history lessons were extraordinarily absorbing, as were I.S. Korostelev's Russian lessons.

Latin came quite easily to me; I was well prepared by my mother. (The stock of Latin that my mother got out of the Fischer gymnasium, has sufficed me throughout my life. Yes, languages were taught well there!) The same was true of my French; with all the incompleteness of my French vocabulary, with all the shortcomings of my grammar, two of my senior French colleagues, Denjoy and Fréchet, have both praised my pronunciation, and this I learned from my mother. Our French teacher at the gymnasium, Zhozefina Karlovna Zalesskaya, an elegant Polish lady, a general's widow who, even at the age of 50, was noticeable for her beauty, taught us French superbly. From her I learned enough scanty grammar to be able, later on, to write my papers fluently in

French, and even prefaces and postscripts of a literary, rather than a mathematical, nature. Zhozefina Karlovna, who had formerly been something like an inspector of the junior classes at the gymnasium, treated her pupils not without severity, but in essence tenderly, kindly, and benevolently. And her pupils repaid her for this: they feared her a little, but loved her a lot.

Aleksandr Romanovich Eiges taught us mathematics. I got a mark of four for the first written algebra paper I did for him. To this day I remember the brief comment he wrote on my paper: "The problems are solved well and intelligently, but signs are important in algebra and your treatment of them is careless". Mistakes in signs have always been a problem for me. I remember how twenty years later Hopf laughed at me, and said that homological topology mod 2 was invented for mathematicians like myself. In any case, to avoid spending time on signs, I invented the first version of homological dimension theory, also mod 2.

When Eiges began to do quite complicated problems about the factorization of polynomials, I could not always see how to group the terms, and all in all I did not show any special ingenuity in factorization. Because of this, there were 'fours' among my marks. The 'fours' disappeared when we moved on to equations. But geometry interested me even more than equations did, because in geometry there were axioms and theorems and proofs, and not only problems.

When we came to the theory of parallel lines, Eiges began with amazing pedagogical tact and skill to tell us about Lobachevskii's geometry. The very statement of the problem astounded me. Never before had anything aroused my interest and enthusiasm to that extent. Geometry became an enchanted kingdom for me, and I dreamed of that alone.

On April 2, 1910, a concert was given in Smolensk by Hoffmann, one of the greatest pianists of his time. My whole family went. The concert made an enormous impression on me, and to this day I remember its program. It included Beethoven's 14th Sonata, Chopin's First Ballad, Liszt's Rhapsody, Schubert's and Liszt's "Forest King", and a number of encores and waltzes, including Chopin's mazurkas and waltzes. But despite all the impression that the concert made on me, when I saw Eiges during the interval I immediately went up to him with a question about non-Euclidean geometry, which called forth his joking remark, "But have you come here without your compass and ruler?"

During the following winter of 1910–11, I was ill almost all the time, first with influenza and then whooping cough and scarlet fever. Although I had this in a mild form, it gave rise to the complication of long-lasting nephritis, which in those days was treated by an endless diet of nothing but milk. As a result of all these illnesses, I hardly went to school at all, but I continued to study mathematics. Sometimes, while I was ill (and I was ill almost all winter), Eiges visited me, and I cannot describe in words the joy that each one of these visits gave me. We talked about mathematics, but it was no longer chiefly

about non-Euclidean geometry. Eiges began systematically to teach me, in his usual enthralling way, about mathematical analysis, and I realized that not only is non-Euclidean geometry interesting, but so is all mathematics, and in particular, mathematical analysis. When towards the spring I finally recovered from all my illnesses and could myself go to visit Eiges, our discourses became even more interesting. As a result I decided, already at that time, to study first mathematics, and then maybe mechanics and celestial mechanics. "Practical conclusions" were drawn. It was decided that when I finished the fifth class that spring, I should leave school and study the curriculum of the 6th and 7th classes on my own, during the winter of 1911–12, so that in the spring of 1912 I could again enrol in the gymnasium, but in the eighth and last class. It was then that I first began to think about my future career, and I definitely saw it as being a mathematics teacher in a gymnasium. I made up my mind firmly to enrol after leaving school in the mathematics department of the university.

This plan, which Eiges had originated, was ardently supported by my parents. I also met with approval from the headmaster of the gymnasium, I. S. Korostelev, who taught literature in the senior classes. He offered to see me during the coming winter as often as was necessary for him to keep himself informed about the work on literature that I was doing on my own, and to guide it along by giving me advice. Indeed, during that winter he often invited me, without standing on ceremony, to come to tea with him. After tea he would talk to me for hours in his study about matters directly, or sometimes only indirectly, relating to Russian literature. It will be understood, without any need for words, that these conversations contributed a great deal to my general development, far beyond the confines of the compulsory literature course at the gymnasium.

In those evenings I became well and truly a member of the Korostelev household, and my relations with them remained warm for many years.

Iosif Semenovich Korostelev was an outstanding person. The son of a poor peasant of the Province of Krasnoyarsk, he had, from his earliest years, had to earn his bread by his own toil, and had studied, as one says, in exchange for coppers, first at a teacher's training academy, then at a pedagogical institute, and finally in the Department of Historical Philology at the University of Moscow. Earning his living by giving private lessons, he graduated with distinction and then became an excellent teacher and, eventually, the universally respected headmaster of the best gymnasium in Smolensk.

In the autumn I began (again) to attend the gymnasium. The teachers were the same as before, but my companions were different, as I had moved up to a new class. I made very good friends with one of my new classmates, Sasha Bogdanov (Shurka, as everyone in the class called him), and this first friendship of mine lasted throughout my student years, and my subsequent years in Chernigov. It came to an end only in the autumn of 1919 in Chernigov, under very dramatic circumstances, which separated him not only from me, but also from his family, which had come into existence by then, and from his native

land.

My studies in the eighth class were easy for me (I had been well prepared) and I was able to continue with my mathematics, continuing my frequent meetings with Eiges, which, however, did not prevent him from giving me the only "two" that I got in my three-year course, true, not in mathematics, but in physics (which was also taught by Eiges). The "two", like all of Eiges' marks, was of course, fully deserved. I failed to understand some kind of physical apparatus, which we had studied, but which did not interest me at all.

With constant interest I attended Korostelev's lessons on Russian literature. I wrote essays on Russian literature and on history with interest and, I think, with profit. But my main pursuit in the eighth class was reading both the original and several Russian translations of Goethe's "Faust", which was for the rest of my life one of my favourites in the world literature. Korostelev, and also Eiges, with both of whom I shared my impressions of "Faust", and the thoughts that it inspired in me, persuaded me to give a lecture on Faust in the gymnasium. The lecture was open not only to pupils at our gymnasium, but also to those from other educational establishments. Teachers also came to it. All in all, the hall was overflowing, and I, as it is put, "was successful". I myself realized that the lecture had gone successfully. Eiges spoke after my lecture in a critical vein, contrasting Goethe's world outlook with that of Dostoevsky (and Tolstoy). During my very numerous and long meetings with Eiges we generally talked not only about mathematics, but about literature, philosophy, and music. Eiges had a great influence on my entire spiritual development, which has lasted throughout my life.

In the spring of 1913 I graduated from the gymnasium with a gold medal, and obtained my school-leaving certificate. At the final examinations, which went either in alphabetical or reverse alphabetical order, I always had to answer either first or last. The last of the final examinations was in religious law, and in it I had to answer last, as the curtain, so to speak, fell on the examination period. This period of examinations – the first that took place at our gymnasium – was a solemn occasion, and the governor, and the bishop of our diocese, as well as the educational area representative, were present as guests of honour at the last examination.

I was given a card with a question about the incompatibility of the moral teachings of the Orthodox Church with the ethic of socialism, which related to a course given in the eighth and last year (the course was also called "The moral teachings of the Orthodox Church"). I did not even have the textbook for the course, but I knew the catechism well, and I was in the habit of axiomatic thinking. Therefore, it was easy for me to extract basic moral axioms from the catechism, and by backing them up with appropriate texts, that is, with quotations (an art I have possessed since my youth, which has stood me in good stead) to answer virtually any question dealing with "the moral teachings of the Orthodox Church" (and not only with that subject). In particular, it was easy for me to answer the question on my card. Naturally, I got a "five".

In this connection I remember that in our lessons on religious law, when one of my classmates did not know his lesson, my role was always to ask a complicated theological question, starting a conversation about it (and our teacher – intelligent, kind, and possessed of a sense of humour – loved these conversations!) and drawing it out, until the bell rang to save the classmate who had got into difficulties.

And so the school-leaving examinations, and with them school itself, became things of the past, leaving me with memories of my schooldays as a bright and happy period of my life.

In June 1913 a company of opera singers gave a performance in the summer theatre of the Lopatinsk Gardens (now a park of culture and recreation) in Smolensk. Its general artistic standard was not particularly outstanding for such a group, but one or two good singers took part, in particular, Kamionskii, a really excellent baritone. During the performance of Yevgenii Onegin, the following event took place, which was later widely remembered: the actress who was singing the part of Tatyana did not have a raspberry-coloured beret for the St. Petersburg ball scene and came on stage in a green beret. Kamionskii, who was playing the part of Onegin, got over the difficulty by singing his phrase thus: "Who, there in the green beret, is talking to the Spanish Ambassador?" The musical rhythm of the phrase and the dramatic realism were both preserved. Thus, early in the summer of 1913 I heard for the first time the operas "Yevgenii Onegin" and "The Queen of Spades". They made a great impression on me, and these operas became my lifelong favourites. Later I heard them repeatedly, and in the best performances. But my enthusiasm for these operas, which was to last throughout my life, was first aroused when I heard them in the theatre in the Lopatinsk Gardens in Smolensk.

Early in September 1913 I became a student in the Mathematics Department of the University of Moscow, with which from that day on my whole life was to be bound. When I entered the university, I thought that my life would be devoted to mathematics and to my pupils (as indeed happened), but I assumed that this would be as a teacher in a gymnasium, like my teacher Eiges. Only to this last assumption was Fate to introduce its amendments.

Bidding farewell to my pre-university years (that is, my childhood and school years), I cannot but say that my whole early youth was really "easy" and cloudlessly happy. (Only once, a year before it ended, was it darkened by the deep sorrow, the death of my sister Tat'yana in 1912.)

But before moving on to the university period of my life, I would like to go back once more to my school, and to Smolensk as a whole. I have already said that my teachers at school were good. There were none of Chekhov's "people in cotton wool" among them. I think the only real failure among my teachers was my German teacher in the fifth and sixth classes. She required of us only the mechanical learning of grammatical rules; in particular, we had to learn by heart all the six classes of verbs of the so-called strong conjugation. As far as I am concerned, her lessons had the natural consequence that gradually

(fortunately slowly) I forgot the German I had acquired at home in my early childhood.

To make up for that, I was very lucky with my German teacher in my eighth and last year. This teacher, Lilli Reinholdovna Ridek, not only had an excellent knowledge of her native language and its literary classics, but she taught these things with enthusiasm, and had as her aim that we, her pupils, should not only reach a sufficiently high standard, but that we should come, if not to love them, at least to be interested in them. She decided to put on, with the help of her eighth-class students, a German play: Schiller's drama "Wilhelm Tell". In this play I had to act the rather difficult but important part, of Walther Fürst. At first everything went well, and we had several rehearsals. But as time went on, my part in the play began to be a burden to me. Probably I sensed my lack of any acting ability, and this weighed on me. Possibly the basic reason for not wishing to do further work in preparation for this play was the fact that at that time I was passionately interested in Goethe's Faust and read it all the time, both in German and in Russian translations, and was almost infatuated with it. In addition, I was then studying mathematics really seriously and enthusiastically, and this left me with neither spare time nor energy. To tell the truth, I had no interest in "Wilhelm Tell". In any case, I refused to take any further part in the play and so greatly grieved Lilli Reinholdovna. I did not realise at once that I had messed up the play she had so lovingly created; that I had above all behaved badly towards her, and that in essence there was no excuse for my action. All these thoughts only occurred to me considerably later, but to make up for that they pursued me agonisingly for a long time. When I left school, I visited Lilli Reinholdovna at her home; she lived in a small wooden house somewhere in a by-street of the so-called Voskresensk mountain, in a remote but very picturesque part of Smolensk consisting uninterruptedly of gardens. Lilli and I had many good talks about various subjects, always in German. She had the habit of keeping in her garden three tame owls, each with its own roomy cage. They were all set free every night and came back in the morning of their own accord and settled down in their cages, where they always had a lot of food.

Earlier I mentioned some of my schoolteachers whom I consider to have been interesting people; in any case, not Philistines, about whom stories are not told, nor songs sung.

Korostelev was one of those renowned Russian teachers of literature who, in the words of Saltykov-Shchedrin, "loved their national literature more than anything else"; for whom this literature was inseparable from Russian citizenship and the teaching of it, from the education of youth in the spirit of progressive social ideas, as they understood them. Among my companions, pupils in the eighth class of my school, there was a whole group who became engrossed in night readings of Chernyshevskii and other literature that was forbidden at the time. I was not a member of this group.

The young people who belonged to this group were close to Korostelev; he

cared for them and was fond of them. But he was also fond of me and encouraged my wide literary interests, though they were quite remote from his own. I was not only Eiges' pupil in mathematics, but came under his influence in the area of my literary, esthetic, and philosophical tastes. Eiges gave me Bryusov's book "Incineration" about Gogol to read, and also Merezhkovskii's books about Gogol, Tolstoy and Dostoevsky. All these were literary criticisms, in a style completely new to me, bearing no resemblance to that of the classical Russian critics, and they made a great impression on me, with the result that in the eighth class I wrote my own immature essays on Russian literature. I feel it my duty to mention that Korostelev showed complete broad-mindedness and tolerance towards my new viewpoint which had little in common with his own, and he gave me "fives" for my essays. My brothers Sergei and Ivan, when they were pupils at the gymnasium, enthusiastically studied music at V. E. Klin's School of Music. Sergei studied with the pianist A. K. Dobkevich, who taught at this school and had himself been the pupil of the famous pianist Leshchetinskii; subsequently he became a professor, first at the Kiev and then at the Warsaw Conservatory. My brother Ivan studied the violin with Vladimir Ernestovich Klin, a good violinist and good musician, who had completed his studies at the Moscow Conservatory under the famous Professor Grzhimali. Klin was the director of his own School of Music at Smolensk.

The other centre of musical education in Smolensk, but only for the piano, was the class of Yevgeniya Il'inichna Gurevich, who had graduated with a medal from the St. Petersburg Conservatory, where she had studied with the famous pianist Malozemova, a pupil of Anton Rubinstein. From her piano class there emerged, in particular, I. Mikhnovskii, who subsequently did advanced work under K. N. Igumnov and became a famous pianist; even when he was a famous pianist, Mikhnovskii always thought of himself as Mme. Gurevich's pupil. My picture of musical life in Smolensk would not be complete without mentioning the outstanding cellist Yuliya Nikolaevna Suburova, who had at one time studied with the famous cellist Verzhbilovich and later gave concerts both in Russia and abroad.

In Smolensk concerts were often given by most outstanding musicians. Among them were the singers Sobinov and Shalyapin, the violinists Sarasate, Kubelik, and Hubermann, the pianists Hoffmann, Paderewsky, Rachmaninov, and Petri, the famous conductor Arthur Nikisch, who gave a concert with his orchestra in Smolensk, and many others. These numerous performances by outstanding musicians contributed a great deal to the musical life of Smolensk and made it stand out from many other provincial towns of Russia. Probably the main reason for the intensity of the town's artistic life was its unusually advantageous geographical location on the main railway artery connecting Moscow with Western Europe. It was very easy, while travelling on this railway, in either direction, to stop for an evening at Smolensk, give a concert, and then travel on.

From my childhood on, I heard quite a lot of music at home. My very first musical impressions, probably dating back to the age of 4 or 5, were of a ballroom mazurka and a moment musical of Schubert, which were often played by my mother, and Rubinstein's "The island of stone" which my sister Tat'yana played. As my brothers progressed musically, I naturally heard more and more good music. In the summer of 1903 we had evenings of quartets at our house, but in later years my brothers Sergei and Ivan began to learn more and more solos, and the quartets somehow ceased. There was an attempt to teach me the piano in 1909 and 1910, when I was already at the gymnasium. My brother Sergei, who by that time had already become a good pianist, began to give me lessons. Both my brother Sergei and my sister Tat'yana learned the piano enthusiastically, with Dobkevich whom I mentioned before. He was able to, and liked to, turn the heads of his pupils by promising them a future as musicians. His pupils regarded his teaching with enthusiasm and worshipped him. With this attitude, but on a much higher level, I became familiar later, not at a school of music, but at N. N. Luzin's school of mathematics.

As regards the repertoire that Dobkevich offered to his "advanced" pupils, there were, of course, Beethoven's sonatas, but little Bach or Mozart; Liszt was there and so was Schumann; but special preference was given to Chopin. My brothers Ivan and Sergei were both preparing for professional work as musicians and accordingly viewed amateur musical activities with scorn. Also, chamber music was not cultivated at Klin's school. As a result, Dobkevich's pupils, with all their success at the piano, did not have a sufficiently serious musical culture. Contempt for amateur musical activities affected me too in my fourteen-year-old stupidity, and my first lessons coincided with my period of enthusiasm for the work I was doing in geometry at school with Eiges. As a result, I declared that I wanted to become a mathematician, and so much of my time and energy would therefore be given to mathematics that there would not be enough time or energy to study music seriously; so I decided to give up studying music and insisted on carrying out this decision. It was, as I only realized many years later, one of the most foolish if not the most foolish thing, that I have done in my life.

My first semester at the university during the autumn of 1913 was rather a disappointment, after my happy and very full life at school. I already knew everything we were taught in mathematics in the first year, and it seemed to me that I knew it in a much better form than that in which it was presented to us in the first-year mathematics course. I do not think that I was far wrong. But I found myself an outlet. In the comfortable round reading room of the university library I found Cantor's memoirs on set theory and I began to read them with delight. One of the last mathematics books Eiges had given to me was Kowalewsky's course in analysis, and it had acquainted me, to some extent, with the rudiments of set-theoretical thinking. But when I began to read Cantor in the original and learned what transfinite numbers are, a new world opened up before me, just as had once happened when I first learned

about non-Euclidean geometry, and I was in a state of excitement. I was in the same state of excitement when in Baire's book, which was given to me by V. V. Stepanov, I became acquainted with the Cantor perfect set, which I immediately saw and still see to this day as one of the greatest wonders (and I mean a wonder, nothing less) discovered by the human mind.

When I was in my first semester, D. F. Egorov was lecturing (to students of more advanced courses) on integral equations and the calculus of variations. Later, when I was in the right semesters, I attended his lectures on these subjects. Among the students of my year I became most friendly with V. N. Veniaminov and M. Ya. Suslin. Veniaminov was a nice young man, of open and benevolent character, who was liked by everybody. After graduating from the university he did postgraduate work under I. I. Privalov, specializing in the theory of functions of a complex variable. Then he became a prominent figure in higher technical education; if I am not mistaken, a professor at the Air Force Academy. But there were complications in his later life, and he committed suicide long before reaching old age.

Even at the beginning of his student years, Suslin proved to be an interesting and picturesque person. Already at the age of 18 or 19 he had made a special plan for his future intellectual development. Mathematics was only the beginning of this plan. Physics and chemistry were to be the second stage and were to be followed by biology. Medicine was to be the final part of this plan, and to this subject Suslin intended to devote his whole future life. As we now know, Suslin did not even complete the first step of his plan. He died of typhus in 1919, at the age of 25, still a mathematician, a bright and original mathematician, one of the founders of the modern descriptive theory of sets.

During my student years my closest friend among mathematicians was Vyacheslav Vasil'evich Stepanov, who was seven years older than I. We became indeed very good friends, and the age difference manifested itself only in the fact that he gave me many a useful piece of mathematical advice and to a considerable extent directed my general mathematical education, not allowing me to confine myself only to problems of a set-theoretical nature that were of immediate interest to me. Following Stepanov's advice I took part in the spring of 1914 in Egorov's seminar, which had infinite sequences as its subject during that year.

Egorov conducted the work of his seminar in several parallel groups. The first and most elementary studied numerical sequences and series, the second group (to which I belonged) had the title "sequences of functions". Here we studied papers of Osgood, Ascoli, and Arzelà on uniform and non-uniform convergence, and also the initial stages of the Baire classification. The third group was devoted to divergent series, the fourth to convergence in the mean and Hilbert space, the fifth to convergence in measure and to various supplementary problems, in particular, Egorov's theorem, which he had proved two years before, and the latest related results.

Each group prepared one or two lectures, which were given at the

appropriate plenary meeting of the seminar. Egorov's seminar occupied a prominent place in the mathematical life of Moscow and, as a rule, all the Moscow mathematicians who took an active part in, or merely observed, the progress of science came to his plenary seminars, meetings, which were to some extent rivals of the meetings of the Moscow Mathematical Society. The meetings of the separate groups took place in Egorov's flat and had, so to speak, a cosy and intimate character. My lecture at the common meeting of the seminar was devoted to the Baire classification, and it began my systematic work on problems in this field: I embarked on a serious study of Lebesgue's famous long monograph on analytically representable functions and on appropriate speculations, for example, about conditions under which a sequence of functions of a given class has a limit function of no higher class.

In my life I have read very few mathematical books and papers properly. Among them there were: Baire's book already mentioned and Cantor's basic papers, and somewhat later Lebesgue's monograph just mentioned, which essentially laid the foundation of the descriptive theory of functions and sets. To this monograph I devoted the whole summer of 1914, which as usual I spent at our Mikheev.

During the summer of 1913 I had become accustomed to studying mathematics while listening to the music of my brothers, Sergei the pianist and Ivan the violinist; I used to slip into the room where one of them was practising and very much liked to study there. That summer my brothers were practising Grieg's first violin sonata, and not only did each of them often play his own part, but they often played the sonata together, which I found especially enjoyable. As a result, all my early pursuits in descriptive set theory became for me associated with Grieg's first violin sonata. But an even greater part in my life was played by Grieg's third violin sonata, which my brothers practised during the summer of 1915.

My whole state of mind during the summer of 1914 was influenced by the imminence and then the outbreak of war. I saw it as a dreadful tragedy for the whole of humanity. Most of all, I saw as a tragedy the complete inability of the so-called Great Powers to avert the world war. The summer of 1914 was one of drought; there were forest fires all around and the smell of burning gave an added shade to the gloomy general mood.

In the summer of 1915 I began to give private lessons, at very good pay. My parents were at first against it, but I insisted. I had a firm rule: I spent money from my parents only on living in Moscow in a nice room and on a desk of good quality in perfect condition. I felt obliged to pay out of my own earnings all my remaining expenses on clothes, books, entertainments (theatre and concert tickets, which added up to quite a substantial sum of money – I never allowed a good concert or a good play to go by), therefore, I gave private lessons throughout my student years.

In the summer of 1915 I prepared a young man for his school-leaving certificate and for this I had to go every other day from Yartsevo to Smolensk

and work for three hours with my pupil, who was only two years younger than I. In the summer of 1915 a wave of refugees came pouring out of the western provinces of Russia, and the White Russian (then called the Aleksandrovsk) railway, which passed through Yartsevo, was extremely crowded so that the train service became very irregular. Sometimes my return train to Mikheev left at 1 a.m. instead of 8 p.m., and accordingly arrived in Yartsevo at 3 a.m. In such cases I spent the rest of the night in a hayloft and then went bathing first thing in the morning. I very much enjoyed these mornings.

All in all, the summer of 1915 was one of the most remarkable of my life. It was one of the moments of highest vital uplift that I have ever experienced. It was during that summer that I obtained my first really significant result: I solved the problem of the power of Borel sets and in connection with this I constructed the so-called A-operation. Leaving aside the creation of whole mathematical theories and looking only at individual results, this result about Borel sets was not only my first but probably one of the most important of my life. There was nothing to compare with my subjective experience of the creative act or, to be more precise, the creative process (for it lasted all summer) leading up to this result. I have already said that my brothers were practising Grieg's third violin sonata (in C minor) that summer; I studied while listening to this sonata, and it thus became mixed up with my whole experience of that summer. But I worked not only when listening to Grieg's music, I worked all the time, without any breaks, or rather I did not notice these breaks. I even thought about my work while waiting in the railway station at midnight. Incidentally, I found one of the decisive steps of my proof while on the buffer platform between two full carriages on the night train from Smolensk to Yartsevo. I thought more about this step while walking from Yartsevo to Mikheev. When I got there, it was dawn and the birds were singing. I just could not go to sleep that morning, and I immediately went to the river to bathe, and then home to an early breakfast.

All the things that were part of my life during that summer – strenuous thinking, sudden illuminating bursts of intuition, crowded trains, bathing at dawn, Grieg's sonata – merged into one thing, which filled my cup to the brim, my experience of the happiness of this life and of the excitement put into it by mathematics, which I was now not only learning, but also beginning actively to create.

The task of solving the problem of the power of Borel sets was given to me by N. N. Luzin in the spring of 1915, after I had gone through the famous result on the power of all sets of type $F_{\sigma\delta}$.

I met Luzin in the autumn of 1914, after his return from a long scientific mission abroad. I have told about the extraordinarily powerful impression he made on me at our first meeting, in my lecture "On the vocation of a scientist", which is published as a separate booklet and is also included in the second volume of my works.[1]

[1] "Dimension theory and articles of general character", "Nauka", Moscow 1979.

When I set about solving the general problem that Luzin had given me, I began with the particular case of Borel sets of the lowest classes and managed to prove that every uncountable set of type $F_{\sigma\delta\sigma\delta}$ (I called them sets of the fourth class) has the power of the continuum. The solution of the problem in this particular general idea was already completely manifest. In fact, I proved that every set of that class can be obtained by applying the A-operation to closed sets, and then I showed that every uncountable A-set contains a perfect set. However, when I told Luzin my idea for the proof, he looked at it with suspicion and tried to convince me that my plan could not be used for anything but $F_{\sigma\delta}$ sets. Curiously enough, when many years later in 1923 Uryson and I began to explain the A-operation (which as we thought had by that time become common property in set theory) to the famous mathematician Carathéodory, who had previously written a book on the theory of sets and functions, he began with complete assurance to prove to us that every A-set is in fact a set of type $F_{\sigma\delta}$. Thus the concept of the A-operation, simple as it was, contained something that presented a certain psychological difficulty at a first encounter. Of course, it is also quite possible that my first account of the idea of proof was not clear enough and justified Luzin's scepticism. Be that as it may, he was totally sceptical and advised me to scrap my plan of solving the problem by contradiction and by trying to construct a Borel set of power $\aleph_1$. Fortunately, I did not follow my teacher's advice on this occasion. By the end of the summer I had succeeded in carrying out my proof in full generality and in all its details. The first person to whom I explained it at length and who probed it with all rigorous severity, was Stepanov, who was capable like no one else of critically examining proofs, in any then known field of mathematics. Then I presented the proof to Privalov and only after that to Luzin, who was thus forced to abandon his initial scepticism.

Ever since Lebesgue had stated in his famous monograph of 1905 that virtually all sets in mathematics are Borel sets, the problem of their power had been seen as one of the central problems of set theory, and its solution was regarded as a great discovery. Even such venerable professors as L. K. Lakhtin and B. K. Mlodzeevskii attended my address to the student mathematical society on October 13, 1915. Egorov and Luzin were present, as were all the young mathematicians, starting with Stepanov and Privalov, and all of our students interested in mathematics. Among them was P. S. Uryson, who had only just entered the university. It was then that I first met him. On the same day I first got to know Sierpinski. He then arrived in Moscow and also came to my lecture to the student mathematical society. I also met Suslin for the first time on that occasion. Naturally, as soon as we finally met, I told him in great detail about my results. We began to talk endlessly about related problems. Stepanov, who always responded keenly to anything that happened in mathematics in Moscow at that time, frequently took part in our conversations. It was then that Suslin proposed that my new set-theoretical operation should be called the A-operation and that the sets obtained by applying it to closed

sets should be called A-sets. He emphasized that he was proposing this terminology in my honour, by analogy with Borel sets, which by then were usually called B-sets.

This terminological detail concerning myself was mentioned recently in articles of M. A. Lavrent'ev and L. A. Lyusternik about the history of the Moscow mathematics school and also later in an article of L. V. Keldysh. This question of my priority in this case never made much difference to me; it was just my first result and (maybe just because of that) the one dearest to me.

Many years later Luzin started to call A-sets analytic sets and began, contrary to the facts, which he knew well, to assert that the term "A-set" is only an abbreviation for "analytic set". But by that time my personal relations with Luzin, at one time close and sincere, were estranged.

As soon as it had been proved that every B-set is an A-set, the question naturally arose whether perhaps conversely every A-set is a B-set. This problem of course came up in Moscow in conversations on my work. It is easy to prove that every A-set is an intersection of $\aleph_1$ B-sets, or that every complement to an A-set is the union of $\aleph_1$ Borel sets. This was known to me, also to Suslin and, of course, to Luzin. The whole problem was whether this process of forming a transfinite union came to a stop at the countable stage. I spent the whole winter of 1915–16 and the whole next summer trying to prove that this break does indeed occur. My extremely persistent speculations only ceased when it became known early in the autumn of 1916 that Suslin had constructed during that summer an example of an A-set that is not a B-set and so had inaugurated a new stage in the development of the whole descriptive theory of sets.

When Uryson and I visited Hausdorff in the summer of 1924 and talked a lot with him, particularly about descriptive set theory, Hausdorff put the question to us directly: what should one call the new sets that Luzin was popularizing everywhere under the name of 'analytic'. I firmly replied to Hausdorff that Suslin (who had died nearly five years before) was the first mathematician to prove that it was really a matter of new sets, whereas I had spent almost two years trying to prove that there are no such new sets and had only come up with a new definition of the old class of Borel sets. Therefore, I declared, these sets should be called Suslin sets. After some hesitation Uryson backed me up, Hausdorff agreed to our joint proposal and in the new edition of his "Mengenlehre" they were called Suslin sets.

In January 1917 Suslin's note, which had been edited and translated into French by Luzin, in which he gave his remarkable example of an A-set that is not a Borel set and also stated the basic theorems of the theory of A-sets, was published in the Comptes Rendus of the Paris Academy of Sciences. It had the incomprehensible title "Sur une définition des ensembles mesurables B sans nombres transfinis". This title would have been appropriate if Suslin had proved that the classes of A-sets and B-sets are the same and not, on the contrary, that they are distinct.

During the winter of 1915–16 Sasha Bogdanov and I shared our accommodation, a rented room with a desk in Khlebnii Lane. By the spring students began to be called up and sent to military schools, with a view to being commissioned as officers after graduation. Sasha, too, went to a military school. After his graduation early in 1917 he was sent as an officer to a military unit, first to an infantry unit, but soon to an artillery unit stationed in the small town of Novgorod-Seversk, in the Province of Chernigov. As for me, after spending the summer of 1916 at Mikheev, I lodged with my brother Mikhail, with whom I lived until the end of 1917, only leaving in the summer to go to Mikheev.

At the very end of 1917 I moved from my brother's house to Zatsepa, where I managed to rent a nice room with full board in a family of railway workers. At that time, when it was already difficult to get food, this was a great stroke of luck. Throughout that winter I taught in two girls' schools, the Fischer gymnasium, which was located on one of the side-streets of Ostozhenka (now Metrostrovskaya) and the Winkler gymnasium on the Clear Pond. My timetable in these schools took up four days of my week. On those days I set out early in my morning, making my way on foot (virtually no trams were running), first along Sadovnik Street (now Osipenko Street) and then across the Ust'inskii Bridge and into Clear Pond boulevard to the Winkler gymnasium. When I had finished my lessons there, I proceeded further (still, of course, on foot) along Myasninlskaya (now Kirov Street) through the centre of Moscow, and on Ostozhenka to the Fischer gymnasium. After finishing my work I went along the Crimean embankment and then the part of the Sadovy circle south of the Moscow River, home to Zatsepa. I did not get back until the evening, and sometimes I even gave private lessons at home later. For the rest of the evening I occupied myself with reading "War and Peace", and I read the whole of this book, from cover to cover, with great enjoyment.

As a problem to work on Luzin put before me nothing less than the continuum problem in its most general formulation. I began to think about it all the time during the three days of the week that I had for mathematical work. I stated the following axiom, which seemed to me to be true beyond all doubt: with every transfinite number α one can associate a number $\mu(\alpha) < \alpha$ such that to distinct α there always correspond distinct $\mu(\alpha)$. Having accepted this axiom, I obtained what seemed to me to be a perfectly correct proof that the cardinal of the continuum is $\aleph_1$. I had no grounds for doubting that all the arguments reducing the continuum problem to my axiom, were valid. Having written out my proof with all due care (it took up a whole thick notebook), I began to think about the assertion I had accepted as an axiom. After a few days of speculation, I became convinced that my axiom was not true, that the function $\mu(\alpha)$ required by it could not possibly exist. Later I published my proposition (this time correct) as a supplement to the "Mémoir sur les espaces topologiques compactes", which I wrote jointly with Uryson. This proposition about transfinite numbers has been strengthened by several authors and is, for example, included in Bachmann's well-known textbook.

It became clear to me, however, that my work on the continuum problem had ended in a serious catastrophe. I also felt that I could not go on, so to speak, to further things in mathematics, and that I had to come to a decision about my life. At that time I received a letter from Sasha Bogdanov, inviting me to come to Novgorod-Seversk, where he had remained after the demobilization of the military unit in which he had served. There was nothing to lose, and I accepted his invitation.

In Novgorod-Seversk Sasha Bogdanov immediately took me to the Assing household, where he felt as at his own home. This family consisted of two sisters of about fifty and a somewhat younger married brother. Of the sisters Assing, one was a good doctor, the best representative of her profession in the town, the other was an enthusiastic worker in preschool education, and the director of a nursery school. The brother, Anatolii Anatol'evich Assing, was a typical Chekhov intellectual, a ruined nobleman (who had, indeed, never been very rich), a man without a fixed profession. He had recently been dabbling in photography, mainly colour photography, which was then still in its infancy. But Assing's real, burning interest, which filled the whole of his not very structured life, was the theatre. He had many acquaintances among Moscow actors in the Arts Theatre and the Intimate Theatre. He had met these people in his youth, before the Revolution. Of Assing's actor friends I should mention, first of all, the prominent actor at the Arts Theatre, Il'ya Matveevich Uralov who had formerly played at that theatre for many years at a stretch the part of the governor of the town in Gogol's "The Government Inspector". Uralov himself came from Novgorod-Seversk and was living there in 1918. The actor at the Arts Theatre whom Assing knew best was N. G. Aleksandrov and at the Intimate Theatre Tseretel. They and other actors from both theatres were frequent guests at the Assing's house during the years before and immediately after the October Revolution. During the summer of 1918 I became acquainted at the Assing's house in Novgorod-Seversk with Aleksandr Yakovlevich Tairov, the director of the Intimate Theatre. Under these conditions Assing's amateur theatre had no lack of advisors and even good guest actors. Soon after my arrival at Novgorod-Seversk in the summer of 1918 I caught a performance of "The Government Inspector" at Assing's theatre, with Uralov playing the part of the governor of the town, his wife (herself a professional actress) the part of Anna Andreevna, and Sasha Bogdanov the part of Khlestakov. Sasha undoubtedly had a talent for acting, and (in the opinon of such an authoritative judge as Uralov) acted Khlestakov outstandingly well. Later he had to take the part of Alyosha Karamazov in a performance of "The Brothers Karamazov" by the actors of the Arts Theatre. I never had any talent or inclination for acting, but I tried my hand at producing, and my greatest achievement was a production of Ibsen's "Ghosts" which ever since I have known almost by heart. But I was already in Chernigov when I produced "Ghosts".

In the spring of 1919 Sasha and I were involved in setting up the Chernigov Soviet Dramatic Theatre: Sasha as an actor, and myself in the post of director of the theatre section of the arts branch of the Chernigov Department of People's Education. For the post of principal producer at the Chernigov theatre I managed to attract from Kiev the very good and undoubtedly talented producer, Konstantin Timofeevich Berezhnoi, who had worked for some time under the famous Konstantin Aleksandrovich Mardzhanov (Mardzhanishvili). Berezhnoi was a widely educated, versatile producer, with great imagination, initiative, and inventiveness. Such a producer was a great asset to the Chernigov theatre. During the summer of 1919 he was able to put on a number of interesting plays. Among them were "The Government Inspector" and a play by A.N. Ostrovskii. Also, as I have already mentioned, Ibsen's "Ghosts" (the play of which I was in charge); Verhaeren's "Les Soirs", a very difficult and from a producer's point of view revolutionary play; L. Andreev's accomplished play "The Life of Man", and others.

In the spring of 1919 Sasha Bogdanov got married to Yuliya Ivanovna Lakida, who came over from Novgorod-Seversk to Chernigov. The Lakida family were natives of Novgorod-Seversk, who lived next door to the Assing's. There was a close friendship between the two families and constant coming and going. The Lakida family consisted of the parents, both over 60, one son and four daughters. Yuliya Ivanovna was one of the younger daughters.

One rarely meets with such warm-heartedness, such goodwill towards people, and such hospitability as at the Lakidas. Everything in this house was lyrical, old-fashioned, and patriarchal, and the clocks in the house, before striking, wheezed, whistled, and buzzed in many different voices, as though they were all getting ready to tell a long story about Gogol's times. Like Sasha before me, I had become closely acquainted with the Lakidas when we were living at Novgorod-Seversk, and what had then been Sasha's friendship with Yuliya Lakida reached its natural conclusion in their marriage.

In 1919, at the height of the summer, L. V. Sobinov came to Chernigov for a few days. He arrived from Kiev, where he was the director of the arts division of the Ukrainian People's Commissariat of Education. Our Chernigov branch was subordinate to the Ukrainian department, so that Sobinov was our immediate superior. He came to Chernigov, so to speak, as an inspector, to see the state of our theatrical work. A meeting was held with Sobinov as chairman, and I, as head of the theatre section, gave a summary report at this meeting. Sobinov was interested in all the details of the life of our theatre and offered his help where necessary, altogether, to report to him on our theatre was very pleasant. In all his manner there was no trace of the fact that he was a person of considerable authority and a great artist. The utter simplicity and modesty of his behaviour, particularly to us quite young participants in the meeting, would be difficult to imagine. Berezhnoi, whom Sobinov knew from Kiev, was also present, of course.

Shortly before Sobinov's visit to Chernigov I had gone to Moscow, also on

theatre business, and on this occasion had met Lunacharskii, and also the head of the theatre department of the People's Commissariat of Education of the RSFSR. In Moscow we had been given material help and, as part of this help, stage material and literary supplies. Naturally, in my report I told Sobinov about my journey to Moscow. During his stay in Chernigov Sobinov gave three concerts. They took place in the auditorium of our theatre, which had been converted from an assembly hall of the former nobility. His performances in this auditorium gave Sobinov a chance to acquaint himself with the condition of our stage and its equipment. I do not need to tell you with what excitement the people of Chernigov welcomed Sobinov. The programmes of all three concerts were enormous. Besides, Sobinov as an artist was always distinguished for his accessibility. He never had to be entreated and always gave many encores willingly. Whether he had a special appeal for the Chernigov public (why should this be?) or whether he was "in great form", the fact is that he sang endlessly at these Chernigov concerts, and all his concerts went on deep into the night.

I had often listened to Sobinov in Moscow. From my first year at the university onwards I never missed his concerts and often heard him at the Bolshoi Theatre. I went to hear "Yevgenii Onegin" at least twice every year, at the beginning and the end of the winter, and I always chose performances in which Sobinov was taking part. I always perceived his singing to be a marvel. It had, on the one hand, an exceptional warmth and humanity, which I did not find in any of the other singers I heard and, on the other hand, Sobinov's singing had a certain abstractness of its own, which made one forget completely the existence of a throat, vocal chords and the entire physical mechanism making the sound. It seemed, at least to me, that when Sobinov sang the air rang all around, and the sound filled everything including myself.

Let us return to the summer in Chernigov. Apart from my work with the theatre, I gave public lectures on literary subjects during the summer of 1919, as in the previous winter. The lectures were about Goethe (my school experience had not gone to waste), Gogol, Ibsen, Hamsun, and Dostoyevsky. My lectures were very successful, not only in Chernigov, but also in several other towns where I went to give them, particularly, in Kiev.

On the whole, my life in Chernigov went on quite pleasantly and agreeably, among all sorts of interesting people who were friendly towards me. But gradually clouds began to form above this idyllic existence: the Denikin troops were moving further and further north, and the danger that they would reach Chernigov which not long ago had seemed incredible, was becoming real.

In October 1919 the Denikin reached Chernigov. Sasha Bogdanov, as an officer, was immediately called to the army. A few days later someone in civilian clothes grabbed hold of me in the street and took me to the Commandant's office. There I was declared to be under arrest, with vile language and most brutal blows instead of an accusation of guilt.

I felt relieved when I was finally taken to the building where arrested people

were held. The following day, to my great joy, Sasha somehow managed to be appointed to keep guard over me. For a few hours he stayed with me. But then a soldier appeared whose duty it was to take me to prison.

Sasha and I said goodbye to one another and have never seen each other again. After some years I learned that he had finally ended up in Paris and had followed an artistic career. Once he even had the good fortune of performing with a group of actors from the Moscow Arts Theatre which was on tour abroad. Later still I learned from Sasha's letters that while living in Paris he had obtained Soviet citizenship. I do not know whether he is still alive.

And so I was taken to prison, where I remained for about a week. Of the details of my stay there I only mention that it was there that I first made the acquaintance of the louse, which was especially unpleasant for me, as I was accustomed to washing myself every day from head to foot (even in cold water and often under very unfavourable conditions).

My case was investigated by a military judge (the Denikin forces had not had time to set up civilian authorities in Chernigov). I was called for interrogation several times. The interrogator was a middle-aged officer, whose rank I could not discern or in any case do not remember. In contrast to what had happened at my arrest, the interrogator behaved correctly towards me and did not venture any insults. When I asked what I was accused of doing, he said to me: "You have voluntarily, actively, and energetically collaborated with the Bolsheviks, and have thus actively supported Soviet power and contributed to its popularity." I was blamed particularly for having given not only public lectures, but even lectures in agitational education: this was regarded as specially wicked. He concluded one of my interrogations with the words: "If the Russian intelligentsia behave like you, the Bolsheviks will still govern Russia six years from now". I made no reply.

As I have said, my public lectures were a great success and this was so with various sections of the population. Among my audience there were some who had access to the influential circles of that time. There were people who petitioned on my behalf, and they achieved an important result: my case was transferred from a military to a civil court, and I was released from prison until my case came up in the civil court. But before the Denikin civil authorities could arrive, the Soviet army reoccupied Chernigov. And there the episode of my arrest ended.

In November 1919 I began giving lectures as before, however, no longer public lectures, but lectures I gave on literature and mathematics at the Institute of Mathematics which had just been opened in Chernigov. During one mathematical lecture I felt an intense chill. I finished my lecture with difficulty, and with even greater difficulty walked back home. I had caught typhus, and I had the illness in a severe form and was unconscious for two weeks. In all, I was in hospital for six weeks.

After my recovery I felt a sudden surge of cheerfulness and joie de vivre and immediately and abruptly made up my mind to return to mathematics. I

remembered my interrupted post-graduate work at the University of Moscow and began to think of returning to Moscow. First, however, I went to Novgorod-Seversk and stayed there with the Lakidas throughout the summer of 1920.

At the beginning of the autumn of 1920 I finally returned from Novgorod-Seversk to Moscow, where I was in the full sense of the word welcomed as the returned "prodigal son". Stepanov and Egorov welcomed me particularly cordially and warmly. It was decided that I should proceed at once to the succession of master's (postgraduate) examinations. I drew up programmes for these examinations, with a lot of advice from Stepanov, and they were approved by Luzin, who was still my official supervisor. During the winter of 1920–21 I lived, in fact, with my parents in Smolensk and came to Moscow for about a week every month to get the next examination problem.

The programmes for the master's examinations were supervised by Egorov and comprised all the basic mathematics of that time. Those who mastered this syllabus could justly consider themselves to be educated mathematicians.

I went to Moscow for one of my regular examinations, on or about November 20.

On returning to Smolensk I learned that my father was gravely ill. He had quickly realized that his illness was serious and had begun, lying in his bed at home, first to write and later to dictate letters to his colleagues and friends in Gubsdrav, requesting them to take care of my mother in the event of his death. The doctors suggested that he might have typhoid, but he himself thought that he had typhus. At that time there was a typhus epidemic all over Russia. In the Smolensk Hospital everything that could be was converted into a typhus unit. My father not only spent hours in these units every day, but also visited them at night, feeling this to be his duty as senior doctor. He had also been very tired. Knowing all this, he realized that it would only be too easy for him to catch the disease. The day before my return my father was taken to hospital with a confirmed diagnosis of typhus. When I went to see him, he recognized me and said a few words to me. But his mind was already unclear, and he soon lost consciousness altogether. At 2 a.m. on December 2, 1920 my father died. After his death my mother was given a personal pension, and the flat belonging to the Smolensk Hospital was kept secure for her for the rest of her life.

From 1922 to 1938 I went to Smolensk for between 5 and 7 days every month (except when I was abroad or on holiday) to lecture at the university and the Institute of Education. One member of my audience was A. G. Kurosh, who after completing his undergraduate course had become my postgraduate student, first at Smolensk University, and then at Moscow. Later he became one of our most outstanding algebraists. At the time of these journeys to Smolensk I lived with my mother. In 1918 Luzin moved for a while to Ivanovo (which was then still called Ivanovo-Voznesensk). Acting on his advice, A. Ya. Khinchin, D. E. Men'shov and M. Ya. Suslin also moved there and, like Luzin,

taught at the Ivanovo Polytechnic Institute. Suslin, however, did not get on well at Ivanovo and soon lost his job there. Therefore, V. V. Golubev and I. I. Privalov initiated a plan to appoint Suslin to a professorship at the University of Saratov. A recommendation from Luzin was expected. But he did not give it and did not support Suslin for a teaching post at Saratov. When Suslin did not get the post, he went away to his home in the country (in the Province of Saratov). He soon caught typhus and died. This was one of the most tragic pages in the history of Soviet mathematics. Until the end of Luzin's life a portrait of Suslin stood on his desk, the only portrait of Suslin that I have seen.

In the autumn of 1920 O. Yu. Schmidt began to take an active part in the mathematical life of the University of Moscow (he had moved from Kiev to Moscow in 1918). Under his guidance an Institute of Mathematics and Mechanics was set up at Moscow. Egorov became its first director and remained in this post until the end of 1930. The President of the Moscow Mathematical Society at that time (since 1905) was Nikolai Egorovich Zhukovskii. In March 1921 he died, not long surviving his only daughter, who had died in her early twenties. He was replaced as President by B. K. Mlodzeevskii. He died in January 1922, and the Presidency passed to Egorov who remained the President of the Mathematical Society as well as director of the Institute until the end of 1930. Thus, throughout the twenties, Egorov was at the head of both the Institute of Mathematics and Mechanics and the Mathematical Society and was therefore head of the whole of Moscow mathematics. This period was undoubtedly not only one of the most productive but also one of the brightest in the life of the mathematics school of the University of Moscow.

Early in the autumn of 1931, Egorov's life came to a painful and sad end in one of the clinics of the Kazan medical faculty, where he had been taken only a few days before his death. Egorov's grave is in the Kazan cemetery, next to Lobachevskii's. Like Lobachevskii's grave, it was for a long time maintained in perfect condition through the support of Kazan mathematicians. I hope that this support still continues.

In the winter of 1915–16, during one of my short visits to Moscow, Eiges had introduced to me his younger sister, Ekaterina Romanovna, and his two (also younger) brothers of whom one was a painter and the other had graduated from the Moscow Conservatory as a pianist but had then taken up literature. The two brothers and the sister lived in the same rented flat on one of the sidestreets of the Novinskii Boulevard (now Tchaikovsky Street). Stepanov was a constant visitor at their flat, and so was a pianist, Igumnov's pupil Dobrovein, later a famous conductor. (He actually played Beethoven's "Appassionata" to Lenin.)

I also was a constant visitor to the Moscow home of the younger Eiges, and this had lasted right up to the time when I left Moscow for Novgorod-Seversk (in the summer of 1918). I had become particularly well acquainted with Ekaterina. When I returned to Moscow in 1920, our friendship was renewed

with all its former cordiality. But in 1918 or 1919 a new figure had come into Ekaterina's life, namely, Sergei Esenin. Ekaterina showed me a thick notebook of his poems, all dotted about with notes in Esenin's distinctive handwriting. There were individual critical comments, but also whole lines underlined by Esenin with his suggested alterations.

Unfortunately, this notebook, which would undoubtedly have been of interest to literary critics specializing on Esenin, has been irrecoverably lost.

In early or mid-March of 1921 Ekaterina Romanovna introduced me to Esenin, and we spent part of an evening together. I do not now remember how long this meeting lasted, but it left its imprint on my mind: I got a feeling of what Esenin was like as a person, it seemed to me I felt that his gentleness, his delicacy and, as it were, his defencelessness.

I spent New Year's Eve of 1926 in Holland, in the company of Brouwer and the people who were at that time his closest friends and mine, among them Emmy Noether. It was one of the pleasantest New Year's Eve parties of my whole life. I did not then realise of course, that it was the night of Esenin's death. But when the next day I read the news of his death in the Dutch papers, I felt a stab and I remembered my only meeting with him, which was a precious but painful memory for me.

During the winter of 1920–1921 the number of Luzin's pupils had increased enormously; they formed a large collective, the famous "Luzitania", and there began, as Lyusternik put it, "the days of the unforgettable Luzitania, the days of inspiration and search".

In the Luzitania and male and female sexes were approximately equally represented. The really striking talent of one woman, Nina Karlovna Bari, came to the forefront in this collective. Some years later, when there was another considerable increase in the number of Luzin's pupils, Lyudmila Vsevolodovna Keldysh was added to their number.

In my opinion, however, the years of Luzin's heyday as a mathematician and also as a human being were not those of the Luzitania, but the preceding years of 1914 and 1915.

Having known Luzin during those years, his earliest creative years, I had known an inspiring scholar and teacher who lived only in and for his science. I had known a man who lived in a realm of the highest human spiritual values, a realm into which no noxious air could penetrate.

On leaving this realm (and Luzin did later leave it), a person inevitably falls under the influence of those powers of which Goethe wrote:

"Ihr führt in's Leben uns hinein,
Ihr lasst den Armen schuldig werden
Dann überlasst Ihr ihn der Pein,
Denn jede Schuld rächt sich auf Erden."

In the last years of his life Luzin drank to the bottom the bitter cup of vengeance of which Goethe speaks.

Uryson took his master's examinations at the same time as I did, in the winter of 1920–21. Our courses of study for these examinations were almost identical, and we soon became accustomed to taking them in the same subjects on the same days. Arriving from Smolensk as I have mentioned, a few days before each examination, I would meet Uryson, and we would give each other a rehearsal of each examination. Sometimes Stepanov who by that time also knew Uryson well, took part in these "dress rehearsals". Our method of taking examinations together was concisely expressed in Stepanov's formula: P.S.A. and P.S.U., or in abbreviated form the PS's, take their examinations "with heads together", and the plural (or rather dual) just mentioned was used throughout the Luzitania.

Uryson loved music no less than I did, and an enormous number of good concerts took place in Moscow during that year and the following years. I don't think that Moscow has ever, within my memory, been treated to serious music of a high a standard as in the twenties. The concerts came in cycles: all Beethoven symphonies, all Tschaikovsky symphonies, all Beethoven quartets, all Beethoven piano sonatas, etc. The concerts were given in packed halls. Most of the audience, of course, consisted of young people. People came to listen to music, serious music, music as such, and not to listen to the performances of individual fashionable celebrities. Uryson and I tried not to let any good concert slip by, so we spent almost every evening at a concert. This was helped by the fact that we both had an entrenched habit of not doing mathematics in the evenings and were accustomed to a regular way of life.

On March 30 we went to the Beethoven Hall in the building of the Bolshoi Theatre, for an evening of Beethoven violin sonatas. After the concert we accompanied one another, alternately, to our respective homes, and we took turns escorting one another: Uryson went with me and then I with him. And so we went, in both directions, between Pimenovskii lane (not far from Mayakovskii square) where Uryson lived, and Kislovskii lane (next to the Conservatory), where I lived with my brother. I do not know how many times we oscillated in this way. But when we finally decided, somewhere in the middle of Tverskii boulevard, to go to our separate homes, it was already 5 o'clock in the morning. By the time we said goodbye to one another, we had reached the thee-and-thou stage and we decided to count as the beginning of our friendship our walk of the night of 30–31 March 1921.

The next day another event in my life occurred: I got married to Ekaterina Romanovna Eiges. This marriage was not a success but a mistake. Ekaterina was a woman made for domestic life and I was totally unfit for such a life, and any marriage would have been a mistake for me.

In the summer of 1921 a group of Luzitanians rented a *dacha* in the village of Burkovo, not far from Bolshevo, on the banks of the Klyaz'ma, near the point where the river changes into the Obraztsovskii pond, about which I will have to say more.

One morning in August, Uryson and I were both at the Burkovo *dacha* and

went to swim in the Klyaz'ma. During our bathe Uryson told me about his definition of dimension at which he had just arrived and then began to expound at great length the basic propositions of dimension theory. As a result, we spent several hours of that hot sunny day at the river. I was thus present at the conception of one of the finest chapters in topology: Uryson's dimension theory. When he finished his long mathematical narrative on the banks of the Klyaz'ma, it was time for us to return to Moscow.

Early in May of the following year, Uryson and I rented a room in the *dacha* estate of Starye Gorki, also on the banks of the Klyaz'ma, but on the other side, almost exactly opposite Burkovo, only a little higher upstream. We stayed in this *dacha* room throughout the summer of 1922. This was a time of strenuous mathematical work for both of us, we wrote our joint "Mémoir sur les espaces topologiques compactes". Let me talk about our joint work on this "Memoir", and also about our life that summer.

That summer, like the one preceding it, was unusually hot and sunny. As soon as we had woken up, we used to go to the river, which was literally a few steps away from our house. We took with us a large amount of black bread and lightly salted butter. We had plenty of it (we received an "academic" ration). On this food we lasted until about 3 or 4 p.m., spending all this time on bathing and on mathematical work, which consisted of the speculations of each of us separately, and conversations between us (that is, joint mathematical thinking); we also went boating (about which more later). Our conversations about mathematics took place most frequently while we were walking along the river bank. It also happened that we spent the whole day going by boat towards the Obraztsovskii Pond. This pond, with its thickets of reeds and large number of water lilies, seemed to us marvellous, the eighth wonder of the world.

As I have said, we used to go back home at 3 or 4. There we made and drank strong coffee with milk (with it we had bread, butter, and cheese). Then we made ice cream; we had a freezer, and our landlady supplied us with milk and eggs in abundance, in return for the entire meat portion of our rations. During the lengthy operation of making ice cream we again talked, chiefly about mathematical subjects.

As I have said; we went boating on the Klyaz'ma quite often, usually rowing to the Obraztsovskii Pond. We did not have a boat of our own, and we had to ask for permission to use the boat of V. E. Fomin, a neighbour of ours in the *dacha*, who was professor of histology at the University of Moscow, and the father of the famous (now deceased) mathematician, Sergei Vasil'evich Fomin (who was then five years old). In our conversation with Fomin we referred to Egorov who, we said, would probably give us a recommendation.

A few days later Professor Fomin reported to us that he had spoken to Egorov and that he had told him the following about us: "as mathematicians they are good but I don't really know whether they can be trusted with a boat." Despite this somewhat doubtful recommendation, Professor Fomin

allowed us to use his boat freely, and we made full use of it. But we did not sink the boat or break the oars.

A troublesome episode took place in our lives at about the end of July. Uryson came down with malaria, which he had obviously caught in the area the previous summer when staying in the Luzitania *dacha* near Bolshevo. There was a lot of malaria in the neighbourhood of Moscow during the two hot summers of 1921 and 1922, and Bolshevo was reputed to be an especially malarial spot. The doctors (members of Uryson's family) ordered him to leave our *dacha* and categorically forbade him to bathe or go out in the sun (and we were used to do these things all day long). Uryson equally categorically refused to submit to these orders and began to take massive doses of quinine every day (certainly not less than a gram a day, perhaps even more). He said that by maintaining a constantly high concentration of quinine in his blood he was guarding against a repetition of the attack. In fact, the attack was not repeated during that summer or later. As before, we kept to our established way of life. I have forgotten to add that in the evenings we often went to the opposite bank of the Klyaz'ma to visit the Luzitania *dacha*, which was still in existence in the summer of 1922.

That summer I wrote one more paper, on the equivalence of the concepts of the Denjoy and the Perron integral. I wrote this paper between lunch (which consisted of coffee and ice cream) and our evening excursion to the opposite bank of the Klyaz'ma. The summer of 1922 was in my life a period of the same sort of exceptional uplift as seven years earlier during the summer of 1915. I again felt myself to be a mathematician; I did mathematics with delight and with excitement, and I was happy.

This excitement lasted into the following winter. Late in the autumn of 1922, Uryson and I proved our general metrization theorem, and during December of 1922 and the first month and a half of 1923 I wrote the text of our joint "Mémoir sur les espaces topologiques compactes". The editing was my responsibility, but, of course, Uryson (who spent almost as much time at my house as at his own) took his share in the editorial work. We discussed it during our night-time walks, which had become our usual activity after concerts to which we went almost every evening as before.

In November 1922 I first met Andrei Nikolaevich Kolmogorov. He was then 19 years old and a student; he came up to me and told me in general outline about his remarkable and important paper, "Opérations sur les ensembles". The notebook with an account of this work was soon handed over to Luzin, who had it until 1924, when Egorov sent it to the "Matematicheskii Sbornik" for publication.

In the winter of 1922–1923 Uryson came up with the plan for us to go abroad to Göttingen the following summer. We needed money for the journey and decided to earn it. (At that time the "purple" monetary system had been introduced, and Soviet money could be freely exchanged for foreign currency; one needed only to have something to exchange.) We began to earn money by

giving public lectures on the theory of relativity. We gave a cycle of four lectures and repeated it two or three times in different auditoria in Moscow. We also gave these lectures in Voronezh, Smolensk, and I think somewhere else as well. The lectures were successful everywhere, both morally and materially, and provided us with the money we needed for our journey.

Early in May 1923 we left for Göttingen. We were the first Soviet mathematicians to go abroad. We were given the warmest possible welcome in Göttingen. We went to visit Klein and Hilbert, Landau, Courant, and Emmy Noether. Everywhere we were welcomed most cordially. In the afternoon of one day, when I was at home, I had an attack of malaria: the summer at Bolshevo had made itself felt, but a year later in my case than in Uryson's. While I was having this attack I was not quite clear-headed and did not quite understand when our landlady came in and told me that Herr Geheimrat Hilbert had invited us both to supper the next day. I began at once to take massive doses of quinine and continued to do so throughout the summer and autumn of 1923. I never had another attack of malaria during my life. The day after my attack we went to supper with Hilbert. This first invitation was followed by many more, to visit Hilbert, and also Courant, and Landau.

Our stay at Göttingen was very interesting mathematically. We attended lectures regularly: Hilbert on intuitive geometry, Landau on analytic number theory, Courant on the equations of mathematical physics. Hilbert's lectures were absorbing, as an outline of a large area of mathematics, which he gave in an inspiring way, with a large number of individual remarks, always interesting, often witty, and sometimes profound. Superficially the lectures were not strong. Hilbert spoke badly and could not draw even the simplest figure. Once he wanted to draw an ordinary rectangular parallelepided. He tried to do so, without success, and finally he turned angrily on his assistant (who that summer was Bernays) and said to him, "Well, what are you sitting here for? Make yourself useful!". Bernays got up and (also without much sparkle) drew the ill-starred parallelepided. These lectures by Hilbert were later published as a book "Anschauliche Geometrie", which won wide fame. When the question of publishing the book came up in about 1930, Hilbert suggested that I should write a short supplement on topology. But I was not able to limit myself to the very compressed form of a supplement, and instead I wrote a short separate monograph, which I wrote and published, with a Preface by Hilbert, under the title "Einfachste Grundbegriffe der Topologie".

Landau gave his lectures more successfully, putting into practice his own rule "Good lecturing means not standing helplessly by the blackboard, but explaining all the proofs so that every member of the audience will understand". Landau's lectures were interesting, clear, and at the same time so thorough that it was easy and pleasant to take notes. From these lectures I not only learned analytic number theory (of which until then I had had practically no knowledge), but I also mastered the theory of functions of a complex variable, insofar as it is necessary for number theory. All in all, attending

Landau's lectures was of great benefit to my general mathematical development.

Courant's lectures did not have the virtues of Landau's, and as they concerned an area of mathematics that was remote from my own, they did not particularly enthrall me. Of all the lectures I heard in Göttingen that summer, the apex were Emmy Noether's lectures on general ideal theory. As is well known, foundations of this theory had been laid by Dedekind in his famous paper that was published as the eleventh supplement to the edition of Dirichlet's lectures on number theory under Dedekind's editorship. I was well acquainted with this paper by Dedekind: Egorov always required good young mathematicians to include it in their course of study for the master's examinations. Emmy Noether always said that the whole theory of ideals could already be found in Dedekind and that all she had done was to develop Dedekind's ideas. Of course, the basis of the theory was laid by Dedekind, but only the basis: ideal theory, with all the richness of its ideas and facts, the theory that has exerted such an enormous influence on modern mathematics, was the creation of Emmy Noether. I can judge this, because I know both Dedekind's work, and the fundamental work of Emmy Noether on ideal theory.

Her lectures enthralled both Uryson and me. In form they were not magnificent, but they conquered us by the wealth of their content. We constantly met Emmy Noether on a relaxed basis and very often talked to her, about topics both in ideal theory, and in our work, which had caught her interest at once.

Our acquaintance, which we struck up quickly during that summer, became much deeper the following summer, and later, after Uryson's death, became a close mathematical and personal friendship between Emmy Noether and myself until the end of her life. The last manifestation of this friendship on my part was a speech in her memory, at the meeting of the Moscow International Topology Conference in August of 1935.[1]

Uryson and I gave talks at meetings of the Göttingen Mathematical Society. They were successful and afterwards Hilbert suggested that we should prepare a short exposition of our main results for publication in the "Mathematishe Annalen". In response to this suggestion we wrote four short papers, which were printed in the volume 94 of the "Mathematische Annalen".

For some years Hilbert had been in charge of this principal German mathematical journal, which had relegated Crelle's famous "Journal für die reine und angewandte Mathematik" to second place. However, the official editor of the "Mathematische Annalen" was still Klein, and his assistant in editorial matters was Alexander Ostrowski, who had studied at the same time as V. N. Delone and O. Yu. Schmidt at the University of Kiev, but after the

[1] This speech is published in Uspekhi Mat. Nauk, no. 2 (1936) and is reprinted on p. 234 of the second volume of my collected works, and also in the journal "Matematika v shkole", 2 (1965), 65–69.

Revolution had gone to Germany, where he was so successful that he became a Privat-Dozent, first at the University of Hamburg, and then at Göttingen, despite the fact that one could always tell from his German that he was Ukrainian born.

As was in order, Uryson and I handed the manuscripts of our papers to Ostrowski. He did not like them and kept them without any action until our next visit to Göttingen in May 1924. This in turn displeased Emmy Noether, who insisted that our papers should be sent immediately (it was already June 1924) to Brouwer, as the member of the editorial board in charge of topology. Brouwer gave his favourable opinion of these papers both to Emmy Noether and to Hilbert. She brought to Hilbert's attention the fact that the papers, already approved by him, had lain for a year without action. Hilbert summoned Ostrowski, and a conversation between them took place in the presence of Emmy Noether, from whom I learned this whole story. Ostrowski began to explain to Hilbert why he considered our papers unsuitable for the Annalen. Hilbert interrupted him and said sharply: "Mr. Ostrowski, I am not interested in your opinion of the papers I have recommended, but I want to know why they have not yet been printed." To this Ostrowski replied, embarrassed: "I am sorry, Herr Geheimrat, I did not understand you correctly at first".

The papers were printed quickly and came out at the end of the year, with the following footnote by the editors: "During the printing of these papers, the editors received the shocking news of the death of Paul Uryson".

At the end of the Göttingen summer semester, in the first days of August, Uryson and I went on a trip to Norway, the only long journey we managed to take together.

First we went by sea from Hamburg to Stavanger. Our plan then was to walk from Stavanger to Molde, more or less along the meridian from south to north; but later we abandoned our plan for walking the part of the proposed route between Sogne Fjord and Nord Fjord, and we went from the one fjord to the other by means of a roundabout second sea journey, in a steamer on its way to Bergen. The fact is that we did not have shoes in which we could have crossed the large glacier on that part of our walking tour. But even with this departure from our original plan we walked approximately 500 kilometres in 25 days, an average of 20 kilometres per day, not only on foot but barefoot. True, in our rucksacks we each had a pair of low Moscow city shoes, in case we needed them, but the only time we wore them in Norway was when we returned by train from Molde to Oslo. There was no snobbery in our walking barefoot: even in the summer of 1922 we had worn shoes only when from time time we interrupted our country life by going to Moscow on some urgent business. We were therefore, accustomed to walking barefoot, and it seemed quite natural to us. We were not afraid of the stoniest ground, or of forest, or of stubble.

Our whole walking tour through Norway was one continuous delight for us. Uryson had planned the route carefully, with a Baedeker, and every evening we arrived at a country inn, where we had supper, spent the night, handed in our

linen for washing in the evening, and put it on, clean, the next morning. When we had eaten breakfast and taken sandwiches for the journey, we set off again. The sandwiches served us for lunch. All these country inns were as simple and unassuming as could be, but immaculately clean, and the food in them was also simple, but nourishing and of good quality.

Norway, or at least the part of it through which we walked, was full of lakes with clear but even in summer very cold water. It was no trouble for Uryson to choose our route so that we came across at least one lake a day, if not more, so that no day went by without a swim. Several times we came out to the sea: we bathed in Hardanger Fjord, in Sogne Fjord, and in Nord Fjord. All this was very cold bathing. Only in Molde Fjord, where we arrived at the end of our journey, was the water a little warmer. Molde Fjord is a fjord only in name; actually it is a wide shallow bay, which only becomes a narrow strait where it joins the sea. The water in it is well warmed in the summer. There we spent the whole final day of our journey, we bathed to our heart's content, and we warmed ourselves in the sun, almost as we had done, a year before at the Obraztsovskii Pond. We then went by night train to Oslo, and from there first by steamer to Hamburg, and then to Göttingen.

We stayed in Göttingen the whole of September without seeing any mathematicians: it was vacation time, and they had all departed in different directions. But the remarkable Göttingen University Mathematical Library (the world-famous Lesezimmer founded by Klein) never closed, and we spent hours there every day. We also did our own mathematics. In particular, during that September I proved my theorem about G_δ-sets, which I count among my best results in general topology. I finally completed the proof in Moscow, where we returned at the beginning of October.

Moscow life went on as usual, differing little from the way it had been the previous summer. For Uryson and myself it consisted of mathematics; of concerts, with walks to follow them; of regular bathing, which continued until the middle of November (later in the winter we went swimming only occasionally, not every day). I remember that once, during some long drawn-out Luzitania birthday celebration, we bathed for a bet in the Moscow river, at 2 a.m. on a December night. All the Luzitanians were present and began at the last minute to try to dissuade us (there was a snowstorm and altogether it was bad wintery weather.) But we honestly fulfilled the commitment we had accepted, and the bathing took place in full, but of course, the swim did not last very long.

In our work on general topology we had a great deal of moral support from Egorov. Luzin had once said that he considered the theory of topological spaces to be a part of mathematics of little interest and quite useless, like ideal theory. Egorov had objected strongly and even a little sharply, saying that he had always regarded ideal theory as important and necessary, and that he felt the same way about the theory of topological spaces. With that the conversation had ended. Uryson and I dedicated our "Mémoir sur les espaces

topologiques compactes" to Egorov, and this dedication is printed on the first page of the original French edition of this "Memoir" and was reproduced in the preface to the Russian edition, which was published as a separate monograph.

As I have mentioned, Eiges moved to Moscow during the first years of the Revolution. Gradually he began to combine his regular job as a mathematics lecturer at one of the Moscow technical colleges with work at the Lenin Library, in its manuscripts section, where he worked on material relating to Chekhov. Chekhov became one of Eiges' main passions, and he did much work on a comprehensive study of Chekhov, his biography, and his creative work. Eiges soon got to know all the prominant specialists on Chekhov. They regarded Eiges with great respect and valued highly his contribution to the study of Chekhov.

Eiges was very fond of his sister Ekaterina and felt the failure of her family life deeply. But at no time in my life did I either hear or feel in his behaviour towards me even a hint of reproach in connection with this. Eiges' attitude towards me remained just as warm and cordial until his death in April 1944. And I cherish and will cherish to the end the memory of Eiges as one of the people nearest and dearest to me.

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PAGES FROM AN AUTOBIOGRAPHY

P. S. Aleksandrov

Part Two[1]

By the spring of 1924 Uryson and I had decided to organize a topology seminar, and in May 1924, before our departure for Göttingen, the first organizational meeting of this seminar took place.

Following the pattern of Egorov's seminars, ours, when it opened, consisted of several groups. The first group was devoted to the topology of continua, and Chersakov was an active member (I do not remember the other members of this group.) The second group, which was purely a study group, was concerned with the topology of surfaces and did not take part in the later work of the seminar. This was also true of the fifth group (which included Efremovich among its members) whose task it was to study, under Uryson's leadership. Poincaré's basic work on combinatorial topology. The fourth group, of which L. A. Tumarkin was an active member (I have again forgotten the others), was to study dimension theory. The core of the whole seminar was the third group, which dealt with abstract topology (the theory of topological spaces). Its members were the founders of our small friendly collective: Vedenisov, Tikhonov, and Nemytskii. The "abstract group" also developed friendly relations with Kolmogorov through common interests (travel, old Russian architecture, etc.)

Not one of the groups of the topology seminar managed to meet in the spring of 1924; the seminar began its work only in September 1924, after Uryson's death and under my leadership. Other coleaders of the topology seminar only made their appearance many years later. At present they are Smirnov, Arkhangel'skii, Lokutsievskii, Pasynkov, Ponomarev, Sklyarenko, Fedorchuk, Filippov, and Shchepin.

And so, in May 1924, Uryson and I went to Göttingen for a second time. There we met the main Göttingen mathematicians, whom we knew from the previous year. Among them I must first of all mention Courant and Emmy Noether who gave us a warm welcome, as old friends. We were also welcomed with great warmth and cordiality by the Göttingen mathematicians of the older generation, Landau, Hilbert, and even Klein, about whose stand-offish inaccessibility we had previously heard so much, but which we in relation to

[1] Part One is in Uspekhi Mat. Nauk 34:6 (1979), 219–249 – Russian Math. Surveys 34:6 (1979), 267–304.

ourselves, did not notice either on our previous visit in 1923 or the present one in 1924.

We were soon on quite informal terms with Courant. Knowing that Uryson and I both loved music, he invited us to one of the musical evenings that often took place at his house. Courant himself played the piano, his wife played the violin and cello with ease and also sang Schubert and Bach. The Courants also had two regular visitors: Hans Lewy (violin), one of Courant's students, and now a famous mathematician, a professor at the University of California at Berkeley, Stefan Cohn Vossen (piano), a young geometer already well-known at the time, who spent the last part of his life in Leningrad, where he died of pneumonia in 1936. Only once did Uryson and I manage to be present at a musical evening at the Courant's, I became acquainted with the musical riches of the Courant household only during my later Göttingen years, 1925–1932.

Before long, and more than once, we were invited to dinner by Hilbert and by Landau. We were constantly meeting Emmy Noether on her famous walks, which were first called algebraic and after our arrival came to be called topological algebraic. There were always many young mathematicians taking part in these walks, which were a model for the topology walks of our Moscow topology seminar, but of quite a different character. We could also meet Emmy Noether and Courant almost every day at the university swimming pool (mainly for students) on the river Leine (see below). There we could also often meet Hilbert but not Landau (who, when I asked him whether he bathed, replied, "Yes, every day, in my bath at home".)

Uryson and I spent the Göttingen summer semester of 1924 in a pleasant and interesting way, participating fully in the lively and absorbing mathematical life of Göttingen. And although we were sorry to bid farewell to that life, we left Göttingen on 15 July, that is, about two weeks before the end of the semester, to stay first with Hausdorff (in Bonn) and then with Brouwer, who lived in the village of Blaricum, about 30 kilometers from Amsterdam.

Both Hausdorff and Brouwer welcomed us with exceptional kindness and warmth. In Bonn we went every morning to bathe in the Rhine and swam across it and back. These swims lasted not less than three hours altogether. The Rhine is wide at Bonn and its current is very swift. Every time we swam across it we were carried several kilometers downstream by the current, and then had to make up for these kilometers by walking along the bank. As Hausdorff (unsuccessfully) tried to convince us, this swim across the Rhine was not without its dangers, as there were steamers and barges along the Rhine (true, not in such numbers as nowadays). We spent the whole of the second half of the day, from lunchtime until late in the evening, with Hausdorff, mainly in mathematical discussions, which were very lively and interesting indeed.

After a week's stay in Bonn we went to visit Brouwer and stayed in his immediate neighbourhood until the end of July. Brouwer asked us with great insistence to come that autumn at the beginning of the winter semester (middle of October) and to spend a whole year with him.

On one of the last two days of July we went first to Paris and then to the sea at Brittany. Our plan had been that we would spend about a week in Paris, but then, under the influence of our persistent conviction (especially mine) that "La mer est plus belle que les cathédrales" (Verlaine) this period was shortened to a single day. Nevertheless, Uryson managed during that one day (we arrived in Paris early in the morning) to take us both to the Louvre and to Notre-Dame, where we even climbed onto the roof and saw the famous gargoyles. But in my memory of that day in Paris (the first in my life) I retain not the gargoyles or the Mona Lisa, still less the Venus de Milo, but the evening that we spent in a room in a small hotel, directly opposite the Sorbonne on, I think, the fourth floor, in any case on a level with the garret of the Sorbonne. Our room had a balcony. We went out. It was late on a warm evening at the very end of July. The whole of Paris stretched out in the fading evening glow. And then a garret window opposite us opened, and out of that window came music, someone was playing a Beethoven piano sonata. The Beethoven sonata, the sunset, and the streets of the Latin quarter beneath us, all this formed the strongest impression of my first visit to Paris. Since then I have been in Paris many times and have spent more hours than one in the Louvre and have seen and come to love many things in that truly great city. But I have forever kept in my memory that first and last evening I spent there with Pavel Uryson.

Early next morning we took the Paris–Le Croisic train to the southern seaboard of Brittany and arrived at the penultimate station on this line, the small fishing village of Batz. We deliberately chose to stay in this at the time quite neglected nook, unknown to anyone, for which we searched ahead of time in Baedeker and which Uryson was never to leave. Nowadays, Batz is a well-known and crowded resort, but then, more than half a century ago, it fully met our needs. There was the ocean, its granite shore . . . and nothing else. In Batz we walked by the sea, selecting the wildest parts of its stony shore, we swam endlessly and besides we did mathematics. It was there that Uryson wrote his famous paper on countable connected Hausdorff spaces, containing many new ideas. I wrote my paper on the topological definition (by means of a special combinatorial spectrum) of an n-dimensional sphere. There by the sea we spent a little over a week. Around 9 August we went to spend about four days in the extreme west of Britanny, in Finisterre, on the cape Pointe du Raz (which is the most western point of France). When we returned on 13 of August from our trip, which had made a very strong impression on us (the ocean and its shore are even more awesome and more majestic at Finisterre than at Batz), the manager of the boarding house where we had been staying at Batz told us that unfortunately he had given the room we had occupied to other guests, but he had other accommodation for us, which we would, of course, like better: a very small house consisting of only one room, right by the shore, so that the spray from the waves would come into our room through the window. He showed us our new room and we were pleased with it; it was indeed a one-room cottage, right beside the sea. We moved in that very day and

by early evening we were living in it, sitting on two adjacent sides of a huge square oak table, which together with two chairs and two camp beds comprised all the furniture of our new abode. Spray from the waves really did come into our new room, and we liked it. On the evening of 14 August, Uryson finished his paper on connected countable spaces, this is the date of the paper.

Meanwhile the roughness of the sea was gradually increasing, and our swims on 15 and 16 August became more and more interesting. On 17 August in the morning when as usual we started work, Uryson began to write a new paper "Zum Metrizationsproblem." It contains the proof of his well-known "great lemma", and the proof, based on this lemma, of the metrizability of all normal spaces with a countable base. Uryson had time to think out the whole paper (it is not long) and to write its first page out neatly. The main part of the day was spent on work, and in spite of our custom it was already five o'clock in the afternoon when we got ready to go swimming. When we got into the water, a kind of uneasiness rose up within us; I not only felt it myself, but I also saw it clearly in Pavel. If only I had said, "Maybe we shouldn't swim today?" But I said nothing . . .

After a moment's hesitation, we plunged into a not very large shore wave and swam some distance into the open sea. However, the very next sensation that reached my consciousness was one of something indescribably huge, which suddenly grabbed me, and this sensation was accompanied by the rather absurd but quite precisely formulated thought: had this wave come to me all the way from Venezuela to no useful purpose here? A moment later I came to myself on the shore, which was covered with small stones – it was the shore of a bay, separated from the open sea by two rocks between which we had had to swim as we made our way to open sea. I had been thrown over by a wave, right across these rocks and the bay. When I was on my feet, I looked out to sea and saw Pavel at those same rocks, already in the bay, passively rolling on the waves (which were comparatively small in the bay) in a half-sitting position. I immediately swam up to him. At that time I saw a large group of people on the shore. (It was a Sunday, and many people from various places had come to Batz to admire the sea.) After swimming to Pavel, I put my right arm around him above his waist, and with my left arm and my legs I began to paddle to shore with all my might. This was difficult, but no one came to my assistance. Finally, when I was already quite near the shore, someone threw me a rope, but within a few moments I reached land. Then eye-witnesses told me that the same great wave that had thrown me across the bay had struck Uryson's head against one of the two rocks and after that he had begun to roll helplessly on the waves in the bay.

When I pulled Pavel to the shore and felt the warmth of his body in my hand, I was in no doubt that he was alive. Some people then ran up to him, and began to do something to him, obviously artificial respiration. Among these people, there happened to be, as I was later told, a doctor, who apparently directed the attempts at life-saving. I do not know and did not know then how

long they continued, it seemed like quite a long time. In any case, after some time I asked the doctor what the condition of the victim was and what further measures he proposed undertaking. To this the doctor replied "Que voulez vous que je fasse avec un cadavre?"

As I now remember, the only thought that entered my mind when I heard these words was that the word "fasse" is the "présent de subjonctif" form of the verb "faire" and that our French teacher at my school had often asked us for this form and for the subjunctive in general.

Some more time passed, and I went into my room and finally dressed. (Until then I had remained in my swimming clothes.) Pavel Uryson lay on his bed, covered by a sheet; there were flowers at the head of the bed. It was here that I thought for the first time about what had happened. All my experiences, all my impressions of that summer, and indeed of the last two years, rose up in my consciousness, with such distinctness and clarity. All this merged into a single awareness of how good, how exceptionally good, things had been for each of us, only about an hour ago.

And the sea raged. Its roaring, its crashing, its bubbling, seemed to fill everything.

The next day, I sent telegrams to Brouwer, and to my brother Mikhail Sergeevich, in Moscow, whom I asked to tell the Uryson family about what had happened. That same evening I received in reply a telegram from Brouwer with the words "Appelez-moi où vous voulez." I asked Brouwer to come to Göttingen, where I planned to stop for a few days on my way to Moscow.

The funeral was on 19 August. In the belief that it would accord with the wishes of Uryson's father, I asked a rabbi to perform the funeral rites. As far as the funeral itself is concerned, I remember the huge number of people who came to it, the pile of living flowers on the new grave, and the noise of the sea, which could be heard even in the cemetery. On 20 August I left Batz and after stopping in Paris for a day I arrived in Göttingen on the 22nd, where Brouwer, Courant and Emmy Noether awaited me. Hilbert and Klein asked me to come and see them. This was my last meeting with Klein. He died in the summer of the following year.

At the very beginning of September I returned to Moscow. Stepanov and Kovner, who had been in Göttingen before that, arrived together with me. In Moscow I took up residence with the Urysons and stayed with them until the end of 1929. The small room I occupied in their flat was also the meeting place of my seminar groups. However, the meetings of the third (abstract) group of the seminar were later held in the large dining room in the flat of Vedenisov's parents.

I spoke of the Urysons' flat. In fact, this was the flat of Pavel's sister, the children's writer L. S. Neiman (who later published her reminiscences of her brother), and her husband Dr. S. M. Neiman. In this flat, next to me behind a plywood partition, in a room much smaller even than mine, lived Uryson's nephew Misha, then 18 years old, who is now the famous jurist M. S. Lipetsker

with whom I am on friendly terms to this day.

My seminar worked intensively throughout the winter of 1924–25. Of all the members of its first group it was Andrei Nikolaevich Tikhonov who stood out for his striking mathematical talent. Soon he began to think about a difficult problem: is every normal space a subspace of a bicompactum? Tikhonov's reflections on this problem led him not only to an affirmative solution but also to several other fundamental topological discoveries. The first of these was the concept of what is now called the Tikhonov cube I^τ of a given weight τ (where τ is an arbitrary infinite cardinal number), that is, of a topological (Tikhonov or Cartesian) product of τ copies of the ordinary real interval $I = [0, 1]$, and it was in this connection that the concept of the topological product of any (uncountable) number of topological spaces was first introduced into mathematics. Here Tikhonov proved the remarkable fact (Tikhonov's first theorem) that the product of any number of bicompact spaces is bicompact and that if there are τ topological spaces, each of weight not exceeding τ, then the weight of their product is τ. From this it follows that the Tikhonov cube I^τ is a bicompact Hausdorff space of weight τ. As it turns out, it also contains a topological image of every normal space of weight τ. However, a subspace of a bicompactum need not be normal: Tikhonov defined a class of spaces wider than that of normal spaces, which he called completely regular and which are now generally called Tikhonov spaces, and he proved, concerning this class that it is precisely the same as the class of subspaces of bicompacta (bicompact Hausdorff spaces). This is Tikhonov's second theorem. Tikhonov spaces of weight $\leqslant \tau$ can also be defined as topological images of subspaces of a Tikhonov cube I^τ of weight τ, that is, those that can be described by means of τ coordinates. Not for nothing are Tikhonov products also called Cartesian, one of the rare cases where a flattering comparison turns out also to be true. Various trends in modern general topology have their origin in Tikhonov's theorems: for example, the theory, on which so much work is being done today, of bicompact extensions of topological spaces; and also the Tikhonov topology in function spaces. Statistical investigations have shown that among all the theorems of general topology Tikhonov's first theorem holds first place for the number of citations.

With the beginnings of the theory of bicompact topological spaces, uncountable cardinal numbers received, so to speak, an active right to citizenship in topology. Along with that, the transfinite mathematics about which Hilbert loved to speak so much and so inspiringly as of a Garden of Eden opened up to us by abstract set theory began to be filled with concrete mathematical substance. Tikhonov's work raised our mastery of this Garden of Eden to a completely new level. Tikhonov cubes of uncountable dimension with their faces, the projections onto them, the factorization of continuous maps associated with them – all this became the beginning of a new uncountable-dimensional geometry with Shchepin has at present begun to construct, supplementing by a completely new and original uncountable-dimensional topological geometry, the countable-dimensional topology of the Hilbert cube and Hilbert manifolds, which has been developed so richly in recent decades.

At the time when Tikhonov made his topological discoveries, he had just reached the age of twenty. I do not know whether he realized to any extent the full significance of the results he had obtained, or whether he was particularly interested in this. It would be hard to imagine a more disinterested, I could say naive, love for mathematics than Tikhonov's during those years. The basic features of his character were modesty, a warm benevolent sense of humour, and exceptional gentleness and good nature. He was always in good spirits, and everyone found it pleasant to be in contact with him. This is how I remember Tikhonov in his early youth.

Among the other members of the abstract group was Nikolai Borisovich Vedenisov, who after obtaining several good mathematical results and making a successful start in university teaching went to the front at the very beginning of the Second World War and was killed soon after.

Nemytskii's mathematical interests directed mainly towards problems on the border between abstract topology and the qualitative theory of differential equations. His research in this area resulted in the famous joint paper by Nemytskii and Stepanov on the qualitative theory of differential equations and also in his numerous special courses at the University of Moscow. Nemytskii was a keen traveller. He died while travelling in the Sayan mountains in August 1967. His last words were, "The stars have come out in the sky; tomorrow we can go further."

Nemytskii was a man whose heart was pure and completely without taint. One rarely meets people like him, and a bright image of him remains in my memory.

At the very beginning of my seminar in the autumn of 1924 Lev Abramovich Tumarkin started on active work in the field of dimension theory. His research went in parallel with the work of Hurewicz, but independently of him. These two authors together wrote a very important new page in dimension theory, directly carrying on from the fundamental work of Uryson and Menger. Brouwer valued Tumarkin's papers very highly, and immediately published them in the Mathematische Annalen.

At the beginning of the thirties, Tumarkin began teaching at the University of Moscow with great enthusiasm and also became involved in public work, having joined the Party. He was quickly appointed Dean of the Faculty and became a prominent figure in our University's mathematical teaching. He fulfilled all his duties eagerly, paying attention to substance rather than formality.

For very many years Tumarkin gave a basic course in analysis in the Faculty of Pure and Applied Mathematics at the University of Moscow; he delivered his lectures in an austere but very comprehensible manner. Many generations of first-year students in our faculty have received a solid foundation for their mathematical education from Tumarkin's lectures.

The administrative work which Tumarkin carried out in the faculty was splendid. It is no exaggeration for me to say that it was under Tumarkin's deanship that the Faculty of Pure and Applied Mathematics at the University of Moscow acquired its present structure.

Tumarkin was a kind man who was fond of his students and, above all, treated them without formality. The students fully repaid him for this. They loved to be examined by him, though Tumarkin made no unnecessary allowances at all and always demanded of his students that they take their work seriously. Tumarkin's long-lasting deanship was a good period in the history of our faculty.

At the beginning of May 1925 I went on my own to visit Brouwer. Then began the three-year period in my life, from May 1925 to October 1928, which I divided between Holland and Göttingen and also included a winter (1927–28) which I spent in Princeton, U.S.A.

As I have already said, Brouwer lived in the village of Blaricum, where he had a house with a fairly large, completely overgrown garden, and in that garden there was a small one-room cottage in which there was a desk, a piano, and a bed. In this cottage Brouwer lived, worked, and played the piano. Brouwer's wife was considerably older than he and resided permanently in Amsterdam, where she managed her own chemist's shop. She came quite often to Blaricum and then stayed in the "big" house. Corrie Jongejan, Brouwer's adopted daughter, also lived permanently in the "big" house, devoting her whole life to him and tirelessly helping him with all his scientific, university, and other activities, which added up to a lot, were always complicated, and often very intricate. In May 1925 I joined this complicated household.

I took up lodgings in the house of Frau van de Linde, a close friend of Brouwer and of Corrie Jongejan. The two ladies were about the same age (between 30 and 32) and were friends. I boarded with Frau van de Linde, who kept to a strictly vegetarian diet, which in Holland was very easy because of the abundance of a variety of vegetables and of excellent milk products. Brouwer often (not less than once a week) invited me to lunch. He ate absolutely no meat, but sometimes small portions of fish. I constantly met Brouwer, sometimes several times in a day. We spent a lot of time together, working on Uryson's papers. The proofs of the first part of his long monograph on dimension theory was printed in "Fundamenta Mathematicae". Moreover, using the rough drafts I had kept after Uryson's death, I wrote the second part of this monograph, which was later published in the Transactions (Verhandelingen) of the Amsterdam Academy of Sciences. Brouwer and I read together every page of the proofs and every page that I had written of the text of the second part, sometimes making small editorial corrections and, here and there, amending my French.

Thus, the time passed until the end of June. I spent the first half of July in Holland, at the seashore. First I walked along the shore itself, then into the water (I was going barefoot), then along the firm sand from Scheveningen (near

The Hague) to Zandvoort (near Amsterdam). I then went to the small seaside village of Katwijk (near Leyden), where I stayed for about 12 days. The present Dutch Queen Juliana, then still the Crown Princess, and a student, I think, at the University of Leyden, was staying at that time in a small villa in Katwijk. I reminded her of this when she welcomed me, along with several other mathematicians, who were members of the 1954 International Congress of Mathematicians in Amsterdam.

I spent the rest of July in Göttingen, where on Hilbert's suggestion I gave a long survey lecture on general topology to the Mathematical Society. The lecture was successful. I spent August in Batz. Uryson's father was also there for one month and every day spent the hour between 5 and 6pm (the hour of his son's death) on the seashore, near the place where the disaster had occurred. That month, which I spent in Batz, had great significance for my whole future mathematical life. Here, among the rocks on the seashore, at the place where Uryson and I had so often gone swimming, becoming tanned and discussing mathematics, the idea came to me of the nerve of a family of sets, a fundamental idea in all my later work in topology. It was then that I realized that the nerves of infinitely refining finite covers of a compactum approximate infinitely closely to this compactum and enable us to reduce the investigation of its topology to that of a sequence of finite simplicial complexes. When I realized this, I immediately settled down to write a new paper "Simpliziale Approximationen . . .", on which I worked so assiduously that there was one day when I did not even find time to go bathing. Thus, during August 1925 I wrote my new long paper, as it were in one go and immediately sent it to Brouwer. He was very pleased with my paper, he wrote a letter about it to me in Batz and sent the paper for publication in "Mathematische Annalen."

In September I went travelling on a walking tour in the Pyrenees, which was somewhat modelled on the one Uryson and I had made in Norway in 1923. My journey along the Pyrenees ended in the small seaside town of Collioure on the Mediterranean, which is in France, but quite near to the border with Spain.

At the very end of October I returned from Collioure to Batz. Two or three days after my arrival Brouwer also came and we spent the whole first week of November there, after which we returned together to Blaricum. At that time Vietoris and Menger were already there and had also come to spend the whole winter with Brouwer. After returning to Blaricum, I wrote a paper on continuous decompositions of bicompact spaces, which took me not quite two weeks, and then he and I went back to our work on Uryson's manuscripts. Besides that, at Brouwer's suggestion I gave a course on general topology at the University of Amsterdam. Menger also gave a special course on dimension theory. Both Brouwer and Vietoris attended these courses regularly.

My winter of 1925–1926 in Holland went by pleasantly and peacefully, with constant important work, but emotionally I was still completely under the shadow of the heavy loss that I had suffered a year before. On Sundays Brouwer, Corrie Jongejan and I went to Amsterdam to symphony concerts,

which were conducted by the famous Mengelberg, often with famous guests. For example, Stravinsky came once and conducted his "Rites of Spring."

In the middle of December Emmy Noether came to spend a month in Blaricum. This was a brilliant addition to the group of mathematicians around Brouwer. I remember a dinner at Brouwer's in her honour during which she explained the definition of the Betti groups of complexes, which spread around quickly and completely transformed the whole of topology.

When Emmy Noether arrived at Blaricum, her student van der Waerden, who was then 22 years old, also came. I remember extraordinarily lively mathematical conversations in which he took part. During that winter Menger, using the concept of a nerve, proved that every one-dimensional compactum can be topologically embedded in a three-dimensional Euclidean space, which is the simplest particular case of the famous general theorem, which was proved some years later by Nöbeling and Pontryagin, about the embedding of an n-dimensional compactum in a $(2n + 1)$-dimensional Euclidean space.

In the spring of 1926 I went to Göttingen and spent the whole summer there. During that summer and the next one the mathematical life in Göttingen was in a state of rapid growth, partly owing to an influx of outstanding foreign mathematicians. During that summer I made friends with Hopf and Neugebauer, and since both these summers as well as the winter of 1927–1928 are described in detail in my reminiscences of Hopf (Uspekhi Mat. Nauk 32:3 (1977), 203–208 = Jahresb, Deutsch. Math. Ver. 78:3 (1977)), I will not concern myself here with that period of my life. After the summer of 1928, which I also spent in Göttingen, I went to the International Congress of Mathematicians in Bologna. At the end of this congress Hopf, Neugebauer and I spent some time in Italy on the shores of the Mediterranean. I then visited Emmy Noether in Venice and returned to Moscow in the middle of October.

In 1928 the Göttingen Academy of Sciences at the suggestion of Hilbert and Courant elected me as Corresponding Member to replace V. A. Steklov, who had died recently. I was told that there was a tradition according to which the Academy always included one Russian mathematician among its Corresponding Members. The first of these had been Lobachevskii, who was elected on Gauss's recommendation. I do not know whether this tradition really existed, nor do I know which of Russia's mathematicians were members of the Göttingen Academy during the period of time between Lobachevskii and Steklov.

In 1928 Pontryagin became my student and at once and for a long time was the brightest luminary in the topological firmament. In that year Pontryagin's first paper was published in the Transactions of the Göttingen Academy. This paper and the ones that immediately followed it formed, as it were, the doorway to Pontryagin's paper published in 1932 in the Annals of Mathematics in which he expanded his famous duality law, which inaugurated an entirely new era in the development of topology.

Also in 1928 Tikhonov's first and fundamental paper on products of topological spaces was published in the Comptes Rendus of the Paris Academy of Sciences.

At the end of 1928 or the beginning of 1929, the Moscow topology school was enriched by two "temporary" members, who remained for something like three years and then moved on to other areas of science. They were Feliks Isidorovich Frankl and Aleksandr Gennadievich Kurosh.

I came to know Frankl in Bologna during the International Congress of Mathematicians in September 1928, which Frankl attended as a young topologist and a student of Hahn. Frankl took a great interest in the new approach to dimension theory I had presented in my address to the Congress. We had conversations that were extraordinarily lively and interesting to us both. Frankl's enthusiasm infected me (it was, as I have said, inspired by my recent work) and our topological conversations became so lively and interesting that neither of us went on the excursion to Florence planned by the Congress, and we spent the whole free day in an open-air swimming pool at Bologna conversing about mathematics. Frankl and I arranged to meet in Vienna at the end of September, and we did spend some days there at his parents' house and also on the Danube. There we went boating a lot, sometimes rowing, sometimes sailing (which was well organized on the Danube) and, of course, went swimming equally often. Frankl's father owned a very small factory in the Vienna area, and the whole family lived there. This did not prevent young Frankl from being not only an enthusiastic mathematician, but also an enthusiastic communist. These two enthusiasms led to a burning desire to move from Vienna to Moscow. As a young mathematician and topologist, he wanted to become my student and, of course, I too liked the idea of acquiring a student who was so undoubtedly talented and so enthusiastic. Naturally, Frankl asked me to help him realise his wishes, and I sent this request to O. Yu. Schmidt. Schmidt's first reaction was, "We have enough communists of our own; let him stay in Vienna and start a revolution in Austria." But he soon softened and actively helped Frankl to move to Moscow, an event that took place in 1929.

In Moscow Frankl soon made the acquaintance of Pontryagin, who was four years younger than he; they immediately developed mutual topological interests, which resulted in a very interesting joint paper on dimension theory published in the "Mathematische Annalen." One can only guess what further successes Frankl would have achieved in topology if he had continued to work in this field. But for ideological reasons he switched to applied mathematics.

Kurosh began to study mathematics under my supervision at Smolensk, first as an undergraduate and then as a research student at the University of Smolensk. At Smolensk I gave a long algebra course in which apart from the obligatory material I presented the fundamentals of modern algebra (the theory of groups, rings and fields.) I brought all these new ideas from Emmy Noether. By the way, I think that it was in my Smolensk lectures that the term "kernel of a homomorphism" was used for the first time in history. In print this term first appeared in 1935 in the algebraic supplement to the book "Topologie" by myself and Hopf. I am using this opportunity to remind algebraists of this fact.

Kurosh was an excellent and very keen student at my Smolensk lectures. In the following year he moved to Moscow and became my postgraduate student at the University of Moscow.

Kurosh's algebraic interests, which had already shown themselves strikingly in Smolensk, developed even more under the influence of the lectures Emmy Noether gave in Moscow throughout that winter. But these interests of Kurosh's did not prevent his first scientific paper from being about topology. This first and only topology paper by Kurosh was his classic paper on projection spectra, which was published in "Compositio Mathematica", which at that time was edited by Brouwer.

During the winter of 1928–1929 my topology seminar flourished. It was also the time of my intensive work on "Aleksandrov-Hopf".

At the end of January 1929 I was elected a Corresponding Member of the Academy of Sciences of the U.S.S.R.

The summer of 1929 was notable as the beginning of my friendship with Andrei Nikolaevich Kolmogorov. As I have mentioned, we met in the autumn of 1922, but our friendship began with a long trip we made in the summer of 1929.

On the morning of June 16 we set out in a rowing boat down the Volga from Yaroslavl'. Kolmogorov's school friend Nikolai Dmitrievich Nyuberg, who later became (under Kolmogorov's influence) an outstanding specialist in floriculture, also took part in this journey, but only as far as Kazan'. We sometimes rowed and sometimes went under a primitive home-made sail. Kolmogorov was in charge of all the navigation, I only rowed. All in all, we moved quite quickly and reached Samara (now Kuibishev) in a little less than a month. It goes without saying that we had no motor.

Our journey did not pass without adventures – minor and not so minor. Once a big box of pastry and a portable typewriter we had taken with us plunged into the Volga. But all ended happily, and the typewriter still serves me faithfully and has not once been sent for an overhaul (a good advertisement for the old Remington firm).

From Kuibishev we went by steamer to Astrakhan and from there, also by steamer, to Baku, and then, partly by bus, partly on foot, across Delizhan to Lake Sevan, where we spent about a month on the island in what had formerly been a monastery. This island no longer exists; it has joined the mainland. At that time the Sevan was in its full glory. We bathed several times a day in its cool limpid waters. We also did a lot of work; in particular, I worked on "Aleksandrov-Hopf" (the typewriter was always with me.)

From Armenia we went to Tbilisi, there we parted, but we both set off for Gagry, I by train, Kolmogorov walking across the Tseiskii Glacier. It was at Gagry (where Pontryagin, with whom we were in constant touch, was living at the time) that we spent the whole of September swimming and doing mathematics, and we returned to Moscow at the beginning of October.

At the beginning of the winter of 1929–1930 Kolmogorov, his aunt Vera

Yakovlevna (who had taken the place of his mother), and I took up lodgings together at the country estate of Klyaz'ma. It was there that I constructed my homological dimension theory. I wrote my memoir "Dimensionstheorie", containing an account of this theory, a year later in Göttingen, and it was published in 1932 in the "Mathematische Annalen." At Klyaz'ma I began to go skiing with Kolmogorov and under his instruction (until then I had only skied a little, in felt boots, on the hills near Smolensk at the age of 14). We also went swimming every day at Klyaz'ma, from early spring until our rivers of Klyaz'ma and Ucha froze over. During the Klyaz'ma winters we read a lot of Hoffmann and other German romantics and also of Anatole France (all in the original).

Our stay in Klyaz'ma was interrupted by several journeys we took together, both in the USSR by river, and abroad. On these journeys we went by canoe along the Tsna and the Desna (from Bryansk to Kiev) and by boat from Kiev to Dniepropetrovsk. I will say more about our trips abroad.

In May 1930 Kolmogorov and I went to Göttingen for the summer semester, and from there to France via Munich early in August. In France we made a long journey on foot, through the south-eastern part of the country, which eventually led us to Toulon. For several weeks we stayed near Toulon in the village of Sanary by the sea. Fréchet was on holiday there at that time, and we had long and frequent meetings with him throughout our stay in Sanary. There I worked quite hard on "Aleksandrov-Hopf" and Kolmogorov did mathematics. At the end of our stay by the Mediterranean we went first to Batz, where we stayed for some time, and then to Paris, where Kolmogorov stayed, while I after stopping for a few days left for Göttingen.

Kolmogorov, after a short time in Paris, caught a cold and in November came as an invalid to visit me in Göttingen, where on Courant's advice and with his assistance he was placed in Professor Straub's therapeutic clinic. To this day I do not know whether what he had was a severe bronchitis or pneumonia.

We spent a little over two months in Göttingen while Kolmogorov was convalescing (during that time he stayed at the famous Kreuznacher boarding house and I at Neugebauer's house). In Göttingen we got together, frequently and on a regular basis, with Göttingen mathematicians, most of all with Courant (and I also met Emmy Noether very often), but also with Hilbert and Landau. We were sometimes invited to Landau's house for a (usually very grand) supper, one feature (and the main attraction) of which was an enormous dish of lobster. The guests were asked to demonstrate their skill at eating these arthropods. Kolmogorov was awarded first prize, as he managed his portion of lobster without even once touching it with his hand, and using only knife and fork.

At the beginning of February I went to America, to Princeton, where I had been invited to give lectures for the whole spring semester. Harald Bohr received a similar invitation and we got to know each other very well during the time we spent together at Princeton. Of all the mathematicians whose lectures I have attended, Bohr in my opinion occupies unquestionably the first place as

a lecturer, for the clarity, organization, and unusual transparency of his lectures.

In June 1931 we returned to Moscow, Kolmogorov from Göttingen and I from Princeton, and set off for Teberda, where Nemytskii and Tikhonov were also staying at that time. The famous pianist K. N. Igumnov (see below) was also on holiday there.

In August 1932 I went to Zurich for the International Congress of Mathematicians, where I met Hopf and stayed with him throughout the Congress. Hopf was by then already a professor at the Eidgenössische Technische Hochschule as successor to Hermann Weyl and was to remain in this post until his death in 1971. In September Hopf went to visit his parents in Germany and I went to the south of Switzerland, where I spent a whole month in the small town of Ascona on the banks of Lago Maggiore. Hausdorff and his wife were on holiday in Locarno at that time and we saw each other every day (it is a short walk from Locarno to Ascona.) The Hausdorffs walked it more than once, and I took them in the rowing boat that was at my constant disposal (it was amazingly light). During these boat rides and especially when swimming I had only to take care that I did not suddenly find myself in Italy (the border between Switzerland and Italy is somewhere in the middle of Lago Maggiore), which in my case was entirely "non-trivial". The Hausdorffs and I had an exceptionally good time. Our parting was all the sadder, though we did not know then that it was to be forever.

From Switzerland, after spending some more time with Hopf (who had, by this time, already returned to Zurich), I went back to Göttingen, where I stayed until the end of November with Emmy Noether, giving lectures at the university and meeting the Courants almost every day. But in November 1932 clouds were already thickening over Germany. Often I was woken in the morning by the sounds of "Deutschland, erwache." This was sung by the young people of the "Hitler-Jugend", as they marched up and down the streets. It was clear that things were about to happen and that it was time for me to go home. The day of my departure finally arrived. As I have said, it was at the very end of November. I spent my last day in Göttingen making farewell visits. Emmy Noether accompanied me. We went first to the Landau's; then to Hermann Weyl's; then we were invited to the Hilbert's for coffee at 5 o'clock. I never saw Hilbert or Weyl or Landau again. I was invited to a farewell supper at the Courant's at 8 o'clock. Courant's closest mathematical friends were there – Neugebauer, Friedrichs, Lewy, and, of course, Emmy Noether.

My train was to leave at 5 a.m. and it was decided that all the people assembled at Courant's house should spend the whole night with him and that we should then all set out for the station together. After a very long drawn-out supper we had a musical evening, which chiefly consisted of the Schubert trio in E-flat Major. It was played by Stefan Cohn-Vossen (piano), Hans Lewy (violin) and Frau Courant (cello). All three played superbly, with a great uplift. I had always loved this Schubert trio, but after this performance on my

farewell night in Göttingen it came to occupy a special place in my appreciation of music and altogether in my consciousness and my life. Finally we went through the dark avenues of Göttingen by night to the station, and I left. I never saw Emmy Noether again, so that this parting was also forever. In 1933 she left for America and died there after an operation on 14 April 1935. Neugebauer and I have also never met again, but we have always corresponded and we correspond to this day. I have met Courant again many times, in Moscow (the last time in 1970) and in Göttingen.

In 1958 once again as before I spent a whole summer semester in Göttingen: I was offered the very honourable Gauss professorship for that semester, and there I met those of my old Göttingen friends who were still alive. In the summer of 1958 Courant took me, as before, in his car to the River Weser, and we both swam across it. This was not easy. The river was completely swollen after several heavy rains, and its current was swift. Courant had reached the age of 70 a few months earlier and I must confess that during this swim I was rather worried about him (swimming was, as a matter of fact, not at all easy.) But all ended well. Courant then treated me to a very tasty meal at a country inn and we went back to Göttingen.

My Gauss professorship in Göttingen during the summer of 1958 was my last long trip abroad. As a matter of fact, my last series of trips abroad began with my journey to Paris at the beginning of the summer of 1954, where together with A. A. Markov I represented our Academy of Sciences at the celebrations organized by the Paris Academy on the occasion of the centenary of Poincaré's birth. During these celebrations I saw Brouwer for the last time in my life. I also met Hadamard and his wife for the last time. When we parted, Madame Hadamard said to me, "I am 88 years old, but nevertheless I will say 'Au revoir'." Unfortunately we never did see one another again. In August of 1954 the International Congress of Mathematicians took place in Amsterdam (and partly in the Hague.) Kolmogorov, Nikol'skii, Panov, and I were members of the Soviet delegation. We had all been invited to give one-hour talks. Two lectures were given not in the usual auditoria for one-hour lectures, but in the famous Concertgebouw (one of the largest in Western Europe). This honour was conferred on Kolmogorov and John von Neumann. A special final session of the Congress (which took place at the Hague) was devoted to the Poincaré centenary. There I read a long paper with the title "Poincaré and topology".[1] The paper, which I read in French, was successful. After it Poincaré's son (a general in the French coastal service) kindly treated me to champagne.

At the next International Congress (in Edinburgh in 1958) I was selected as a representative of the USSR on the Executive Committee of the International Mathematical Union. Hopf was at that time elected President of the Union, and Denjoy and I were elected Vice-Presidents. For this reason I went several times

[1] Russian translation in Uspekhi Mat. Nauk 27:1 (1972), 147–158 = Russian Math. Surveys 27:1 (1972), 157–168.

during the following four years to Western Europe and met those of my friends who lived there. These four years ended with the International Congress of Mathematicians in Stockholm in 1962. This was followed by the Congress in Moscow, one of the most brilliant of International Congresses of Mathematicians (it has remained so in the memory of many of those who participated in it.) The president of the organizing committee of this congress was Petrovskii, and his scientific secretary was V. G. Karmanov. The Moscow Congress was the last one in which I took part.

In the spring of 1968 I went to Holland for a week. Throughout that week I was the guest of Freudenthal in Utrecht. At the ceremonial opening of the new building of the Utrecht Mathematical Institute I gave a lecture "Die Topologie in und um Holland," a Russian translation of which was published with the title "*Brauerovskii period v razvitii topologii*" ("The Brouwer period in the development of topology.") I visited Blaricum and spent a few hours there in the company of Corrie Jongejan and Frau van de Linde. Corrie Jongejan and I visited Brouwer's grave; he had died on 2 December 1966 at the age of 85, when he was run over by a car a few steps from his home in Blaricum; Corrie Jongejan died in December 1968, also in Blaricum, after being ill throughout the summer and autumn.

My most recent trips abroad were in 1970, 1971, and 1974. These were three journeys Mal'tsev and I made together. The first in June 1970 was to West Germany: to Frankfurt (where I bade goodbye forever to Hopf), Münster, and Göttingen. The second in November 1971 was to Zurich, where I took part in the memorial meeting for Hopf which was held on his birthday, 19 November. The third and final journey was again to West Germany: to Bochum, where we enjoyed Zieschang's hospitality; to Frankfurt; to Heidelberg; and once again, most important of all, Göttingen. Göttingen was the first foreign town I ever visited. It was also the last. I had come full circle. After my return to Moscow from this journey, I was ill for several days, and with that illness began the period of my old age in which I am today.

As I have already said, I met Hausdorff for the last time by the Lago Maggiore in the autumn of 1932. During the winter of 1932–1933 we carried on a lively correspondence at first. Then Hausdorff began to write to me more and more rarely and after some time it became clear to me that it was not safe for him to receive letters from me. Our correspondence ceased. At the beginning of 1942 Hausdorff learned that he was liable to be sent to a concentration camp, and in February of that year Hausdorff and his wife committed suicide in their home in Bonn.

In the 30's, Aleksei Serapionovich Parkhomenko and Igor' Vladimirovich Proskuryakov became my students. Proskuryakov and I have a joint paper which I value highly, on the so-called reducible sets. Parkhomenko, after writing some interesting papers on a class of continuous maps, the so-called contractions (that is, one-to-one continuous maps) began to switch more and more to teaching work with first-year students. In this teaching activity, to

which in my old age I also began to devote more and more energy, Parkhomenko became my closest colleague and collaborator, and this contributed to the development of a close friendship that has bound me to Parkhomenko now for several decades. It was my habit constantly to consult Parkhomenko about difficult problems of my life connected with my work and with the lives of my younger students and thereby also with the most varied aspects of my personal life.

In 1934, after the Presidium of Academy of Sciences moved to Moscow, I became a member at the Steklov Mathematical Institute of the Academy of Sciences of the USSR, where I am still working in one of my several positions.

In 1934 Kolmogorov became the Director of the Institute of Mathematics at the University of Moscow. After taking this post he was not only in charge of all the mathematical life of the university, but also of the training of all the young postgraduate students (and the senior undergraduates) at the university.

One of his first administrative steps as Director of the Institute in the area of international mathematical contacts was a plan to set up a whole series of international conferences on various branches of mathematics. Only the first two links of this broadly conceived chain of conferences came into being: a conference (in 1934) on differential geometry and tensor analysis, with V. F. Kagan as president of the organizing committee, and in 1935 a topology conference under my leadership – the first international topology conference ever to take place. Both conferences were successful and were big events in the international mathematical world. They attracted many outstanding mathematicians. Participants in the conference on differential geometry included, for example, Elie Cartan, Blaschke, Schouten, and Hlavaty. Papers were presented to the conference by the Soviet mathematicians, Bogolyubov, Kolmogorov, Pontryagin, Tikhonov, and others; and by the foreign mathematicians Alexander, G. Birkhoff, Borsuk, André Weil, Knaster, Kuratowski, Lefschetz, Mazurkevich, Nöbeling, von Neumann, Neilsen, de Rham, Sierpiński, M. Stone, Whitney, Heegaard, Hopf, Čech, and many others.

In 1935 Kolmogorov and I bought a house in Komarovka, which remains in our possession to this day. This house had been the property of Anna Sergeevna Alekseeva, a sister of K. S. Stanislavskii (she was married first to Shteker and later to Krasyuk). Anna Alekseeva's property was, in fact, managed and disposed of by her son by her first marriage Georgii Andreevich Shteker, with whom the business of its transfer to new owners was also conducted. Among the new owners, apart from Kolmogorov and myself, was Vladimir Ivanovich Kozlinskii, an artist whose best-known works include, on the one hand, some theatrical productions in Leningrad and Moscow (including the Bol'shoi theatre in Moscow) and, on the other hand, numerous book illustrations.

Kozlinskii and his wife Marianna Mikhailovna Knorre (also an artist), Kolmogorov and I were good neighbours in the Komarovka house and lived in

peace and friendship in that house for 15 years until 1950, when Kozlinskii's share in our joint ownership of the house was transferred to Kolmogorov. From that day on Kolmogorov and I have been the sole owners of this house.

When she sold it to us, Anna Alekseeva kept for herself the right to the lifelong use of one of its rooms. But she did not make use of this right for long. She died in 1936.

The house in Komarovka deserves to have some lines devoted to it. One part of it was built in the 1820's by the Naryshkins, and the other part in the 1870's by the Alekseevs who owned it then. A summer extension (two-storey like the rest of the house) was build in 1912, also by the Alekseevs. For a long time the outstanding Russian actress Mariya Petrovna Lilina (K. S. Stanislavskii's wife) loved to stay in this extension during the summer.

When we acquired the house in Komarovka, Anna Alekseeva was already 68 years old. In her face one could see signs of former great beauty, in particular, features that resembled those of her brother Stanislavskii. In her youth Anna Alekseeva had also been an actress and had appeared at the Arts Theatre under the name of Aleeva. In 1935 she was already coming to the sunset of a life rich in experiences, acquaintances, and emotions, about which the Alekseev family said that if a book had been written with the title "My life near art", it would have been no less interesting, although in a different way, that Stanislavskii's "My life in art". Anna Alekseeva's close friends included the great conductor Arthur Nikisch. To the end of Anna Alekseeva's life a large portrait of Nikisch stood on her desk with his autographed sentiments in German. Nikisch had died in 1922. He had given concerts in Moscow in 1913–1914. The portrait dated from that time. Once Anna Alekseeva's son played the countess scene from "The Queen of Spades" on the piano. When he reached the famous song of the countess, Anna Alekseeva came towards the piano from the side, and leant over it pensively, lost in memories. There was something of which this music had reminded her.

In the Alekseevs' time and, in particular, throughout the first decade of the present century, Komarovka was a sort of branch of the Alekseevs' main country estate Lyubimovka, about a kilometer from Komarovka in the direction of Tarasovka. Komarovka was linked to Lyubimovka by a well-worn footpath, which was always kept in good condition and is still in existence today; at the beginning of the century it was freshly sanded every day; it was there that Elizaveta Vasil'evna Alekseeva (Stanislavskii's mother) took her morning walk each day. A small forest between Komarovka and Lyubimovka on the Lyubimovka side bordered on a small park in which the Alekseevs' great manor house stood on the banks of the River Klyaz'ma. In that same house K. S. Alekseev-Stanislavskii, his brother Vladimir Sergeevich, and his sisters Anna Sergeevna and Lyudmila Sergeevna were born. The house, which is now in a state of decay and consists of a number of neglected communal flats and separate rooms, was visited by many outstanding representatives of Russian literary, theatrical, and musical culture; above all, by Chekhov and Gorkii, Sobinov, Shalyapin, and many others.

In the last years of her life, in her extreme old age, Ol'ga Knipper-Chekhova once came to Komarovka and asked Kolmogorov and me to let one of the rooms of our house to her for the summer. At that time, our household was already quite complicated and we thought that to add a new person to it, who required as much attention and care as Olga Knipper-Chekhova at her age, would be very difficult. And although it was unpleasant to refuse her request when she spoke of memories dear to her, we were nevertheless unable to grant her wish.

Between 1935 when we acquired the Komarovka house and 1939 we made a series of capital repairs. The house needed thorough repairs from top to bottom, which took up a considerable portion of our time, energy, and resources for a few years.

The organizer and to a considerable extent the performer of this work, involving carpentry and joinery, was P.A. Kapkov (he subsequently changed from being a carpenter to being a joiner and cabinet-maker and made our cupboards not only in Komarovka but in our Moscow flats). He was an honest and very competent, I would even say, talented man. In his work as a carpenter, he was helped by his son Lev, who later became a good surgeon and got an M.D. In August 1935 our repair work had only begun, but the Komarovka house, which was then in a state of great disorder, had already had its first overnight guests. These were the Hopfs, who had just come to Moscow for the topology conference.

At the end of the topology conference, the Hopfs, Kolmogorov, and I went to Gaspra in the Crimea, where we spent about six weeks. Here Hopf and I first of all completed our work on our book and wrote the Preface. Kolmogorov and Anna Evgen'evna Hopf (a Baltic German, née von Mikwitz, who had been educated at the St. Petersburg high school in Tsarist times and spoke fluent Russian), went on an excursion to Ai-Petri. The latter part of our stay in the Crimea (about a month) was intended to be for us all simply a holiday, but it was clouded by my short-lived, but quite serious illness (paratyphoid). I took my illness lightly and on the first day on which doctors allowed me to get up, I went bathing in the sea. After the Crimea, the Hopfs went back home to Switzerland, not without adventures on the way (a brief arrest while passing through Germany), and Kolmogorov and I went back to Komarovka. I did not see Hopf again until the spring of 1950, fifteen years later, in Rome (about which, see below.)

The second half of the 30's went by peacefully in Komarovka. For a short time Kolmogorov and I studied open maps intensively, which resulted in Kolmogorov's famous example of an open zero-dimensional map that increases the dimension, and in my theorem about the impossibility of such an increase in the case of open maps of countable order. Both these results had consequences for the later development of dimension theory. As far back as 1939 I wrote in Komarovka a paper on bicompact extensions of topological

spaces, in which I gave a new method of constructing such extensions, quite different from Tikhonov's first method, which was subsequently applied by Čech. Both methods later proved to be useful and found many applications in topology.

During the summers of 1938 and 1939 Kolmogorov and I went on two wonderful boat trips with Mal'tsev and Nikol'skii, the first from Krasnoufimsk to Ul'yanovsk, along the rivers Ufa, Belaya, Kama, and Volga, and the second along the middle Volga. During the second half of the 30's Kolmogorov and I went almost every year to Batiliman (in the Crimea) where I made friends with A. I. Alikhanov. This friendship was originally based on our mutual love of music and of long swims in the sea. It was also in that place and at that time that I got to know the violinist Slava Roshal', who married Alikhanov soon afterwards.

In 1939 Kolmogorov was elected to the Academy, but at once he developed a serious and complicated illness. After his recovery, he was swept by a whole ocean of new and responsible duties (he was elected Academic Secretary of the Department of the Physical and Mathematical Sciences and automatically became a member of the Presidium of the Academy). He handled all these duties efficiently and well, and his influence over the whole of mathematics and our country's science in general grew remarkably. There was also, of necessity, a very unfavourable result: Kolmogorov resigned as Director of the Institute of Mathematics at the University of Moscow.

In 1939 Zhenya Mishchenko, a mathematically enthusiastic schoolboy then aged 17, now a Corresponding Member of the Academy of Sciences of the USSR, came to Komarovka for a few days. He was soon called up into the army and went to the front (first for the Finnish War and then for the Second World War), taking with him the mathematics books he had been given in Komarovka. At the end of the war Mishchenko was demobilized only after a certain amount of trouble in which I was involved: he was a model officer, highly regarded by the authorities, and they tried in every possible way to persuade him to stay permanently in the Soviet army. But his burning love for mathematics, which made itself manifest in his earliest youth, proved stronger than all their persuasion and he was demobilized.

Immediately after his demobilization he enrolled in the Faculty of Mechanics and Mathematics at the University of Moscow and began to study mathematics with enthusiasm. He was a good student and when the time came for him to choose a topic for specialization, he became a topologist. He also did a lot of public work. When he was still in the army, he joined the ranks of the Communist Party and soon took such an active part in public activities at the university that he was elected First Secretary of the Faculty's Komsomol Organization, a position he held for several years. After completing his undergraduate courses he became my research student.

The first mathematical problem I gave him was related to my Kazan paper and, as I later realized, it was not stated properly; it has remained altogether

unsolved. The second problem required the construction of examples in connection with my duality law for non-closed sets. Mishchenko succeeded in solving it, showing in the process his inventiveness and creative mathematical ability. His result was published in "Mathematicheskii sbornik".

While still an undergraduate, Mishchenko became acquainted with Pontryagin and came more and more under his mathematical influence. But though eventually he became Pontryagin's student, I never ceased to regard him as one of my students, in accordance with my firm belief in the irreversibility of the relationship between teacher and student: once it has begun, this relationship cannot be abolished, except perhaps by a catastrophe, just as in the case of the relationship between father and son. I have always thought and still think that Mishchenko shares my point of view; there have never been any fluctuations in our relationship, which has always remained and still remains very cordial.

I remember the summer of 1950, which Mishchenko, Sitnikov, and I spent at Vasil'sursk on the Volga. We had a rowing boat at our disposal, and every day, early in the morning, we set off in it for the Volga, where we rowed upstream, with all our might, towards some place or other that appealed to us, where we would spend a few hours, swimming and reading Homer's Odyssey in Zhukovskii's translation (which I read aloud.) We read the whole "Odyssey" by the Volga that summer. I think that we all gained pleasure from it.

On returning home (usually quite late) we ate the lunch prepared by our landlady, consisting of abundant sterlet soup and often mushrooms and berries as well. In the evenings we climbed the Vasil'sursk Plateau (which is quite high) and walked through its forests, copses, and fields.

In the mid-fifties I more than once spent the better part of the summer with Mishchenko at Gelendzhik, in the Moscow University rest home. There we went on long swims and boat trips and Mishchenko also played volleyball.

In 1940, before the war, I wrote a paper "General homology theory" containing the construction of a cohomology ring of an arbitrary bicompactum on the basis of nerves. As was later proved, this ring is isomorphic to the ring directly constructed earlier (in 1936) by Kolmogorov. I knew how to construct it and was only interested in obtaining the same result by my method of nerves. This was a preparation for my 1942 "Kazan' paper", about which I shall say more later.

The war began. Kolmogorov and I were evacuated with our families to Kazan'. Kolmogorov's family consisted of his aunt Vera Yakovlevna Kolmogorova, then 78 years of age, who had to all intents and purposes taken the place of his mother, who had died when Kolmogorov was born. My household was more extensive and consisted of my 80-year-old mother, my sister Dr. Varvara Sergeevna Aleksandrova, and my mother's domestic help, who had lived with her for a long time as a member of the family.

In the middle of July we went off to Kazan' very comfortably by train and, on our arrival, we were put up in the assembly hall of the University of Kazan',

again with the maximum amount of comfort that was then objectively possible. We stayed there for about a week and then managed, with the active help of the Academy of Sciences, to find a permanent place of residence. It was with the Vil'de family, who then lived on the Akademicheskaya Street (not far from the Arskii Field.) The family consisted of the 85-year-old Al'bert Al'bertovich Vil'de (formerly the owner of a chemist's shop on the ground floor of that same house, immediately under the Vil'de's flat), his wife (about 70 years old), their daughter Nina Al'bertovna, a teacher of German, and her son Volodya, a pupil in the tenth class. This whole united and happy family welcomed us, their unexpected guests, with cordiality and hospitality, which were very precious during those hard times.

Leaving our families in Kazan' with the Vil'des, Kolmogorov and I returned to Moscow on 2 September and began to give lectures at the university, and in addition Kolmogorov fulfilled his duties in the Academy of Sciences. In Moscow I had a room in a university building on Granovskii Street and Kolmogorov had a room in the flat of Uryson's sister L. S. Neiman on Pimenovskii Lane near Mayakovskii Square. Her flat served as our common "headquarters" in Moscow. We spent practically the whole of September and half of October at Komarovka.

Late in the evening of 15 October we were told officially that we had to go back to Kazan' that night. Carrying my precious portable typewriter in my arms, I set off on foot from the house in Granovskii Street (where the order had reached me) to the Neiman flat. To this day I remember that journey across a Moscow plunged into darkness. But I do not know how I managed to cross Gor'kii Street on foot with one column of tanks after another rolling on their way to the centre of Moscow. I remember only that as I crossed this street, I struck my typewriter against a lamp post; but as it later turned out, this did it no harm, only the case kept a trace of this blow.

At the Neiman house a car was already waiting for Kolmogorov and me and soon delivered us to Paveletskii Station, where we boarded a train. In the rather crowded upholstered carriage Kolmogorov and I each had a berth, so that this journey was quite comfortable. However, the train did not take us to Kazan', but to Gorkii, from where we went to Kazan', this time by steamer. The winter of 1941 began very early and icy sludge was floating down the Volga from Gorkii to Kazan'. Then it turned out that our ship was the very last of the season. Somehow or other, we had a good voyage to Kazan', which lasted from 16 to 20 October, and we went back to the Vil'de flat, as though we were going to our own home.

On one of our first days after our return to Kazan' Kolmogorov and I walked to the Volga and went swimming in the icy river; even that year we did not abandon our Klyaz'ma. But we did not swim in the Volga again that winter.

All the housekeeping for the combined household of Kolmogorov and myself was managed by my sister Varvara Sergeevna, whose aspirations were entirely directed towards providing Kolmogorov and me with the best possible

conditions for scientific work. She combined her housekeeping activities, which under the circumstances of that time were complicated, with her work as a doctor at a blood transfusion station, and also with writing up of her dissertation, which she had begun in Moscow at the Tareev clinic. She did this in the early mornings before performing her other duties and got up every day at 5 a.m.

The fact that our lives in Kazan' went on smoothly and satisfactorily was facilitated to no small degree by the good relationship between ourselves and the Vil'des. I always remember them with warm feelings.

In March 1942 Kolmogorov after writing his famous notes on the theory of turbulence, which were published in the Doklady of the Academy of Sciences, went to Moscow. During the first winter of the war (1941–2) I was completely engrossed in writing my so-called Kazan' paper on the homological properties of complexes and closed sets. I wrote this paper both in English and Russian, so that one text was a faithful translation of the other. The Russian text was printed in the Izvestiya Akademii Nauk SSSR (1943) and was naturally regarded as the primary one. On the recommendation of Lefschetz the English translation was published in the Transactions of the American Mathematical Society – a sign of the great interest in the work because translated articles are not as a rule printed in the "Transactions."

That winter I worked with great enthusiasm; my work, as the saying goes, went swimmingly. But I had not at first been in the mood for work; the fact is that when I came to Kazan' I like everyone else was oppressed by a deep sadness, brought on by the very fact of war and aggravated by the prevailing uncertainty how events at the front would develop, whether or not the Hitler hordes were near Moscow. The general feeling among scientists was naturally that only problems connected with the war effort deserved attention. This found its outward purely material expression in the fact that mathematicians who worked on applied problems received 800 gram of bread a day, while the rest received only 600 gram. Later, after the speech of O. Yu. Schmidt that is mentioned below, this differential was abolished. It was known to everyone that I was an incorrigible theoretician, and, as the expression goes, "one couldn't expect anything from me." It only made my state of mind worse when some special attention was shown to me, and it was suggested that I should attend a seminar on applied mathematics; and when I said that I would not understand anything at this seminar, I received the answer, doubtless dictated by sincere kindness, that nobody would notice this. But I expressed my thanks for the concern shown to me and absolutely declined the suggestion made to me. My frame of mind became worse and worse and was in no way not conducive to work.

And then one fine day Schmidt, who was at the time Vice-President of the Academy and personally in charge of its Kazan' section, made a declaration to a large gathering of scientific workers at the Academy, in which he said, in particular, that in wartime the attention of scientific workers, as of citizens

in general, should naturally be devoted in the first place to the immediate needs of defence and to the achievement of victory, but that this in no way means that all the scientific work of a theoretical nature not immediately related to the war should be discontinued. He said that one thing is beyond question: in wartime one should not occupy oneself with trifles; theoretical scientists, more than ever, should take care that the problems on which they work are important and of fundamental significance for science.

This is how I remember the contents of Schmidt's speech on the subject of scientific research in wartime. Naturally, it made a great impression on me. I realized that I could work on the things on which I could really do useful work and did not have to pretend to be doing things I was not capable of doing.

Scientific workers were also supplied with food, on the basis of 800 gram of bread a day and the other provisions obtained on ration, as well as those that were from time to time distributed among the workers at the Academy by its management staff. Naturally the food supply still left something to be desired, and I do not venture to judge whether its shortcomings were caused only by the objective circumstances of wartime. Academicians and Corresponding Members were in a privileged position: firstly, they had preference in the issue of extra rations. These were managed by a certain Noi Solomonovich Gozenpud, in whose honour there are the following lines by Lazar' Aronovich Lyusternik:

An honour was conferred on me: Do not forget, today I stood
Triumphantly before Noi Solomonovich Gozenpud.

There was also a special canteen for Academicians and Corresponding Members, but it was of very poor quality. Nevertheless, nobody went hungry, although one highly and deservedly respected Academician was brought before a V.I.P. for an anthropometric measure of the size of his waist, to show how much thinner he had become in Kazan'. And then, in November 1943, all Academicians and Corresponding Members, irrespective of the place of their evacuation, were invited to a session of the General Meeting of the Academy in Sverdlovsk. During this session a banquet was held; to describe all the splendour and abundance of it one would need the pen of Homer or at least of Gogol'. Throughout the following night the medical staff of the Academy was at work, toiling tirelessly to give medical assistance to luminaries of science who had overestimated their digestive systems. To this day it makes me ashamed when I remember my part in that feast: right next to the halls where it took place our colleagues in science (even those from the University of Moscow) who were not decorated with the rank of Academician were living in that same town of Sverdlovsk on very frugal food rations.

But back to the winter of 1941–1942 in Kazan'. The mathematicians from Moscow who were in Kazan' organized a section of the Moscow Mathematical Society, which met every Tuesday, together with the Kazan' Mathematical Society. These joint meetings of the two societies were chaired alternately by their respective presidents, N. N. Parfent'ev of Kazan' and myself. When I

returned to Moscow on 1 October 1943, the joint sessions continued under Parfent'ev's chairmanship until the return to Moscow of all the members of the Moscow Mathematical Society who had been evacuated to Kazan'. But even before this, at the very end of the winter of 1942, I took the chair at the 75th anniversary meeting of the Moscow Mathematical Society, at which Krylov and Khinchin gave very interesting lectures of a general nature (on the history of mathematics).

The notable events in the mathematical world of Kazan' during that winter included the presentation of two D.Sc. theses by (the future Academicians) A. I. Mal'tsev and S. M. Nikol'skii and two Ph.D. theses by S. V. Fomin and N. A. Shanin. Mal'tsev's and Nikol'skii's theses were rounded off by "banquets", which were frugal owing to the wartime conditions, in the small garret room (under the roof of the main university building) in which the two were living. Kolmogorov and I were guests at these banquets. I still remember the comfort and cordiality of their atmosphere, and the banquets were (as our meetings were in general during that winter in Kazan') like continuations of our unforgettable boat trips, although in different sterner conditions.

The Kazan' winter was also the time of great progress in my friendship with Pontryagin. We had frequent and very pleasant meetings and conversed a great deal about the most diverse subjects. I also had very pleasant meetings with Tikhonov and his wife Natal'ya Vasil'evna. I had very frequent and cordial meetings with Abram Isakovich Alikhanov and his brother Artem, who were known among their friends as Abusha and Artyusha. Abusha's wife, Slava Solomonovna Roshal', whom I mentioned earlier as an outstanding violinist (Oistrakh rated her highly), fell ill with typhus in Kazan' and during her convalescence had to have her hair cut quite short and appeared at concerts with a black velvet beret on her head, which actually suited her very well. Besides Slava Roshal' I listened a great deal in Kazan' to the pianist Miklashevskaya; her recitals were arranged by Natal'ya Nikoaevna Semenova, who always had plenty of music around her. She herself played the piano well. I had already become acquainted at Batiliman with her and her husband Academician Nikolai Nikolaevich Semenov.

Jumping many years ahead, let me now say a few words about my last meetings with the Alikhanovs in their Moscow house, when A. I. Alikhanov was already an Academician, the Director of one of the most important Institutes of Physics. The Alikhanovs lived in a beautiful villa in the grounds of the Institute of which Alikhanov was director, in the Cheremushki, which one could enter only through a gate office with strict controls. How far removed this was from the closet under the stairs they had occupied in Kazan'! Apart from Abram Isakovich and Slava Solomonovna, their son Tigran (born in Kazan' or soon afterwards) also lived in this villa. By the time of my visit to the Alikhanovs in Moscow Tigran was already a famous pianist, a laureate of the International Competition in Paris. A daughter was also growing up and was a violinist like her mother. The house was full of music. I remember one evening

the physicist Igor' Evgen'evich Tamm (also a great music-lover) and I spent at the Alikhanovs'. After supper Tigran played Beethoven sonatas the whole evening. I especially liked his performance of the Sonata No. 5, in c minor, op. 10.1. And Slava Roshal' played beautifully Bach's violin sonata in g minor for solo violin. One rarely meets with people who love music as passionately and ardently as Alikhanov did or with as much fine music as could be heard at this house. Not for nothing had the Alikhanovs become engaged listening to a Grieg violin sonata (this was the same third sonata to which I listened when I proved my first and perhaps best mathematical theorem, in 1915).

In 1964, the centenary[1] of the Moscow Mathematical Society was solemnly celebrated. After the official session, where I presented my opening address and Kurosh gave a lecture (on the Society's last 30 years), there was a concert in the auditorium of the University of Moscow in which Slava Roshal' and Tigran Alikhanov played Beethoven's "Kreutzer Sonata" and Tigran also played the "Appassionata."

In the late 60's Alikhanov fell seriously ill. Slava Roshal' immediately discontinued her concerts, and very soon gave up music altogether, saying that now her work was not to play the violin but to nurse her sick husband. In December 1970 Alikhanov died. I was in Erevan at the time. Alikhanov's death was regarded in Armenia as a national tragedy.

Let me return to the winter of 1941–1942 in Kazan'. That winter I became well acquainted with Konstantin Konstantinovich Mardzhanishvili and his mother Nadezhda Dmitrievna Zhivokini-Mardzhanishvili, a member of the famous Zhivokini acting dynasty, different generations of which have had representatives on the stage of the Little Theatre in Moscow for a hundred years. Mardzhanishvili's father, the famous producer Konstantin Aleksandrovich Mardzhanishvili, became part of the history of the Russian theatre, even before the revolution, under the name of Mardzhanov; after the revolution he became one of the creators and one of the most brilliant representatives of the Georgian theatre.

Ever since my stay at Novgorod-Seversk and Chernigov I had been very interested in the theatre and loved it as a great independent art form, closely linked but in no way subordinate, to literature. I have always found unacceptable the point of view of some theatre lovers and actors of a literary and psychological turn of mind for whom the acting of a play is not an independent product of the creativity of actors and producers, but rather something in the nature of a collective reading of the play, with expression. My perception of the theatre as a complete independent art form was strongly supported by Mardzhanishvili's creativity as a producer. Naturally, Konstantin and Nadezhda Mardzhanishvili and I had plenty to talk about, and in our conversations the evils of the day by no means occupied the first place.

[1] The actual beginning of the activities of the Mathematical Society was in 1864; it only went through the legal formalities of registration in 1867. From this stems the discrepancy in the dates of the jubilees of the society.

I will again skip forward almost ten years. My friendship with Mardzhanishvili reached a new peak when we both travelled to Rome at the very end of April 1950 to represent the Academy of Sciences of the USSR at the 70th birthday jubilee of the famous Italian mathematician Severi. Never before or since Severi's jubilee have I seen anything comparable in splendour and magnificence (if we speak of festivals given in the honour of one particular individual). But there was also a serious aspect of these celebrations: an integral part of them was an international mathematical conference, which lasted about a week and was devoted mainly to geometry and topology.

If I am not mistaken, this was the first post-war international mathematical gathering in which German mathematicians took part. The conference was very impressive; many of the most outstanding geometers and topologists took part in it and there were also mathematicians of other specialities. Hopf also took part, and this was our first meeting after a gap of fifteen years. In the tense and at the same time hectic conditions of the celebrations it was difficult to find a suitable place and time for a friendly meeting with Hopf, and we both greatly needed such a meeting when we could tell each other all we had saved up for fifteen years. We were after all very close friends. I am truly thankful to Mardzhanishvili for actively helping us to meet under conditions in keeping with our wishes and feelings.

The mayor of Rome had arranged an official banquet in honour of Severi. He asked me to speak at this banquet and emphasized that he was making this request because I was at the head of the Soviet delegation and he hoped that my speech would be of great general interest. He added that he had made a similar request to the American ambassador, who was also a guest at the celebrations. It was 1950. The situation all over the world was very complex and I had to touch upon it in my speech. My task was all the more crucial because I received the invitiation to speak only a few hours before the banquet and had very little time to prepare it. I do not know how I would have coped with this task if it had not been for the friendly assistance of Mardzhanishvili, who gave me what I needed so much at that moment: moral support. According to the testimony of people who are for me authorities on this problem and whose opinion I value highly, my speech was successful in all respects, and this was a source of great satisfaction for me.

In every way I remember my stay in Rome together with Mardzhanishvili not only with sincere friendly feelings toward him, but also with heartfelt gratitude. These reminiscences of my trip to Italy in the spring of 1950 are put as an episode into my account of my reminiscences up to the end of the wartime winter of 1941–1942 in Kazan'.

I also spent the summer of 1942 in Kazan' mainly swimming in the Kazanka and the Volga, and resting from the strenuous work of the previous winter. That summer was darkened by a great sorrow. Volodya Vil'de, who had been called up right at the beginning of the summer after he graduated from school, was killed in the war. It was hard to be a witness to the terrible grief that

attacked the whole Vil'de family and most of all his mother Nina Vil'de. When Kolmogorov and I visited Kazan' during one of our rowing trips in the first half of the 50's and met Nina Vil'de, it was clear that the years that had gone by had not effaced her grief.

I returned to Moscow on 1 October 1942. The University of Moscow had first been evacuated to Ashkhabad (in 1941–1942) and then (in 1943) to Sverdlovsk. But a few professors (especially in the Faculty of Mechanics and Mathematics) remained in Moscow. Therefore it was possible during the academic year of 1942–1943 to set in motion the work of this Faculty even in Moscow. Students who wished to take part could be found both among young men who for health reasons had not been called up, and among girls. Somehow or other, first-year lectures were given in Moscow by Kolmogorov (mathematical analysis), Glagolev (analytic geometry), and myself (advanced algebra). There were also some specialist lectures and seminars, including mine on topology. In particular, L. D. Kudryavtsev (now a D.Sc. and Professor of higher mathematics at the Moscow Institute of Physics and Technology) participated in my seminar. Under my supervision Kudryavtsev wrote his Ph.D. thesis (on topology). A. M. Rodnyanskii (who subsequently worked at Bryansk) also submitted a Ph.D. thesis on topology, but his mathematical work was frequently interrupted by a serious illness he had contracted during his undergraduate years.

It was in February or March 1943 that I formed a really good and close friendship with I. G. Petrovskii, who had come to Moscow for a short time from the place of evacuation, where he stayed with the Faculty of Mechanics and Mathematics of the University of Moscow. During the two wartime winters Petrovskii was Dean of this Faculty and remained with it first in Ashkhabad and then in Sverdlovsk. Petrovskii had come to Moscow to find out how things were going in that part of the Faculty that had remained in Moscow. We had many occasions for discussion of university affairs, and not only of these: it was the height of the war and there were many disturbing topics. I came to know Petrovskii well, both as an outstanding university administrator and as a man of rare intellectual and moral stature. He was among those students of Egorov who had inherited all his exceptional moral strength. Petrovskii's administrative abilities, which he already showed clearly as Dean during the hard war years, reached their full strength when he became Rector of the University of Moscow, an office he held during the last 22 years of his life (1951–1973). I have repeatedly said in public lectures that in my opinion the most remarkable of the many outstanding Rectors in the history of Russian universities were N. I. Lobachevskii, Rector of the University of Kazan', and I. G. Petrovskii, Rector of the University of Moscow. I was lucky enough to be in continuous close contact with Petrovskii in connection with a wide range of professional, social, and personal questions, during the last two decades of his life, and whenever I think of this association, I always remember it as the most valuable of the second half of my life.

Throughout the winter of 1942–1943 Kolmogorov and I lived mainly in Komarovka and usually spent only two or three days a week in Moscow. We would return from Moscow to Komarovka late in the evening: first to Tarasov or Bolshevo Station by the local train, and from there on foot, usually with heavy rucksacks (we got most of our provisions from Moscow).

During my stay in Moscow that winter I ate lunch at the Scientists' Club (on Kropotkinskii Street.) The lunches were very good (there was no comparison with the Kazan' lunches) but they proceeded with strict respect for rank. For example, for hors d'oeuvres the Academicians had Cracow sausage, while the Corresponding Members had Poltava sausage. Apropos, I have even remarked that without questioning the validity of hors d'oeuvres for distinguishing between academic ranks, as regards serving them with different kinds of sausage I consider that from the point of view of Soviet patriotism the Academicians should be served the native Poltava sausage, and the Corresponding Members the foreign Cracow sausage.

The famous pianist Konstantin Nikolaevich Igumnov also ate at the Scientists' Club (as a People's Artist of the USSR he was on a level with the Academicians and we treated him to Cracow sausage). I often met him at the Club and frequently we had lunch together. But Igumnov and I also used to meet at concerts in the Great and Small Halls of the Conservatory. He always attended good concerts and quite often performed in them himself. I tried not to miss good concerts when they took place on days when I was in Moscow. After a concert we often went to my Moscow flat on Granovskii Street, drank tea with jam, which I always had there, and sometimes sat up talking until late.

I had made Igumnov's acquaintance long before, in the summer of 1931, at Teberda, where he was staying in a sanatorium, and where Kolmogorov and I came on our return from abroad (with my typewriter on which I diligently typed Hopf's and my joint book). Kolmogorov and I then set off from Teberda to spend about two weeks at the Badukskie lakes, not far away in a forest in the mountains. There the two of us stayed in a tent in the dense forest and cooked our meals over a bonfire, as we had done earlier at the time of our Volga trip. Once a severe thunderstorm broke out during the night. I have kept forever the memory of the peals of thunder and their repeated reverberations in the mountains. On the evening after our return from the Badukskie lakes Igumnov gave a concert for the people staying at the sanatorium. Before his performance he said that unfortunately he did not know of any piano piece devoted to the Badukskie lakes, and so he would play Liszt's "On Wallenstadt lake" in our honour. To conclude he played Tchaikovsky's "Lullaby" at my request. Afterwards Igumnov stayed with us several times in Komarovka often at the nearby sanatorium "Pine forest".

On the 2 December 1947 Igumnov gave the last concert of his life. The programme, as I remember, was unusually extensive. It included Beethoven's 7th Sonata, Chopin's Sonata in C-minor, Tchaikovsky's Great Sonata, and many other compositions by Lyadov and Tchaikovsky. That enormous

programme was quite exceptional. But Igumnov was indefatigable that evening, as though he foresaw that this was to be his last public performance. He played endless encores and was endlessly called. Finally, the lid of the piano closed and the lights were turned off, but the audience did not disperse. I too did not leave but stood right by the platform, literally two steps from the piano. Igumnov then opened the piano again, sat down, and played Tchaikovsky's "Lullaby." Then, he himself closed the lid and slowly walked in the direction of the artists' room. The concert was over.

Playbills were hanging in the vestibule of the conservatory, announcing a forthcoming chamber music concert a few days later in which Igumnov was to play the piano part in Tchaikovsky's trio "Memories of a great artist." But this concert did not take place.

Two days after the concert at the Great Hall which I have described I learned that Igumnov had come home quite ill. At first pneumonia was suspected, but this diagnosis was later changed. The illness was obviously lengthy (it lasted nearly four months). The patient was fully conscious and talked readily to the people close to him, but he was very weak. He spent most of the time lying down, though sometimes he went up to the piano and played for a short while. Next to his bed stood a table on which lay the score of Bach's "St. Matthew's Passion" and a book of Tyutchev's poetry. Both were, as he told me, his constant reading. During those months of Igumnov's illness I often visited him, sometimes travelling to Moscow especially for the purpose. I also brought him milk from the cow that belonged to our neighbour in Komarovka. The milk was really good and, in Igumnov's words, had a beneficial effect on him.

Our frequent meetings were very cordial and our relationship during the last months of Igumnov's life took on the character of a true friendship. But although we had many lengthy conversations during my frequent visits, it was clear that his strength was failing. All the best therapeutists of Moscow were called in to treat him. Nevertheless, none of them succeeded in establishing a definite diagnosis. Finally they agreed that there was a malignant disease of the blood (leukaemia). Igumnov understood the seriousness of his condition and often said that it was time for him to prepare "for a long journey." Being a religious man, he received the church sacrament, but obtained only transitory relief. Finally it was suggested to him that he should go into hospital and he agreed. He invited his students and ordered champagne to be served, saying that he would of course not return from the hospital and that he wanted to say goodbye to them.

In the hospital (the so-called Kremlin department of the Botkinskii hospital) he had two severe haemorrhages, as though to confirm the diagnosis at which the doctors had finally arrived. His condition deteriorated rapidly, and after spending only a few days in hospital he died on 28 March 1948. But the true diagnosis of his illness was only established at the post mortem. Igumnov had died of pulmonary tuberculosis. I did not attend his funeral (I was ill at that time.) But a short time later I went to some beautiful concerts dedicated to his

memory. Some years afterwards at a supper with the Alikhanovs I sat next to another of our great pianists, G. G. Neigauz, and the conversation turned to Igumnov. I told Neigauz that I had once asked Igumnov why he had ceased for some time to play the Skriabin concerto, which had formerly been part of his repertoire. Igumnov replied that he had played that concerto before Neigauz's arrival in Moscow, and after hearing him he had realized that Neigauz played the concerto better. When I told Neigauz about this conversation with Igumnov, he said in his somewhat rapturous manner, "Oh, he was a great musician" and began to shed tears.

In March 1943 Yu. M. Smirnov – then simply Yura – was sent from Stalingrad to Moscow. He began to stay in Komarovka all the time, and became firmly and deeply a part of our lives. Yura first appeared in Komarovka late in the autumn of 1940 and often stayed with us during the first half of 1941. He was then an undergraduate student in the Faculty of Mechanics and Mathematics of the University of Moscow. He had first chosen astronomy as his speciality and even built quite a good telescope for himself. He was also a first-rate wireless enthusiast, and this was soon to play an important role when Yura was called up. This only happened at the end of 1941, and until then Yura was in September and the first half of October still simply an undergraduate student, diligently and successfully putting out the incendiary bombs that were then falling in quite large quantities, in particular on the University observatory on Presnya Street, where Yura spent much of his time in the evenings (during the day he attended lectures).

On the night of 16 October Kolmogorov and I went to Kazan', as I have said above, and Yura Smirnov was very soon called up and assigned to the Northern Navy as a wireless operator. He spent quite a long time in the Navy, including a spell in hospital with pneumonia, if I am not mistaken. He was then sent to Stalingrad in the middle of the winter of 1942/3, also as a wireless operator. From there he came to Moscow as I remember in March 1943.

Throughout the spring and early summer of 1943 he was serving in Moscow, spending most of his free time in Komarovka. That whole part of the 'Komarovka period" in the lives of Kolmogorov and myself bears the seal of the large and varied part that Smirnov played in it.

That summer he was again sent to the Front, once again as a wireless operator, and this time to Kursk, to the famous Kursk bulge. After only a short time, when the rate of our progress towards victory was quickening noticeably and victory itself was not far distant, Smirnov was again sent to Moscow, as wireless operator in the railway department. In Moscow or to be more accurate in Komarovka Smirnov began to study mathematics seriously, which had replaced astronomy as the subject of his scientific interests. Smirnov's first paper, written jointly with A. A. Petrov, had a computational-algebraic nature, was concerned with probability theory, and was written under the supervision of Kolmogorov, who persistently and earnestly hoped to attract Smirnov to the field of applied mathematics in the broad sense of the word, considering

incidentally that Smirnov's recognized qualification as a first-rate wireless operator would favour such a development of his scientific interests. But Smirnov's yearnings were in the direction of abstract mathematics; he became a topologist and soon was a distinguished representative of the Moscow school of general topology. Smirnov was the first member of the second generation of my students: apart from him there were O. V. Lokutsievskii and K. A. Sitnikov, each of whom enriched topology with first-class results.

With Smirnov's extensive and productive scientific activity in mind, which by the spring of 1945 was fully and unquestionably determined, Kolmogorov and I took steps to get him demobilized in the middle of May 1945, after the victory of the USSR. With that aim we visited Krylov and asked his advice. He received us very favourably and there and then wrote an appropriate letter to the People's Commissariat of the Navy. He took this letter personally to the People's Commissar. As a result there followed an order from the People's Commissariat of the Navy: Smirnov, Yu. M. of the Red Navy is to be demobilized and put under the direction of P. S. Aleksandrov, Corresponding Member of the Academy of Sciences, for scientific work. To this day, the copy of this order that was sent to me remains in my possession, and a portrait of Krylov hangs in the dining room of my Komarovka house, next to the portraits of Egorov and Igumnov.

During the first two-post-war winters of 1945–1946 and 1946–47, I wrote first a paper on the dimension of normal spaces and then my long paper on the duality laws for non-closed sets, which was printed in *Matematicheskii Sbornik*. This paper absorbed me completely as my "Kazan" paper had done earlier, and "Gestalt und Lage" and "Dimensionstheorie" earlier still. No wonder that I consider these four papers to be my best on general homological topology. On Pontryagin's initiative I gave a long lecture on the duality of non-closed sets at the general meeting of the Division of Physical and Mathematical Sciences (the secretary of this division was then A. F. Ioffe). Pontryagin told me afterwards that he considered this work, and that on the homological dimension theory to be my best papers, and this made me very happy. I too was pleased with the new paper, and although I was very tired from the lengthy process of writing it, I was in a mood of great enthusiasm, just as five years before when I had finished my "Kazan'" paper.

My scientific work has not been a continuous process, developing uniformly throughout my life. It has taken place in several great upsurges, which were like peaks in my life with essentially passive periods in between. These bursts of scientific activity, accompanied by the writing of papers that to me were the most important of all I wrote, coincided with emotional uplifts in my life. They were:

1. The summer of 1915 (the power of Borel sets and the A-operation).
2. A long period beginning in May 1922 and ending in August 1924 (my basic papers on general topology).
3. The period when I constructed the homological theory of compacta, beginning in August 1925 with the definition of the nerve of a family of sets and ending in the spring of 1928 with the paper "Gestalt und Lage."
4. The homological dimension theory (the first half of 1930).
5. The period of my "Kazan" paper (January–May 1942). This emotional upsurge (if it can be described as such at all) was accompanied by a peculiar feature: it consisted in the sharply painful experience of war with all the awareness of which I was capable of its cruel tragedy.
6. The winter of 1946–1947: the paper on the duality theorems for non-closed sets.

I regard this as my last important paper. The last great burst in my strictly mathematical activity, fortunately it was not the last in my life as a whole. But from then on the peaks in my life were no longer based on my own work, but on the joy caused by the work of my students; on the last two occasions by the papers of V. I. Zaitsev and E. V. Shchepin.

And so in 1948, it was just time for a new student to appear, Kirill Aleksandrovich Sitnikov (Kira). He was still an undergraduate. His brilliant mathematical ability was displayed in his first papers (about dimension-reducing maps, a so-called paper "about sacks" and one following closely "about girdles"). I regard these papers, of which the first later became his Ph.D. thesis, to be the most striking achievements at the time in the topology of compacta, in particular, the homological dimension theory. In these papers Sitnikov's brilliant talent as a geometer showed in all its strength.

His personality, always complex and, I would say, rather disharmonious, also had a peculiar charm. On the whole, I was very glad that Sitnikov had become my student. Kolmogorov was also pleased with him and we suggested to Sitnikov that during the second half of the summer of 1948 he should come with us to Kalyazin on the Volga, with good swimming and rowing in mind. Kira, a native of the Volga region (he was born in Gor'kii), readily agreed and our trip took place. We spent about a month in Kalyazin. Yu. V. Prokhorov, a contemporary of Sitnikov, who had also proved to be a very able mathematician studying probability theory successfully under Kolmogorov, was also there with us on Kolmogorov's invitation. He is now an Academician. He went with us on our boat trips, which took up the greater part of our time in Kalyazin. As a whole and in its parts our journey was very successful and gave much pleasure to us all.

After his papers on the topology of compacta Sitnikov proved his remarkable duality law for non-closed sets, taking it considerably further than I had. He also essentially laid the foundations of the homological dimension theory of non-closed sets, proving the fundamental theorem in this field, and constructing very interesting examples. This paper became his D.Sc. thesis. But Sitnikov's brilliant work in topology lasted only three or four years, after which on Kolmogorov's advice he went into celestial mechanics, where he obtained excellent results. His scientific work then began to decline and never again reached the level of his earlier work. For a number of years he was a

constant member of the Komarovka household.

Lokutsievskii began to work in topology at about the same time as Sitnikov in 1948, and constructed his famous example of a bicompactum in which the inductive and Lebesgue dimensions differ. Smirnov successfully continued his productive work in topology, this led him to what is now the classic metrization theorem (the Bing–Nagata–Smirnov theorem), which formed his brilliant Ph.D. thesis, and then to the construction of the theory of proximity spaces, which became his D.Sc. thesis. At present Smirnov's theory of proximity spaces together with André Weil's theory of uniform structures properly constitutes uniform topology, the rudiments of which can be traced as far back as the beginning of the present century.

In the autumn of 1953 a new member was added to the collective known as the Komarovka house and to this day keeps extremely close ties with it. This was Volodya (now Professor Vladimir Ivanovich Ponomarev), who was then only seventeen years old. Having passed successfully his entrance examination, which consisted of a swim in the already very cold autumnal Klyaz'ma, Volodya came to stay permanently at Komarovka. He was still at school and had not yet chosen his career. His mathematics teacher, who was not bad on the whole, told him that he would never become a mathematician and advised him not to choose that thorny path. Nevertheless, towards the end of the academic year 1953–1954 I had a serious mathematical conversation with him, which remained entirely within the limits of the secondary school syllabus of the time, but touched on some delicate subjects such as an infinitely decreasing geometrical progression, the isometry of pyramids (the so-called devil's ladder), and so on. Having observed that Volodya had a really good understanding of the concept of a limit, I went on to lead him so to speak to the mastery of the concept of a continuous function. Afterwards (I think this was in a second conversation) we passed on to quite another area and by our combined efforts mastered the concept of a group. To sum up, I became convinced as a result of these conversations (there were at least three of them) that Volodya Ponomarev must enrol in our Faculty of Mechanics and Mathematics. He passed the entrance-examination (with A's in mathematics and chemistry, I do not now remember his other grades) and was admitted to our Faculty in 1954. Two other boys, Shurik Arkhangel'skii and Borya Pasynkov, also passed the examination well and naturally were also accepted. Borya was the same age as Volodya and Shurik a year younger. At the university they quickly became friends and in the second year wrote good course papers on topology (in those far-off days course papers were already written in the second year) and formed the third generation of my students. And, while Volodya in his undergraduate years simply spent a lot of time in Komarkovka, Borya and Shurik were his constant visitors.

To the same age group and the third generation of my students there also belongs Arkadii Anatol'evich Mal'tsev (born in 1935). He was not formally my student (officially he did his postgraduate work under Sitnikov). But

Mal'tsev's Ph.D. thesis was in the area of homological dimension theory and close to my mathematical interests. Therefore, it is natural that I regard Mal'tsev as one of my students, and – in the sphere of my personal relations – he is one of my students closest to me. My old friendship with Arkadii's father Anatolii Ivanovich Mal'tsev was as it were the substratum of our friendly relations. My relationship with Arkadii forms a smooth, continuously ascending curve without any oscillations and has taken hold of ever more and deeper layers of my life.

Pasynkov, Arkhangel'skii, and Ponomarev presented their D.Sc. theses successively in 1964–1966. None of them was more than 30 years old at the time. Each of these theses was a serious contribution to general topology, and their presentation, one after the other, had altogether a considerable influence on the Moscow school of topology.

At the very beginning of the 60's two members were added to this school: Arkhangel'skii's students V. V. Filippov and V. V. Fedorchuk. Fedorchuk began to develop rapidly as a mathematician; obtained good results one after another, presented first a Ph.D. thesis and then a D.Sc. thesis; and spent a year with Dowker in England, where his results were deservedly successful. By that time Filippov had also developed and had defended a D.Sc. thesis, which contained brilliant results in dimension theory. Pasynkov, Ponomarev, Fedorchuk, and recently Filippov also had students, undergraduates and postgraduates, who have written good original papers. This whole collective of young mathematicians makes up a centre of serious topological research, which has justly received considerable international recognition.

As far as I personally am concerned, let me say once more that my last really significant work was the 1947 paper on the duality laws for non-closed sets. After that I wrote only one paper on the metrization of topological spaces, which contains a new and unexpected approach to that old problem and so is perhaps of some interest. This approach was continued and brought to full completion by Arkhangel'skii. I also wrote three joint papers with Ponomarev, in which, however, I was only so to speak a "producer": the basic mathematical ideas are due to Ponomarev. After the end of my strictly mathematical activity I wrote some survey articles (quite good, I think), the most recent of which with Fedorchuk as co-author came out not long ago under the title, "The main aspects in the development of set-theoretical topology"; (Uspekhi Mat. Nauk 33:3 (1978), 3–48 = Russian Math. Surveys 33:3 (1978), 1–53) it contains, in particular, a detailed survey of the principal results of my students mentioned above.

In 1963 V. I. Zaitsev (Vitya) became my student and quickly began to obtain first-class mathematical results, which are also set forth in the survey I wrote with Fedorchuk. Some of the most fundamental results of my students Arkhangel'skii, Ponomarev, and Zaitsev, and also, of course, the Bing–Nagata–Smirnov metrization theorem, went into my textbook, "Introduction to set theory and general topology". The results in dimension theory of the Moscow

topologists are set forth in my joint book with Pasynkov "Introduction to dimension theory".

Now that I have said quite a lot about my students of different generations, I think that it is time to consider the question of how I view the whole problem of relations between teacher and student, a vivid and interesting question.

In the relationship between student and teacher the latter always has influence over the former, which means that it must be of an asymmetric nature. The teacher influences the student; the student perceives this influence and to some extent surrenders to it. The question is: how extreme is this surrender; what emotional colouring has it; and how much does it impinge on the boundaries of the student's personality and the inner freedom of that personality. How the relationship is established between teacher and student, how easily and satisfactorily the problems that arise in their relationship are solved, depends upon the characters of the people who come into contact with one another, on how determined and active a personality the teacher exhibits in his relations with other people, on how imperative an influence he exerts, or seeks to exert, on his student, on whether he really wants to subordinate the will and personality of his student to himself, or whether, on the contrary, he strives to treat the student's individuality with care, wishing to help it to open up rather than to stifle it. The student's character is, of course, of no less importance, the extent to which it is open to favourable influence (it only makes sense, of course, to speak of that kind of influence), or whether the student, having a clearly-shown resoluteness of character, strives first and foremost to eliminate even the threat of any encroachment upon the rights and freedom of his personality. From what I have said it is easy to imagine a situation where a relationship between teacher and student takes a collision course between two strong characters, essentially ruling out any degree of lasting influence of one over the other, and inevitably leading to conflict between them. This, however, would seem to be an extreme case; it is, in my opinion, the exception and by no means the rule. Nevertheless, this situation sometimes occurs in practice. The most striking of the examples known to me of this extreme case actually occurring was the relationship between two great mathematicians, Hilbert and Brouwer. Brouwer was not Hilbert's student in the strict sense of the word. But Hilbert showed a great interest in Brouwer's first topological papers, which won him fame as the first-ranking topologist of his time. Hilbert published these papers in the most influential German mathematical journal "Mathematische Annalen" and publicized them in every possible way. For his part, Brouwer at that time not only treated Hilbert with great respect as a younger man treats an older one, but also had great inward affection for him. This emotional quality in Brouwer's relationship with Hilbert, when Brouwer was about 30 years old (and Hilbert was about 50) attracted my attention to Brouwer's letters to Hilbert, which I read in the original. This is the reason why I speak here about the relationship between Brouwer and Hilbert. Later on a serious crisis in this relationship took place

and led to a complete breach between those two great mathematicians. There were many and varied grounds for this crisis. Here I have to talk first of all about a fundamental difference of opinion as to the foundations and nature of mathematics. This difference of opinion, which was related to their fundamental view of the world, had by the very nature of things not only theoretical significance for them, but penetrated to the depths of their psyche, to the very core of their personalities. Subsequently they began to differ on scientific and social problems, on problems concerning the scientist's way of life, and in the end there was a complete breach between them.

Hilbert had many students who became outstanding mathematicians, but even then they never ceased to regard themselves as Hilbert's students. Among them I knew Carathéodory, Hecke, Hellinger, Dehn, and many others. But of all Hilbert's students, Courant was the closest to him, right until the end of his life, and was in fact Hilbert's closest friend during the second half of his life. When Courant had to leave Germany after Hitler came to power, Hilbert felt heavily the loss of a really close friend, a loss that was doubly painful because it took place against the background of a catastrophic development of events in his native land, a development to which Hilbert could never reconcile himself.

Many of the students who subsequently became eminent Soviet mathematicians and made up the first generation of the Moscow school of mathematics trained by Egorov. Among them I mention in the first place Luzin, Golubev, Stepanov, Privalov, and Petrovskii who was considerably younger. They were all Egorov's students and always regarded themselves as such. The character of Egorov, a man of exceptional moral stature, with a rare sense of duty and a rare sense of responsibility, was also marked by great emotional restraint, even a certain superficial sternness. It is not surprising that he had exceptional, I would say absolute, authority over his students and that his relationship with them was not darkened by any conflicts. The great restraint in these relationships did not exclude inward affection. I read (thanks) to Professor A. Yushkevich) some letters from Egorov to Luzin, dating from a time when Luzin was experiencing emotional problems connected with his work as a mathematician and his attitude towards it. These letters are full of the most heartfelt sympathy on Egorov's part with the problems of his student, who was undoubtedly very dear to his teacher.

Egorov's students had not only great respect but also great affection for their teacher, and it was not only those who studied directly under him who treated Egorov in this way, but also the young mathematicians, Luzin's students, who founded the famous "Luzitania", which has gone down in the history of Moscow mathematics.

The Luzitania was considered to be an "order", whose "Knight Commander" was Luzin and whose "Grand Master" was Egorov. It was a unique and inimitable collective of young people, who lived not only a full and strenuous life as regards mathematics, but a life that was in itself joyful and merry. Such a collective could only come into being during the earliest years of

the revolution, when the whole country experienced an upsurge, unique in history, in all areas of its life. The merry and unusually lively meetings of the Luzitania, at which by the way there was not a drop of wine, took place with the indispensable participation of Egorov and Luzin, the teachers of all those young people, which shows how easy and natural the relationship between a teacher and his students can be.

I would also like to say a few words about one mathematical collective with which I was closely acquainted and which was composed of the students of a single teacher, the outstanding Göttingen algebraist Emmy Noether. As far as her appearance was concerned, Emmy Noether was not notable for her femininity, but femininity was inherent in her nature and was expressed in the strong maternal instincts she possessed. Emmy Noether had no children of her own and her maternal instincts were expressed in her relationships with her students. I know of no other case where a teacher has shown such concern and, frankly speaking, tender affection for her students. On the whole I think that in teacher-student relationships the "satisfactory" conflict-free cases are in the majority. But it is neither the completely satisfactory cases, nor the rare completely unsatisfactory cases, that are of greatest interest to us, but rather the cases in between, where there are certain psychological complications which eventually are solved in a satisfactory way. More deserving of attention, in my opinion, is the situation where, on the one hand, the attitude of the teacher to the student is not only friendly but also attentive to his personality and his self-respect and, on the other hand, the personality of the student is friendly and open to the influence of the teacher, yet nevertheless complications arise in their relationship. I imagine the following as an example of the latter kind of relationship: a student places himself of his own accord under the authority of his teacher, and the teacher, without exerting any blatant pressure, nevertheless gradually puts his student's personality under his authority. As a result of this slow process, unperceived by either side, part of the student's personality – his views, his tastes, his aspirations – are as it were replaced by corresponding parts of the teacher's personality; and at some point the student notices the substitution that has taken place; he begins to feel that some of his views, tastes, and desires are no longer his own, but belong in essence to his teacher, and that there is an alien substance in the student's mind. There arises within the student an unconscious protest against the foreign substance; a striving to free himself from it, to "reject" it from his "Ego". The unconscious nature of this striving only adds to its imperativeness. The danger arises that "the baby will be thrown out with the bathwater;" that of the teacher-student relationship not only those elements are eliminated that are burdensome to the student and lead to excessive influence on the part of the teacher, but also other elements of absolute value both for the student and the teacher. It is here that a danger of serious emotional conflict arises. But I remain an optimist: I believe that in most cases in next subsequent development the complications in the relationship are perceived by both

student and teacher, and – passing from the subconscious to the domain of consciousness – lose their acuteness and become susceptible to reasonable control and hence to eventual elimination.

To conclude let me say a few words about my own experience as a student. At the university as an undergraduate who wished early on to study mathematics seriously, I became Luzin's student and immediately fell under the spell of his scientific ability and outstanding talent as an educator. For his part, Luzin quickly included me among the students closest to him and he expected great things from me in mathematics. Everything went as well as could be, both in mathematical and personal matters, until after my first important successes in mathematics I experienced my first catastrophic failure (about which see Uspekhi Mat. Nauk 34:6 (1979), 236–237 = Russian Math. Surveys 34:6 (1979). This made me give up mathematics for about two years. Luzin was apparently disappointed in me as his student. Later when I returned to mathematics and again began to do productive work our broken relationship could no longer be restored, but this breach was quite untypical of teacher-student relationships and is of no interest to us here.

My mathematics teacher at the secondary school (gymnasium) was Aleksandr Romanovich Eiges, and I owe it to him that I became a mathematician at all. Eiges' influence on my youthful mind, which was just beginning to form, came to extend over all its new regions. In particular, it was extraordinarily strong in the area of my literary and later my philosophical interests. That "replacement reaction" of which I spoke above came into effect – and to a considerable extent – but it did not lead to any "conflict situations". As time went on, my relationship with Eiges assumed more and more the character of a true friendship and kept this nature right until Eiges' death in 1944.

Let us turn once again to the Komarovka household. It included not only my, but also Kolmogorov's students. There were many of them and I can name only some of them here, giving preference to those with whom I was on terms of friendship at first hand (not only through Kolmogorov): these were first and foremost the eldest of them, Boris Vladimirovich Gnedenko, and the considerably younger Vladimir Andreevich Uspenskii, Vladimir Mikhailovich Tikhomirov, and Al'bert Nikolaevich Shiryaev.

Among the most outstanding mathematicians of Kolmogorov's students we must include V. I. Ar'nold and Ya. G. Sinai, who stayed at Komarovka many times. V. Zasukhin, who was killed during the first year of the war, stayed frequently at Komarovka, but only for short periods. Among a younger generation of Kolmogorov's students there is Igor' Zhurbenko, who went with him on a journey around the world in 1971. Igor' also became a very good friend of mine and often stays with me in Moscow. I still remember one dazzlingly sunny March day, which must have been in 1965 or therebouts, when Vitya Zaitsev and Igor' Zhurbenko, wearing only shorts, cleared the snow from the whole of the Komarovka house (and cleared it with complete

success). One could only wonder at the ease with which they lifted big layers of compact snow, partly covered with ice, and standing on the very edge of the roof threw the snow down.

When on Kolmogorov's initiative and under his guidance the Physics and Mathematics Boarding School that is attached to the University of Moscow was founded and began to flourish, the boarding-school children sometimes came to Komarovka with some of their young teachers and set out in long ski trips together with the masters of the house. Ski trips were a continuing tradition in the Komarovka household. They sometimes included only a few participants of various ages and sometimes quite a lot. During the earliest post-war years, Kolmogorov and I with the participation of other people (including Smirnov, Prokhorov, Sitnikov, A. A. Petrov, and so on) went on several long boat trips (or canoe trips), sometimes on the waters near Moscow, sometimes on the various reaches of the Volga. The last time Kolmogorov and I were on the Volga, in the neighbourhood of Saratov in 1954, we spent more or less the whole of the month of August there, occupying ourselves with "radial boating", that is, sometimes floating downstream, sometimes rising against the current (usually by towing, a skill Kolmogorov possessed to perfection). Sometimes we simply loitered on the river, remaining more or less in the same place.

As regards strictly "topological" walking and sporting activities, we must first of all remember the topology walks, as they were called. Arkhangel'skii, Pasnykov, Ponomarev, Fedorchuk, and Iliadis participated regularly, and occasional participants included all members of the topology seminar who wished to take part, with wide powers of co-opting. For many years this whole large company and I used to go to the Tishkov Reservoir and later, when I got older, to the Fryazinskii lake. On the latter walks, Kolmogorov sometimes came from Komarovka and joined us for a while. After choosing a good place on the banks of the water (the requirements were availability of a football pitch and a place to build a bonfire), we spent the whole day there from morning to evening. The "trip" itself consisted of endless swimming, endless football, boat trips (particularly interesting at Tishkov) and endless meals by the bonfire. This kind of activity easily took up the whole day, and when we all went home, it was usually late in the evening and we were always very happy.

In the mid-60's the topologists went to the Upper Volga (not far from Okatov) three or four times and spent a month there each time, taking half a cottage (sometimes in Okatov itself, sometimes in the nearby village of Peretryasov). We rented not only half a cottage but also a boat, and in it we spent most of our time, going on what were sometimes quite long boat trips and spending the night in a tent. We also experienced storms and other adventures. It was always the same people who took part: Zaitsev, Fedorchuk, Ponomarev, Pasynkov, and Arkhangel'skii (with minor variations; on one occasion Arkhangel'skii and on another Pasynkov did not come). Besides boating and swimming there was also the inevitable football and (only

sometimes, and in small quantities) mathematics.

I also call to mind the times when I went to the seaside. These were the trips I took, together with Volodya Ponomarev to Gelendzhik in 1955, 1956, and 1957, and each time we stayed for about a month in the sanatorium (more exactly, a rest home) of the University of Moscow. Once or twice Mishchenko came with us. Many students took their holidays there, and there was a good volleyball team (often the best in the whole of Gelendzhik). There I rented a whole "fleet" (of, I think, three or four boats) of which I made continual use organizing boat rides in the Gelendzhik Bay, and (with permission from the border guards) sometimes even a little beyond its limits (once as far as what is called the Blue Bay). Mainly, we went for long swims with many participants (who always included Volodya Ponomarev and myself). These swims were organized with regard for all safety rules: the team of swimmers was always escorted by two boats, one in front and one behind. During the whole time there was not a single accident.

In the autumn of 1958 Arkhangel'skii, Pasynkov, Ponomarev, and I spent a month in Novyi Afon. Alesha Chernavskii, who was their contemporary and a student of Ludmilla Keldysh doing research in geometrical topology under her, also came. In Novyi Afon the members of our company not only swam and played volleyball: we read Hoffmann ("Meister Floh" and other pieces) aloud taking turns, and I also read "Evgenii Onegin" aloud. Many times I went to the seaside with Vitya Zaitsev. We spent three summer holidays together at Nida (Lithuania) on the Baltic Sea, one summer at Palanga and one at Novyi Afon on the Black Sea.

In the mid-60's topology in our country was enriched by a new undertaking, which turned out to be interesting, lively, and fruitful. This was the so-called Tiraspol symposium on general topology and its applications, which takes place regularly at intervals of four or five years in the town of Tiraspol' (in Moldavia), based at the Tiraspol' Pedagogical Institute, and is held in that institute's summer sports camp, not far from the town, on the banks of the Dnestr, in picturesque woodland surroundings.

The Tiraspol symposium is in every sense of the word an All-Union undertaking, drawing mathematicians, mostly young ones, from all parts of our country. The main credit of being the founder and tireless organizer of this symposium belongs to Peter Kuz'mich Osmatesku, now a professor at the Kishinev Polytechnic Institute.

Born into a working-class family in Moldavia, Osmatesku as a postgraduate student at Moscow University did research under Ludmilla Keldysh, but began his original work in general topology under Arkhangel'skii and is in full measure his student.

I was on two occasions a member of the Tiraspol' symposium, the last time in 1969. I have very pleasant memories of the symposium, despite the fact that my stay in Tiraspol' in 1969 was accompanied by a disagreeable adventure, about which I will say a few words.

The last day of my stay at the Tiraspol' camp was a Sunday at the very end of August. While swimming in the Dnestr during the second half of the day, I suddenly noticed that a motor boat was coming at me at full speed. Then I experienced the first contact of my back with its bows, and it took a fraction of a second for me to understand clearly that in a moment its stern would come down on my head with the full thrust of its metal propeller. My mind worked in a staggeringly responsible way, and the time took amounted literally to moments. Nevertheless, I remember clearly that the legend flashed through my mind about the prophet Mohammed, who flew around the earth seven times in the time that it took for the water to pour out of an overturned pitcher. I also realized clearly that if I did not do something within the next moment, my life would come to an end right then. With an abrupt movement I plunged my head so far down that it touched the river bottom. At that moment I felt a blow from the boat's propeller right at the bottom of my spine. I then felt a sharp pain and realized that I was alive. Within a minute Vitya Zaitsev was beside me and immediately set about pulling me to shore; I could only help a little with this by making swimming movements with my arms. I could not use my legs at all because of the severe pain. After a few minutes the ill-starred boat came up to me and its passengers (those of them who were sufficiently sober) offered me their services for transportation. I declined this, because the pain made it impossible to lift me into a boat and there was no need for it, because Vitya energetically and skillfully pulled me to the shore. When we were there, I even told Vitya that I wanted to plunge once again into the water, but he said that there was no need to do this, and with the help of one of the people staying in the nearest tent he carried me on a stretcher to that tent. Then a nurse appeared and I was bandaged for the first time. But contrary to my hopes I was told that I was to be taken to the Tiraspol' Hospital. A short time later a special boat came for me from Tiraspol', and I was carried onto it on a stretcher. Arkadii Mal'tsev and Vitya Zaitsev did this together, and I still remember the feeling of pleasure I experienced from the accuracy and smoothness with which they carried me up the very steep ladder from the shore to the boat. This feeling of pleasure fully alleviated the pain, which I felt all the time, at the place of the injury. That same evening I was operated on, the operation being performed brilliantly by one of the Tiraspol' surgeons. I had quite a serious and complicated fracture of the ischial bone. Throughout the operation Vitya was right there, next to the operating table, despite the fact that the hospital's resident surgeon tried to protest against Vitya's presence in the hospital late in the evening and asked him who on earth he was. But Vitya categorically refused to leave the hospital before the end of the operation.

I spent the night and the main part of the following day at the Tiraspol' Hospital. I was then taken to Kishinev Hospital, in the so-called 4th district. Throughout that time and, in particular, while I was being transported to Kishinev, Vitya was near me. I spent over a month in Kishinev Hospital. Vitya

stayed throughout that time in a hotel in Kishinev. He came to see me every day as soon as my medical treatment ended and was in the ward with me all day, only leaving after supper when he went back to his hotel. There, in the evenings and early mornings, he did mathematics. The results of this work subsequently formed the basis of Vitya's excellent paper on projection spectra, which was published in the "Proceedings of the Moscow Mathematical Society" and essentially became Vitya's Ph.D. thesis. We used most of the time Vitya spent at the hospital with me for mathematical discussions. He told me, systematically and in detail, about his very intensive mathematical ideas, which I found very interesting. Besides, Vitya read aloud to me a lot. In particular (and I remember this very well), he read all Gogol's "St. Petersburg Tales," much of Pushkin's prose, and other books. When towards the end of September I was permitted to get out of bed and take walks, first around the open gallery surrounding the hospital's inner courtyard, and then in the courtyard itself, Vitya naturally became my constant companion on these walks. As a consequence, my stay in the Kishinev Hospital became a pleasant memory for me, despite the fact that the first two weeks of it were accompanied by quite severe pain, especially during dressings. Volodya Ponomarev and Arkadii Mal'tsev both came from Moscow to visit me. Of course, this also brightened my life in hospital very much, as did many displays of concern and kindness on the part of my Kishinev colleagues, chiefly P. K. Osmatesku, but also Vladimir Alexandrovich Andrunakievich. I am particularly indebted to him for getting Vitya Zaitsev into the best hotel in Kishinev, which made it possible for him to do mathematics so successfully, and for having a special hospital routine created for me, which allowed Vitya to spend practically the whole day in the hospital with me. Vitya and I only returned to Moscow in the middle of October.

Unfortunately, during the time we spent in Kishinev, the first signs appeared of Vitya's allergic cough, which was to develop a year later into a serious case of bronchial asthma.

In the summer of 1970 Vitya Zaitsev presented his Ph.D. thesis, the basic results of which form the contents of his long and very interesting paper published in the "Proceedings of the Moscow Mathematical Society." Unfortunately, Vitya was quite ill when he presented his thesis, and it was only with difficulty that he could deliver his dissertation speech using a microphone: by that time he already had bronchial asthma in quite a severe form. This illness has not left him even now, despite the most active attempts at treatment in hospitals and sanatoria.

In 1968–1969 Vitya Zaitsev and I advertised a topology seminar for first- and second-year students. At this seminar, two students (who had, incidentally, been classmates at boarding school) immediately stood out for their striking mathematical ability: Pasha Kurchanov and Zhenya Shchepin. Kurchanov soon switched to algebra and began to work under Yu. I. Manin. Zhenya Shchepin continued to study topology and poured out remarkable papers, one after the

other (about which, see my joint article with Fedorchuk, "The main aspects in the development of set-theoretical topology").

Shchepin's very first papers dealt, on the one hand, with projection spectra, and, on the other hand, with the so-called nearly normal spaces, and were close to Zaitsev's. Then, Shchepin quickly set off on his own broad mathematical path, which has led him far ahead.

Vitya Zaitsev and Zhenya Shchepin are of all my students the two most recent and maybe partly for that reason the nearest and dearest to me. To them most of all I owe the fact that the extreme and largely feeble old age I have reached, with all its inevitable bitterness, is all the same not of the kind that Gogol' feared so much when he said that it is impossible to read anything into the cool and emotionless features of inhuman old age.

Postscript

To my students

I have already mentioned the fact that I entered university to devote myself, after graduation, to secondary school teaching and to become a mathematics teacher in a gymnasium. As things turned out, I hardly taught in secondary schools at all but worked practically all my life in higher education, at the University of Moscow, combining teaching and research as far as possible. In the course of time the first of these two activities (teaching) has taken on an even greater weight, and in the end, coinciding roughly with the emergence of the third generation of my students (or even a little earlier), has filled my life completely. My scientific work has always been nourished by the emotional substance of my life, but the latter has come to stem, more or less entirely, from my students. And so, now I thank them all for everything they have brought to my life, first and foremost, for having existed and for existing.

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