A Good Journal for Inquisitive People

SCIENCE First Hand

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THE CAPITALS HAVE BEEN ABANDONED …

A TOWN OF PASSIONARIANS

HERE DREAMS CAME TRUE

THE UKOK DIARY

On What Cannot Be

2/3. 2017
popular science journal

SCIENCE First Hand

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Academician N.L. Dobretsov: "The famous scientists who came to Siberia were those who stifled in the capitals, who were seeking for new opportunities to implement their ideas"

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Doctor of Chemistry A. K. Petrov: "In those best years of our life we could approach any Academician or full professor, ask a question and get an answer. It was an invaluable school of science, ethic and life itself"

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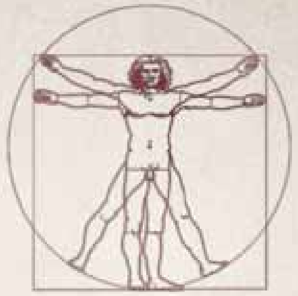
for Inquisitive People



"The natural desire of good men is knowledge"

Leonardo da Vinci

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"...First come people and their ideas, and only after them, buildings and equipment"
M.A. Lavrentiev

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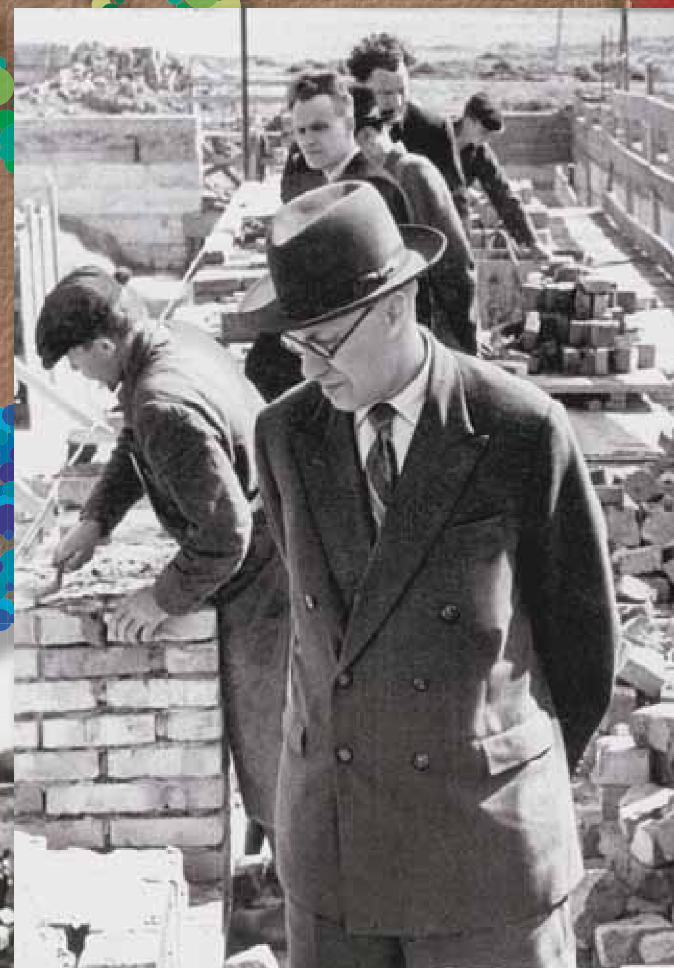
СО РАН
SB RAS

N.L. DOBRETSOV

A Town of PASSIONARIANS



Academician M.A. Lavrentiev (1957—1975), a founding father and first Chairman of the Siberian Branch, USSR Academy of Sciences, at the construction site of the Institute of Hydrodynamics, Novosibirsk Academgorodok

Academicians S.A. Christianovich (*photo on the right*), S.L. Sobolev (*photo on the left*) and M.A. Lavrentiev put forward the idea of setting up large research centers of the USSR AS in the east of the country

Key words: SB RAS, Novosibirsk Akademgorodok, mantle plumes, subduction, kimberlites, diamonds, oil, gas

Almost a century ago, in the 1920-30s, a special commission of the USSR Academy of Sciences on the organization of regional affiliates denied the request of local governments in Siberia and the Far East of the country to create local affiliate divisions. The stated reason was that it was impossible "to deploy Academicians to the specified cities without the destruction of the Academy of Sciences as such, and selecting new Academicians, forcing them to live and work in a specified city, is impossible as well." Even though during the Great Patriotic War the first affiliate branch of the Academy appeared in Siberia, it was late in the 1950's that «the impossible» happened: several dozen of the most prominent scientists from Moscow, Leningrad, Kiev, Lvov and other cities, joined by their talented students, moved to Siberia – voluntarily and simultaneously

Nikolay L. DOBRETSOV, Full Member of the Russian Academy of Sciences (RAS), Professor; Chairman of the SB RAS United Scientific Council on Earth Sciences; Chief Researcher at the Seismic Tomography Laboratory, Trofimuk Institute of Petroleum Geology and Geophysics, SB RAS (Novosibirsk, Russia); Head of the Chair for Mineralogy and Petrography, Geology and Geophysics Department, Novosibirsk State University.
The field of scientific interests is magmatic geology, mineralogy and petrography. The founder of the Siberian scientific school on deep geodynamics. In 1997—2008, Chairman of the Siberian Branch of the RAS.
Winner of the Lenin Prize (1976), State Prize (1997), Demidov Prize (1999), Kosygin Prize (2003), Red Banner of Labour Award, etc. Author and coauthor of over 700 scientific publications
Editor-in-Chief of *SCIENCE First Hand*.

1957 The USSR Cabinet Act on the creation of the Siberian Branch of the Soviet Academy of Sciences (SB AS USSR)

The Siberian Branch of the Russian Academy of Sciences has turned sixty. It owes its existence to an amazing historic event: a large group of prominent and active scientists volunteered to abandon the urban coziness of their homes and workplaces and leave for the remote frontiers in the unknown land that had been a GULAG destination before. These people, who came along with their students and young colleagues to the new scientific center near the Siberian city of Novosibirsk, were the catalyst that spurred the growth of new academic teams and schools.

Academicians S. A. Khristianovich, S. L. Sobolev, M. A. Lavrentiev and A. A. Trofimuk discussing the general plan of Akademgorodok construction. *SB RAS Photo Archive*

Early in 1956, *Pravda* published a piece called *The pressing tasks of organizing scientific work*, signed by M. A. Lavrentiev, S. A. Khristianovich and S. A. Lebedev. It drew the readers' attention to the fact that the vast majority of research institutions, higher education and experimental production facilities were located in Moscow and Leningrad, far away from major production centers, and raised the issue of a more uniform distribution of these facilities around the country. Soon afterwards, M. A. Lavrentiev, S. L. Sobolev and S. A. Khristianovich proposed a specific initiative: to create a number of major research centers of the Academy of Sciences in the eastern part of the country. The initiative was approved by the government. Science historians say that special and intelligence services were the most adamant supporters of the initiative for strategic reasons: science, and defense-related research in particular, had to be disseminated all over the country as an insurance against the full loss of intellectual potential in the case of a possible nuclear strike. Academician M. A. Lavrentiev, who was highly valued by the general secretary of the Communist Party Central Committee, Nikita Khrushchev, played a key note in implementing this major project. Lavrentiev's initial idea was even more grand: in essence, he wanted to create the Russian Academy of Sciences in the East, beyond the Ural mountains, because by that time, all other Soviet Republics, except the Russian Federative Republic, had their own Academies

The First Seceretary N. S.Khrushchev visiting in Akademgorodok. *1959*

We must admit that this phenomenon had its historic precedents. For instance, the Tomsk University, which is the oldest in Siberia, and the Siberian Physico-Technical Institute, founded in the 1920s, are the fruit of the effort of professors, who moved to Siberia from St. Petersburg. Stalin' exile campaign was the moving force, which brought educated people to the most remote nooks of Siberia – and it was in no way voluntary. For example, in 1950, Yu. B. Rumer, an outstanding theoreticist of physics who had worked with Niels Bohr and Albert Einstein, was transferred to Novosibirsk on the personal demand of S. I. Vavilov. Rumer is considered to be the founder of laser research in Siberia, and of the Institute of Radioelectronics of the Western Siberian Filial Office of the Soviet Academy of Sciences in particular. Nevertheless, these events were more of an exception than a rule for Siberia and the Far East: it suffices to say that by the moment the Siberian Branch of the USSR AS was founded, there was not a single mathematician with a degree of Doctor of Sciences, and there was just one Corresponding Member of the Academy of Sciences.

The King of Sweden Carl XVI Gustav presenting the Nobel Prize to Academician L. V. Kantorovich, who performed comprehensive studies in linear programming and theory of optimal planning of economics

Many leading scientists of the country took part in the development of the foundations of the organization of the Siberian Branch; they also helped to staff it, recommending their best students. For instance, the director of the RAS Institute of Atomic Energy, I. V. Kurchatov, sent a large group of his specialists to Novosibirsk, headed by G. I. Budker. As the result, the Siberian "science troopers" were more than simply brilliant scientists; they were scientists who felt restrained in the capital cities of Moscow and Leningrad and sought new ways to bring their ideas to life, both in research and in science organization. Obviously, everyone had their own personal reasons, but in the end, the common argument in favor of moving was the new possibilities it would open.

The second key moment in the birth of this unique academic center was the new way of training our own specialists. I remember very well the words spoken by Academician Lavrentiev at a seminar in the Institute of Hydrodynamics: "We cannot teach you everything. But we can teach you to think!" This key idea was implemented in numerous seminars which began in all institutes right away, and in the creation of Novosibirsk State University – a new school, which prepared the new type of teachers.

The first field season for Nikolai Dobretsov. *Kamchatka peninsula, 1965*

Kimberlite, the main diamond-bearing rock, does not always contain precious gems: from the hundreds of kimberlite pipes discovered in Yakutia in the middle of the twentieth century, only 4 percent were found suitable for industry-scale mining. In the late 1960s, the future Academician N. V. Sobolev proposed a method of using minor mineral inclusions as markers of the presence of diamonds: specific types of pyropes and chromites. Thanks to the development of a complex of prospecting methods for diamond deposits, the V. S. Sobolev Institute of Geology and Mineralogy of the SB RAS booked over 145 million carat of prospective diamond resources

Akademgorodok, the outpost and headquarters of the Siberian Branch built in Novosibirsk, was the first structure specifically designed to develop pure research and theoretical education. This was a unique experiment that came up to the expectations: with its high concentration of outstanding researchers with a variety of interests and schools and a large number of young eager researchers the project took off like a rocket.

School of Sable Pups*

From 1960, my research career as a geologist has been linked (with a short break) with one of the first research institutes of the Siberian Branch – The Institute of Geology and Geophysics. Nowadays its successors are two major research institutions – the V. S. Sobolev Institute of Geology and Mineralogy and A. A. Trofimuk Institute of Oil and Gas Geology and Geophysics. Its founder and first director, Academician A. A. Trofimuk, who supervised research management in all major Siberian towns for many years, decided not to tailor the new structure to his own wishes and instead picked a group of researchers capable of creating powerful scientific schools in different fields. These schools, formed as the result of mutual enrichment of "sources" from Tomsk, Irkutsk, Moscow, Leningrad and Lvov schools, played a crucial part in the development of geology and ore mining sciences in Siberia.

One of the founding scientists was Academician V. S. Sobolev, who I consider to be my "father in science." Already well known in the world of science, he moved

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* The Russian name Sobolev (Соболев) means "of sable", from соболь – sable

The International Assembly of the Mineralogical Association: Academician V. S. Sobolev, Professor N. L. Dobretsov, Corresponding Members of the AS USSR E. A. Kulish and V. A. Zharikov. *1978*

A comic portrait showing the Lenin Prize winners. *A drawing from an unpublished article by E. V. Sklyarov, "N. L. Dobretsov and the Tectonic Aspects of Metamorphism."*

Giant deposits of carbohydrates in Siberia were discovered by I. M. Gubkin (in West Siberia) and A. A. Trofimuk with his colleagues (in East Siberia) literally "in writing" on the bassis of theoretical predictions and calculations.
Photo showing Academician A. A. Trofimuk

N. L. Dobretsov wrote: **"Apart from numerous other achievements of our geologists I will mark the Siberian school of oil research headed by Academician Trofimuk, which has earned worldwide recognition. Trofimuk followed the best traditions started by the founder of the petroleum geology in the USSR, Academician I. M. Gubkin, and consolidated virtually all academic, industrial and production oil-related organizations in Siberia. Our country owes the discovery and development of oil and gas fields in West Siberia to this consolidated team. It was here that where world's first oil and gas deposits in very ancient (over 900 million year old) Upper Proterozoic strata were discovered, followed by discoveries in other countries."**

OIL IS A GLOBAL BUSINESS!

Academician A. E. Kontorovich wrote: "It is a common belief that the success of Soviet scientists and engineers in the atomic and space programs is a unique marker of the creative roots and intelligent power of our science; this is, indeed, true. Without a secure missile and atomic shield it would be impossible to defend our economics, our independence, and keep Russia's position in the world. But it is hard to imagine what would happen to the Soviet and Russian economies if not for the discovery of the West Siberian petroleum province with its unique deposits of oil and gas. This discovery i a unique achievement of the Russian science and the Russian engineering thought, which I place on a par with the space and atomic projects…

For this reason, when some people in our government, who have very vague understanding of science and its mechanisms, speak of inefficiency when discussing the work of the Academy of Sciences, I want to ask a question: what feeds you, except for what our science, and the Siberian Branch in particular, has given you? Without West Siberia, the economy would lie if ruins because of your reforms.

The foundations of the paradigm which originated in the Soviet Union stem to the late 1920s and early 30s; I call it the Gubkin-Baybakov-Trofimuk paradigm. <…> The essence of the paradigm of the development of the whole oil and gas industry in Russia consists in consecutive eastward development of new oil and gas provinces with a focus on the discovery and development of major and giant fields. Since this paradigm was formed not in Russia but in a state that was twice larger – the Soviet Union – it included the development of oil and gas resources in Middle Asia (Uzbekistan and Turkmenia) and Kazahkstan, in particular, in the Peri-Caspian depression, and successive works in Azerbaijan and Northern Caucasus. Nowadays, due to external circumstances, the problem of deposit development in the southern territories has become irrelevant, and those deposits are now being developed independently; however, that development follows the patterns formed in the Soviet oil production school.

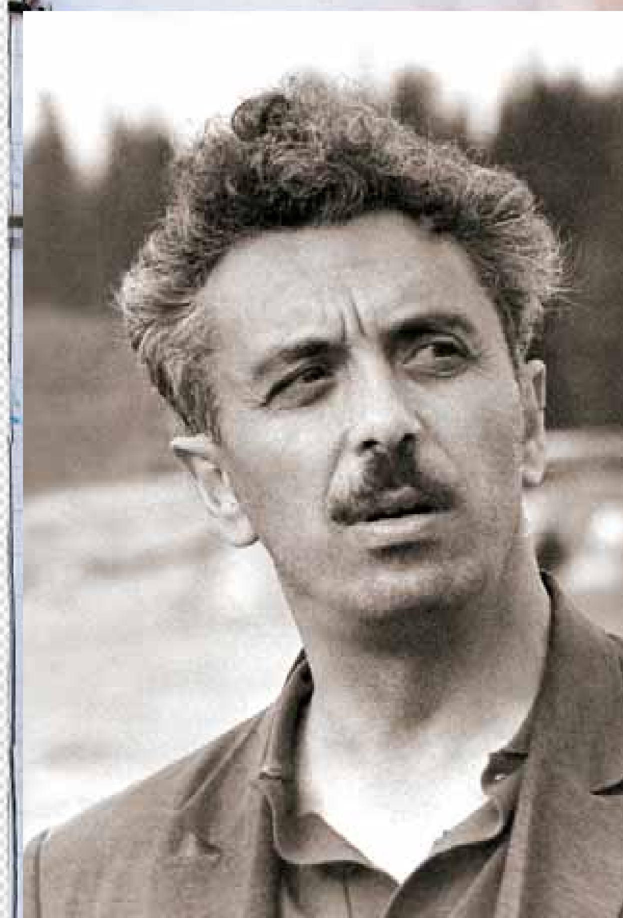
What concerns Russia, it has consistently adhered to the Gubkin-Baybakov-Trofimuk paradigm: we went from West to East and reached the Pacific ocean. There was no place further to go. The Okhotsk Sea oil deposits are rather well developed, at least in the shelf around Sakhalin. Strictly speaking, we solved the problem of northern access: in the Yamalo-Nenetsk Autonomous Okrug, we created a unique oil production center. This is the Arctic Ocean coast. Our geologists have already made some outstanding discoveries on the West Arctic shelf: the Shtokmanskoye gas field, the Pechora sea group of oil fields, the Komsomolskoye and Rusanovskoye fields in the Kara sea, a number of fields in the Ob and Taz deltas, – and they continue their work in these territories. Overall, the problem has been solved: the Gubkin-Baybakov-Trofimuk paradigm has exhausted itself. In 2015, we extracted 44 million tons of oil from these fields, and we are heading toward 100—120 million tons a year. Developing small and very small deposits has become an important state affair and the primary task of the industry.

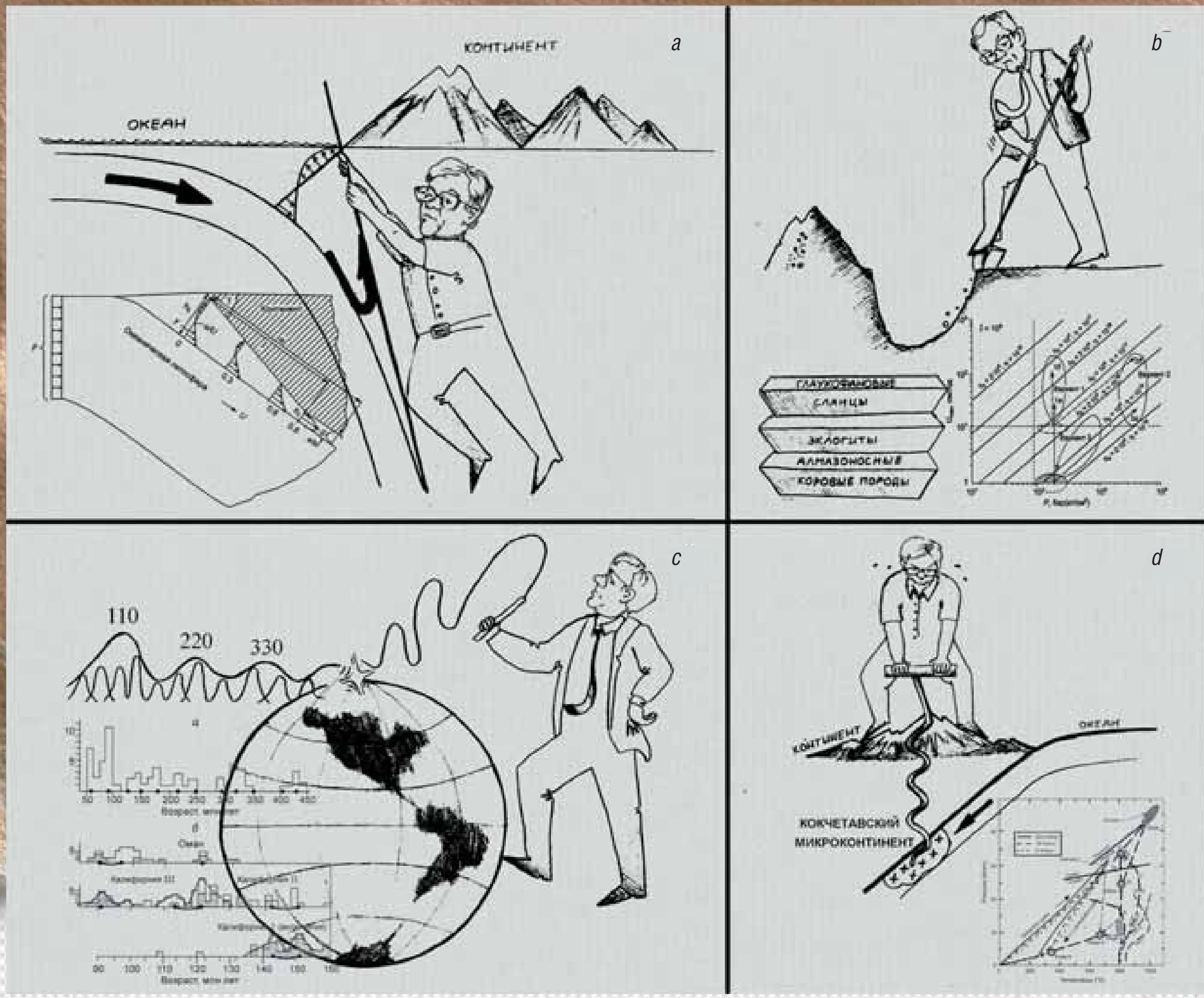
The second problem that the new generation of researchers, geologists, geophysicists, drilling specialists, oil and gas field developers are facing is to continue developing old, exhausted deposit and extract the remaining oil from the sediments. <…> We must continue our work in those oil and gas provinces which still have major undeveloped deposits. Most important of all, this is the territory of the Siberian platform between the rivers of Yenisei and Lena, which still harbors many future discoveries. At the moment, this territory is being thoroughly studied by the A. A. Trofimuk Institute of Oil and Gas Geology and Geophysics of the SB RAS."

Kontorovich, 2016

Gas hydrates, the possible future fossil fuel, were discovered by Siberian geologists led by Academician Andrey A. Trofimuk. Gas hydrates are ice-like mixtures of gases and water, in which gas molecules are trapped within the framework of water molecules. In nature, gas hydrates are formed at high pressures and low temperatures in permafrost regions and in marine environments, and consist mostly of hydrates of hydrocarbon gases (especially methane). The hypothesis that the Earth's crust may store accumulations of hydrated gas was proved valid in the late 1970s. The total amount of methane that occurs in hydrated form is estimated to exceed 10^{19}g of methane carbon, which is more than the total amount of all other known sources of organic carbon in the Earth

The legendary Farman Salmanov – one of the most prolific geologists who took part in the discovery of giant and major petroleum fields. He was the first to obtain an oil fountain from the so-called Bazhenov formation – the main oil generator in West Siberia





N. L. Dobretsov wrote: **"By metamorphism we mean the major processes occurring in the Earth's interior. The main process is recrystallization of rocks, phase transitions of matter under the effect of ever higher – as moving towards the planet center – temperatures and pressures. The second process is melting of rocks and shift of the melt. The processes are called metamorphism and magmatism, respectively. Ores, oil and diamonds are material results of both processes. The surface manifestation of these main processes is called tectonics. The movement of plates affects the course of geological processes: some plates submerge, others collide and rise, as the Himalayas, which consequently causes metamorphism, melting and displacement of rock melts. This, in turn, affects the movement of plates, changing their direction, velocity, etc. Today, research of the evolution and structure of Earth is focused on geodynamics – a complex discipline where tectonists work hand to hand with mathematicians, geophysicists, geochemists, ore mineralogists, petrologists and many others. Many achievements of Siberian scientists in this field are marked by the State Award of the Russian Federation."**

Sketches of models and theses proposed by Academician N. L. Dobretsov:
a – a model of the accretional wedge as the main stability regulator of subduction zones;
b – exhumation of high and super-high pressures from subduction zones (transformation of accretional wedge into collision-integumentary systems)
c – normal periodicity of overpressured metamorphism. It has turned out to correlate well and is probably defined by the periodicity of plume magmatism;
d – exhumation of diamond-bearing metamorphic complex of the Kokchetau "rock."

Drawing from an unpublished article by E. V. Sklyarov, "N. L. Dobretsov and the Tectonic Aspects of Metamorphism."

to Novosibirsk from Lvov together with a group of young and talented followers.

After graduating from the Leningrad Mining Institute in 1957 I worked in the industry and was the head of a survey party. I spent winters in Leningrad and worked summers doing geological surveys in Kazakhstan.

But then again fate interfered – in the person of my grandfather. He said: "Go to Siberia – why waste your time in Leningrad? Here, people like you are packed like herrings. There, you will find open space, new prospects. You will be able to show your worth." He wrote a letter of credence half in jest to Academician V. S. Sobolev, which contained the words like: "... Volodya, do you remember how you carried measuring rods for me once on Magnitnaya Mountain? My grandson seems to be interested in science. Have a look at him if he might be of help."

Sobolev impressed me at first sight. We met during one of his visits to Leningrad. It was in the Astoria hotel. He was a kind of sleepy, in a night gown, but very imposing. On the whole, I did not like his outward appearance. But immediately he proposed me to start studying the problem of jade. The proposal was so sudden that I could not remember anything about jade, three years had passed already since graduation. Sobolev continued: "Take this paper, everything is described there. Think about this and give your proposals." I was shocked because in industry people used to work in an absolutely different way: no unclear problems, no papers. The more so, the paper was in English! To put it shortly, I neglected all other variants and started working for Sobolev. And I have never regretted this decision.

V. S. Sobolev and his team of young researchers were at the forefront of the studies of deep physical and chemical processes in the Earth crust and upper mantle. In 1976, Sobolev and his "pups" were among the first scientists in the Siberian Branch to receive the Lenin Prize – for their studies in the theory of metamorphism. Further joint research of Sobolev's team together with specialists from Yakutia and Irkutsk in the area of kimberlite magmatism led to the discovery of the first diamond province in the country, and later discoveries of deposits in Arkhangelsk district, in Syria and in Canada, as well as the discovery of unique diamonds in metamorphic rocks of Kokchetau in Kazakstan.

During the first few years in Akademgorodok I did not neglect my self-education and attended seminars and courses in the institutes: two in our IGG, a course in the Institute of Hydrodynamics, which was initially read

N. L. Dobretsov among ignimbrites and acid hassocks (rocks formed in major volcanic explosions) in the Uksichan volcano caldera in the Sredinny Range of the Kamchatka peninsula. This caldera was formed in what was probably one of the most dramatic explosive eruptions on Earth

N.L. Dobretsov (2006): "During the two last decades, a new scientific school of deep-level geodynamics has formed at the Siberian Branch of RAS. Its members actively study and simulate the processes occurring in the Earth's interior. It should be noted that the geodynamics theory that integrated very different notions and phenomena and made a revolution in geology is derived from a hypothesis that seemed weird one day. This was Wegener's hypothesis on the floating continents. Wegener substantiated his hypothesis in the early 20th century, but later it was disproved, when geophysicists established that the Earth is solid elsewhere, there is no layer of molten mater under the continents, on which they could move. The hypothesis was rejected completely. But now it becomes clear that no melt is needed. Instead, there should be a special plastic state of matter at a certain depth, where everything flows, and above – continents are passively drifting, like ice floes in the river.

In this regard, the ice cover of Lake Baikal can be used as an unusual object for modeling the movement of the Earth's crust plates and prediction of earthquakes. This idea dawned up on me, as I am a keen fisher, who was lucky enough to ice-fish many times on Baikal. There, when blocks of ice collide, ice-hummocks grow before one's very eyes! The boom is as strong as that during earthquakes, and water splashes out from the hole: that's a true "ice quake." Certainly, this is due to the movements of ice plates rather than seismic reasons. It is noteworthy that this happens only in spring when the thick ice floes become nonuniform: their upper part becomes brittle, while the lower part at the interface with water is at the stage of submelting, a kind of a special visco-plastic state. And all this diversity occurs at a one-meter depth…"

by Lavrentiev himself, and a seminar on mathematical statistics and probability theory read by A.A. Borovkov, a future Academician. By the way, we shared a posgraduate student, who worked on stochastic models of crystallization and preservation of diamonds.

Sobolev sent me to the Novosibirsk State University to teach. When I was young, I was always short on money, just like everyone else, so I had a side job unloading railroad cars with perishable fruit on the Seyatel station nearby. Sometimes I would make more money on a single weekend than my whole monthly salary of a junior staff researcher. When Sobolev learned about it, he said: "Working as a loader is a good thing, but university work is easier and more stable…"

My leadership and management skills were molded during my work at the Buryatia Science Center, an affiliate of the Siberian Branch of the Academy. Before that, I was head of laboratory and did not plan to climb the ladder. But when local authorities dismissed F.P. Krendelev, who was the director of the Geological Institute at the time, and did it ignominiously and with a scandal, A.A. Trofimuk felt insulted and decided to send me there. The main argument was almost the same as my grandfather's: "There are many heads of laboratories like you here. Out there, you will get a chance. It will be a difficult road, the more so that there are some national peculiarities. But what is the most important – you will get new opportunities."

Next, I basically followed the scheme which had already proven successsful during the creation of the Siberian Branch (it should be added that this scheme was later used with all other regional centers of the Academy). I brought several young scientists and graduates from Novosibirsk State University. Together with the staff selected by Krendelev, they made up an energetic young team. We fulfilled the tasks set by Trofimuk: the Institute has become one of the best geological institutes in Russia.

Andrey Alekseevich Trofimuk headed the Institute of Geology and Geophysics, which he founded, for 30 years. When he was still new at his position, he addressed his teammates with the words which any good leader can use as a motto: "I am not the best among you, but destiny has decided that I become your director. Work, and your glory will be my glory, too."

Sixty years have passed since the foundation of Akademgorodok; it has become home for six generations of scientists (ten years is the average period of writing a Candidate of Sciences thesis; afterwards, the former student can become a mentor). Thousands of research works, scientific awards, hundreds of authorship certificates and patents testify to the success of this venture; many books, collections, memoirs, articles and electronic pieces have been written on the history of the establishment of science in Siberia.

The chronicle of these achievements is a long story. It is impossible to seize the unseizable; so we decided to focus on one thing in the anniversary edition of our magazine: to convey, as accurately as possible, the phenomenal atmosphere of liberal thinking, joviality and creativity which saturated the town of passionarians in the very beginning of its existence. A town where people met not only in the multitude of joint academic seminars, but during volleyball games and on the beach; where seasoned scientists and green students shared hallways and a rookie could approach any Academician or professor, ask a question and get an answer.

The cowboys of Akademgorodok: A.M. Grishin, I.V. Ashchepkov, A.A. Postnikov, N.L. Dobretsov (*astride*), E.V. Sklyarov, S.V. Kuklin

Development of the young Siberian research has attracted the attention of the world academic community. Academgorodok was visited by some outstanding political and public figures, as well as by foreign delegations and well-known researchers. Foreign visitors were interested in the results achieved in innovative and boundary areas, where different research fields overlapped. It was here, at the Siberian Branch, that the first particle colliders were created – ideas generated in this area had a profound impact on further development of world physics. Among many other achievements made by Siberian researchers was the revival of Russian genetics and the development of new directions in spin chemistry and investigations into the synthesis of gene-targeted biologically active compounds on the basis of oligonucleotides. People would come here also to gain experience – similar research centers sprang up in Russia and all over the world (*Dobretsov, 2007*)

This independent spirit of Akademgorodok nourished the Tree of Knowledge, which bore amazing fruit: in a mere decade, research conducted in Akademgorodok reached, and in some cases, beat the world level. Scientific schools created by the pioneer scientists and their scientific children and grandchildren were built on a conceptually new level; with the maximum freedom of research thought, they were more than just a starting point; they became the foundation for all future achievements of the Siberian Academy.

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N.A. PRITVITS

THE CAPITALS have been abandoned . . .

Today, it is scarcely imaginable that a native of Moscow quits a well-paid job and comfy apartment and moves to Siberia, which is a four-hour flight from the capital. And not to today's Siberia with its cities having populations exceeding one million and developed infrastructure of entertainments but to the Siberia where one goes not on one's own free will but is deported under guard. In the 1960s, the voluntary move of Academician M.A. Lavrentiev and his adherents, young researchers and their families, from Moscow to Siberia to most people seemed unthinkable. Nonetheless, the idea of going to Siberia to make Big Science allured quite a few. That way, a grandiose project and just as grandiose construction started in the USSR, which turned the Akademgorodok of Novosibirsk into a phenomenon of the 20th century.
One of its aborigines became Natalia Alekseevna Pritvits, a post-graduate of the Hydraulics Department with the Kuibyshev Construction-Engineering Institute, Moscow. As everybody else, she went there to conquer Siberia and do science. She began working in the first of Akademgorodok's research institutes, the Institute of Hydrodynamics. However, the destiny had other plans for her: several years later, at the suggestion of M.A. Lavrentiev, Natalia Pritvits became the Academic Secretary of the Siberian Branch of the USSR Academy of Sciences responsible for media relations and later, a chronicler of Akademgorodok

...The capitals have been
abandoned –
Having fled the banks of the Neva
And the Academies of Moscow,
The cream of society now
lives in a valley,
The celebrated valley
Benamed Golden.
*"The Doliniad" by N.A. Pritvits**

Key words: Novosibirsk Akademgorodok, Golden Valley, Presidium of SB RAS, Chairman of SB RAS

From Wolf Ravine to Golden Valley

The Wolf Ravine was a nook on the skirts of a pine forest near the Zyrianka River. The pathfinders planted themselves here: Academician Mikhail Alekseevich Lavrentiev and his wife Vera Yevguenievna lodged in a woodman's log cabin; his disciples, son with his wife and all young researchers settled down in wooden bunkhouses nearby.

Thirty aborigines and their twelve children welcomed the new, 1959, year in snow-covered Siberia busy with routine chores like felling, cutting and chopping dry trees to burn them in stoves: the thin walls of the houses did not keep warmth and got completely frozen by the morning. Another concern was snow clearance: the snow would sometimes smother the house doors. The adults were never idle, and the children went to a play school set up by the residents of the Wolf Ravine. In the summer of 1959, another couple dozen new settlers arrived, and the Wolf Ravine was renamed as the Golden Valley.

We were lucky to be young during the era of enthusiasm. That was the time of initiative. My dream was to go to Siberia after graduation; I wanted to participate in the construction of hydro power stations. Unexpectedly, the Soviet government prescribed the development of thermal power, so all my plans of conquering Siberia fell through and I went to graduate school. As soon as my studies began, the construction of hydro power stations renewed. I remember I was so upset that there I was, stuck up in graduate school while my friends were working in Siberia, but how could I leave school?

It was my good luck that in 1957 the government issued a decree on the establishment of the Siberian Branch of the USSR Academy of Sciences. M.A. Lavrentiev invited Academician Pelagueya Yakovlevna Kochina to work in the Institute of Hydrodynamics, which had not been set up yet. She invited my research advisor, the hydrodynamicist Oleg Fedorovich Vasiliev, to join her, and he in his turn took me. It happened, however, after I completed my graduate studies. This is why I came a year later than the first settlers of the Golden Valley (in the summer of 1959), and cannot consider myself an aborigine in every sense of the word. It did not prevent me though from perceiving the atmosphere of that wood nook: it was freedom. Freedom to create and freedom to live – they are interrelated. We lived at will and communicated at will, and this liberty extended to doing science. Today, we can hardly imagine that somebody works not by hours but for the common cause. When there was no Institute of Hydrodynamics yet, we pursued science at home because this was our life.

* The name of the poem is a derivative of *dolina* (the Russian for "valley")

Natalia Alekseevna PRITVITS is a Candidate (Ph.D.) of Engineering, hydraulic engineer and journalist. From 1970 worked for the Presidium of the Siberian Branch of the USSR Academy of Sciences. At different times she held the positions of academic secretary in editing and publishing and media (press, radio, television, cinema) relations and was the manager of the newspaper *Za nauku v Sibiri* ("For Science in Siberia";from 1982, "Science in Siberia"). Was awarded with the Order of the Badge of Honor and with the medal of the Order for Merit to the Fatherland, 2nd class. From 1973, member of the USSR Union of Journalists. During almost 40 years, N. A. Pritvits was an associate of the chairmen of the USSR SB RAS: Academicians M. A. Lavrentiev, G. I. Marchuk, and V. A. Koptyug. From 1997 worked for N. L. Dobretsov, and from 2008, for A. L. Aseev

The atmosphere catalyzed not only scientific research but creative writing as well. I wrote *The Doliniad*, a poem in the Pushkinian style, which was read at the New Year celebration. This was the year 1960, and we welcomed it in Lavrentiev's small house. Mikhail Alekseevich (or Granddad, as he was lovingly called among us) and his wife Vera Yevguenievna used to invite us to Sunday lunches. It goes without saying that we celebrated all the holidays together. We were like a big family, we were all Lavrentiev's children.

Mikhail Alekseevich appreciated *The Doliniad* so much that he and Vera Yevguenievna presented me with a ten-volume edition of A.S. Pushkin, which they had brought from Moscow for their family library but then decided to give it to me. I still keep it. After the gift, Lavrentiev made me a business offer. At the time, he used to give gazillions of interviews, and the texts were sent back to him for approval. Of course, he did not have time to do it, and I started to proofread for him. At the same time, I continued to do science: worked enthusiastically in the research institute and passed Candidate's (Ph.D.) defense. One fine day in 1970, Lavrentiev offered me to become his assistant and head of the media relations group (its name changed a few times). At first, I worked alone and then with an assistant, and it lasted over 30 years.

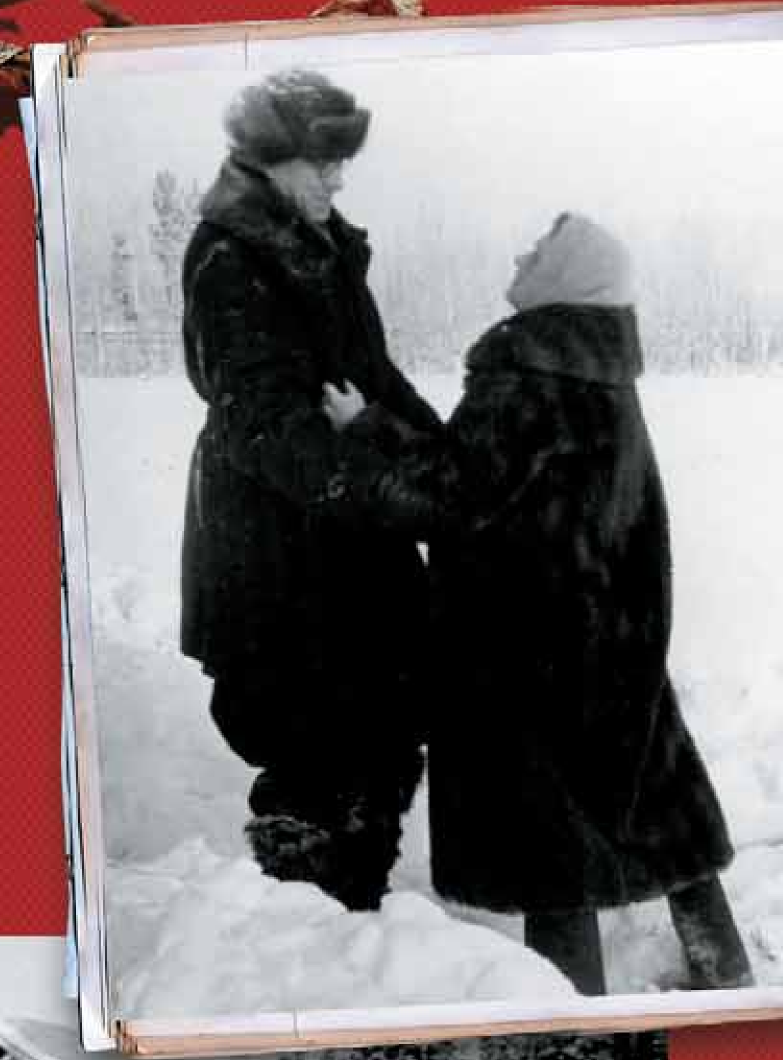
Wolf Ravine – Paris

I worked at Lavrentiev's side throughout his tenure of the office of Chairman of the Siberian Branch of the Russian Academy of Sciences. He was a person of immense energy and immense valor. Despite his high position, he was outgoing and accessible to everyone. He loved young people and communicated with them a lot. This is how the team was built. No doubt, Mikhail Alekseevich was brilliant at organizing research but what's more, he was a remarkable man, and I'll tell a couple of stories about our daily routine to prove it.

Since at first the Golden Valley could not boast of many gaieties, Lavrentiev and his wife would invite everybody to their home, especially the single ones, and there were 15–20 of us. How the young could entertain themselves out in the woods? In winter, Mikhail Alekseevich

...There is a house looking very similar to others
Nothing special about it
But for quite a few trails stamped in the snow
Join here, on the steps
Well-known to everyone.
And all the night through
Somebody paces up and down…
Married and single,
Good or bad,
We all come here often,
And we all love this home.
A visitor, even if uninvited,
Is never unwanted;
The lights are on late into the night
And music sings for hours;
It is always packed
And there's total freedom in any way –
Some people drink and others eat,
And there's enough room for everybody,
There's children's babble and chatter,
There's no trace of boring formalities,
And Lavrentiev here is just Granddad.

From "The Doliniad" by N.A. Pritvits,
about the house where
M.A. Lavreniev's family lived



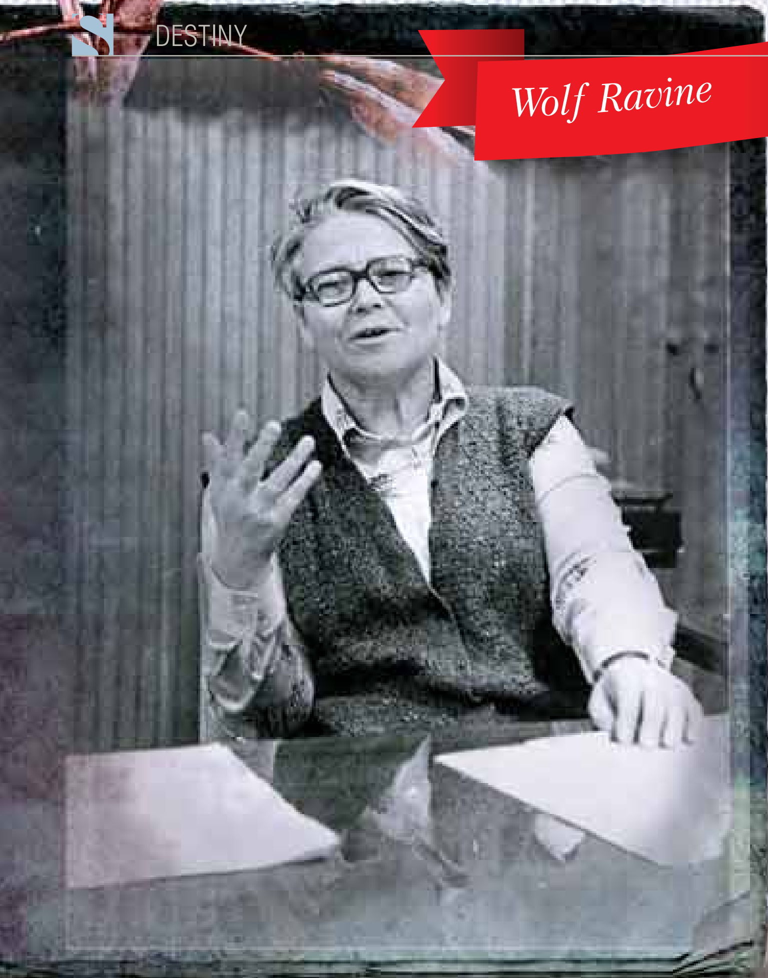
Mikhail Alekseevich and his wife Vera Yevguenievna in the winter of 1958–1959

The first laboratory building of the Institute of Hydrodynamics, SB RAS.
SB RAS photo archive. Source: G.I. Marchuk's archive

The first winter in Siberia. *1958–1959*

Wolf Ravine

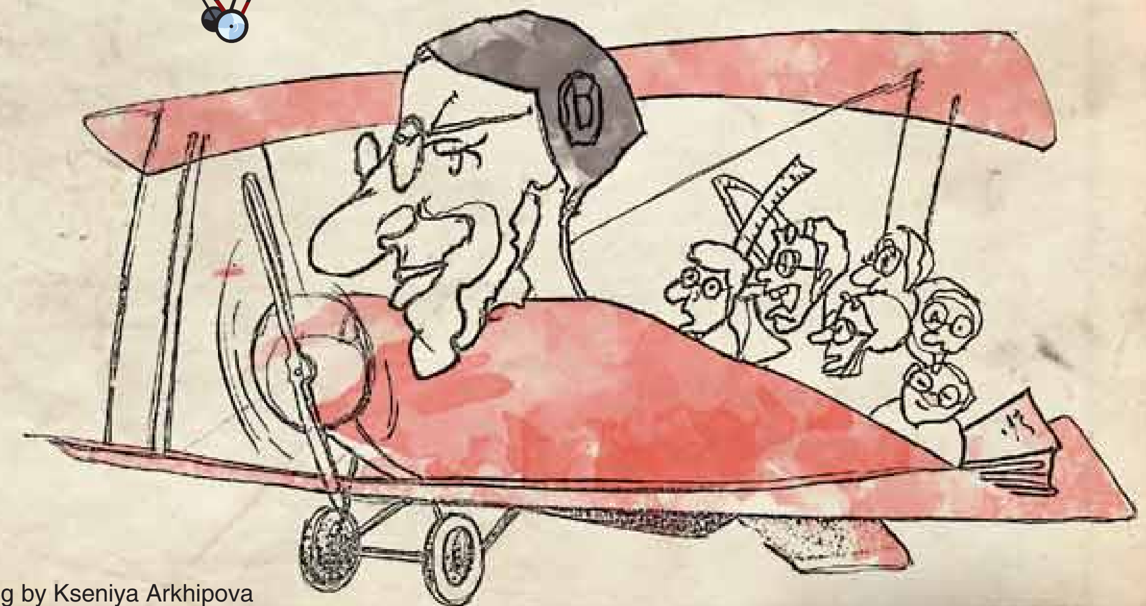
Paris



1961 Explosion welding invented

1962 The first summer school of NSU

M. A. Lavrentiev, A. A. Deribas and L. V. Ovsiannikov during an experiment conducted at the Institute of Hydrodynamics, SB USSR AS (Novosibirsk)



Drawing by Kseniya Arkhipova

1963 The school of Physics and Mathematics has been set up

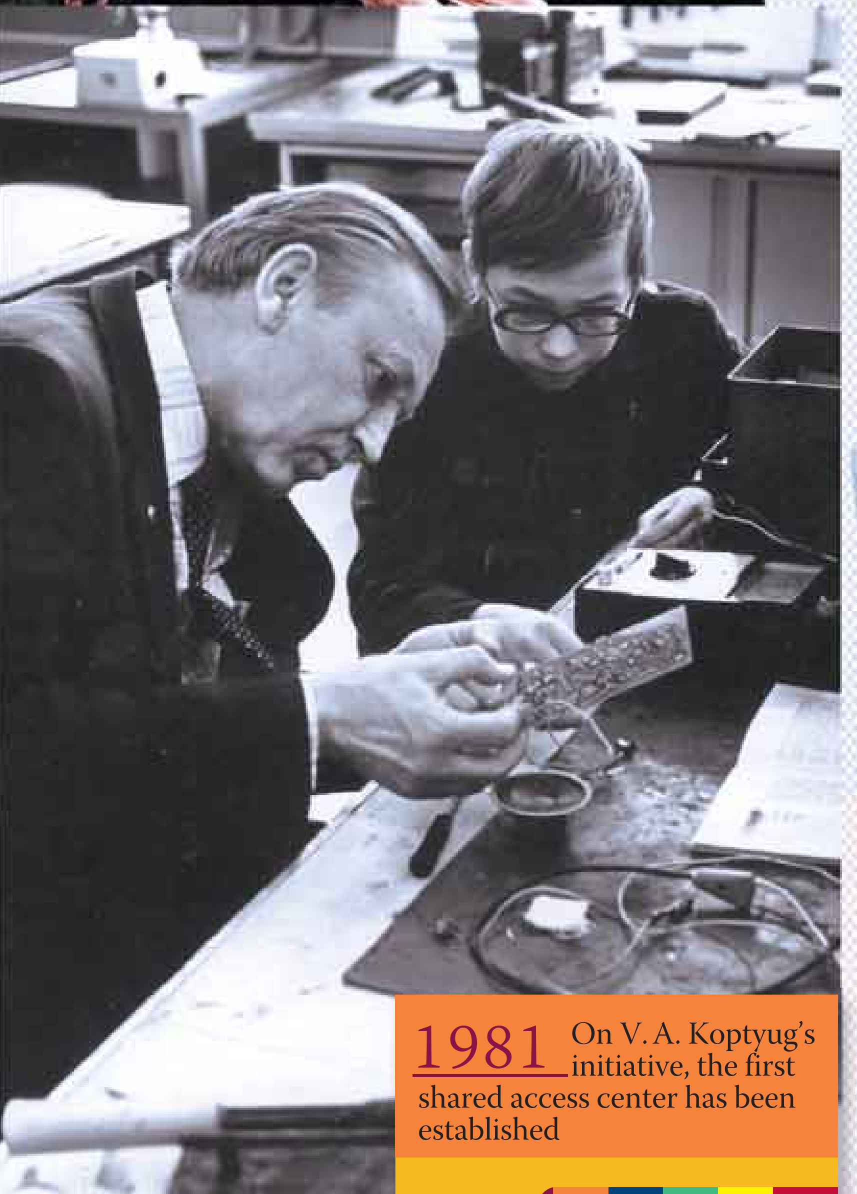
allowed us to attach a tow wire to his car and would give us a ride of Akademgorodok, which was then in process of construction, as far as the Institute of Hydrodynamics.

One day Vera Yevguenievna told her husband: “Why don’t you take the kids somewhere? Shouldn’t they get a life?” And Mikhail Alekseevich took 20 people to Paris!

Going abroad at that time was a great challenge, and for those involved in classified subjects, such as explosions, it was totally unbelievable... However, Lavrentiev organized this as a travel-study trip. The travel costs were up to us, and everybody handled it in his or her own way: I borrowed the money from P. Ya. Kochina, and Mikhail Alekseevich sold his car to pay for the trip of his son Mikhail with his wife and his daughter Vera. And there you go; we all made it to Paris! Today, you can hardly imagine the way it was.

Of all the chairmen of the Siberian Branch I worked for (M. A. Lavrentiev, G. I. Marchuk, V. A. Koptyug, N. L. Dobretsov, and A. L. Aseev) the one most congenial to me was Valentin Afanasievich Koptyug. He was exceptionally tactful, composed and friendly. We were of the same age, I was just ten days older, and it brought us together in many ways.

M. A. Lavrentiev. *SB RAS photo archive*



1981 On V. A. Koptyug's initiative, the first shared access center has been established

V. A. Koptyug in the Young Engineers' Club, SB RAS

"What are we, Germans in Siberia?"

When Lavrentiev was arranging our trip to France, he (as I found out later) came across some problems related with my departure. I appeared to have relatives abroad. A while later they found me, and it happened thanks to Akademgorodok, where I made friends with the future documentary film maker Leonia Vuss. After graduation from the All-Union State University of Cinematography, she made a documentary called *What are we, Germans in Siberia?* which had a photograph of my father. A few years later this film was run in Germany, and it was how my German relatives, the Pritvitses, found me. My father happened to be a baron of ancient lineage. I had not known anything about it.

He has always been diligent –
Good little boy,
So he ended up as the chairman
Of all the SBAS sciences.
No matter what topic he takes up,
He sees a system at once,
Is not afraid of any burden,
And works like a dog day and night!
Was elected to the Academy,
But didn't get on the high horse –
Has remained an endemic
Of romantic days.
He cannot use bad language,
Or escape responsibility,
Or evade a clear answer,
Or take a week's holiday in summer.
He pursues the general line
For all he is worth.
He's made up his mind
To reconcile chemistry and ecology
Because he is green himself
Though has common sense
And wants not to go back to the cave
But to create noosphere in the world.

N. A. Pritvits to Valentin Afanasievich Koptyug, 1990

It happens sometimes that the will, executive talent and commitment of a single person determine the present and future of an entire community. Valentin Afansievich led the Siberian Branch of the Russian Academy of Sciences through the most difficult period, when the reorganization of the national system entailed a crisis in the economy and, as a result, in national science. Valentin Afansievich brilliantly coped with this challenge and initiated systematic changes in the Siberian Branch.

Thanks to Koptyug, the Siberian Branch managed to save face and remain highly important for domestic science. This became possible owing to his efforts to preserve the main thing – scientific brainpower. He succeeded in pursuing strategic plans, flexibly and promptly responding to the constantly changing conditions and preserving the key points of the philosophy of the Branch founders: multidisciplinary nature of scientific research and its high level; focus on promoting scientific results from the idea to their implementation in the region, country or abroad; attracting young scientists; providing the young with a high level of education and conditions for scientific research.

Dobretsov, 2011

N. A. Pritvits, V. A. Koptyug, and I. N. Glotov

Valentin Afanasievich initiated systematic changes in the Siberian Branch in tough conditions, mapped out and largely implemented the basic provisions of the development strategy for fundamental science, which allowed for a flexible and prompt response to the constantly changing conditions and preserved at the same time the main things put in place by the founders of the Siberian Branch.

Owing to various funding sources, a multitude of shared access centers have been set up including the Synchrotron Radiation Center, Center for Photochemical Research Based on Free-Electron Lasers, Center for Cainozoe Geochronology, Center for New Medical Technologies, etc.

Dobretsov, 2011

1996 Lake Baikal is put on the list of the World's Natural Heritage

In 1994 the UNO General Secretary Boutros Ghali invited Koptyug (the only one from Russia) to join the Sustainable Development Advisory Council. One of Koptyug's proposals was to designate areas, in a number of countries, that could become models of sustainable development. He also proposed to make the Baikal region such a territory in Russia. As the result of intensive work carried out in the institutes of the SB RAS together with the UNESCO representatives, in 1996 Lake Baikal was included in the World Environmental Heritage List and as such recognized as not only national but international heritage.

Dobretsov, 2011

I was born in Leningrad in 1931. As early as in 1935, after Kirov was killed, they started to remove the people of noble birth from the city (I did not realize it then, of course, as I was four). Our family was deported, and until the beginning of the war (1941) we lived in Ufa. My mother worked as a typist, and my father completed a geodesy course and worked in all sorts of places.

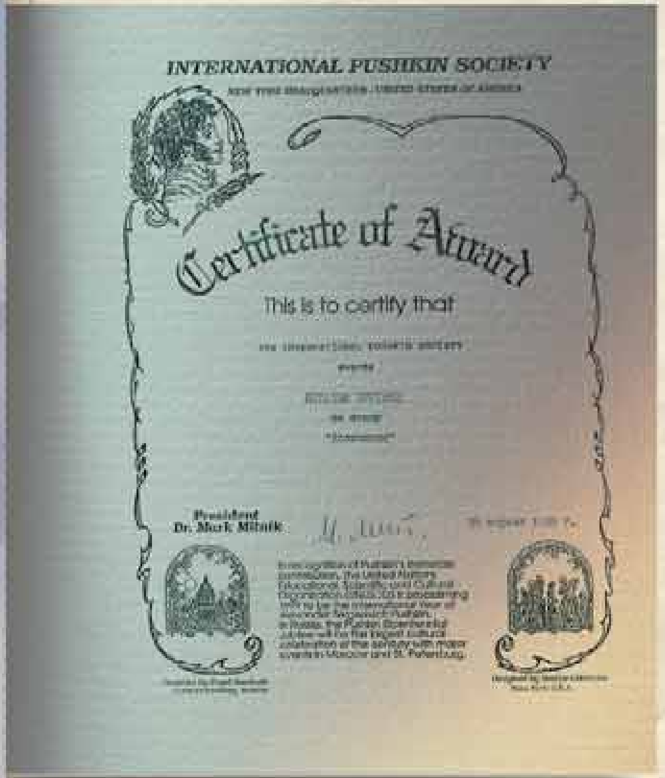
In the first days of the war, the father was drafted to military service. He was marching off to war together with other recruits, and my mother and I were running after him like in the film *The Cranes are Flying*. In three days, the father came back: geodesists were badly needed behind the lines.

In the same year, 1941, we were ordered to leave the town in ten days at the latest and were told that our failure to do it would be considered a crime. It was winter and it was very cold...we were sitting at the railway station and just did not know where to go. Suddenly, a man we didn't know approached my father and began asking him questions. He appeared to be the head of a survey party that was in charge of designing a railroad from the Mikhailov alkali-works in Altai to Kulunda Station on the Trans-Siberian Railway.

The father landed a job in the survey party and worked there until 1943. After that, he was often relocated from one construction site to another, and we were always on the move, mostly around the territory of Ukraine, which was being liberated. In eight years, I went to twelve schools. The last three years of my schooling were in Kherson. This was our longest stay in one place. After that I went to university in Moscow and after graduation, to Siberia, this is why I did not know much of my family history. In that situation it was just impossible to find out anything about the family skeletons: there was no time and probably it was not safe for my parents to tell me about the aristocratic ranks and roots. Germans helped.

Much later, when I went to Germany in the 1990s, they gave me a book with the Pritvits lineage from the 13th century. My grandfather, grandmother and father were there. Information about the father comes down to his year of birth, and then "married..daughter...got lost in Russia." During that trip I found out a lot about my relatives. For example, my father's godfather was Emperor Nicholas II. My grandfather was a colonel in engineering troops; he was in charge of railroad construction and would often accompany the tsar in his journeys around the country – railway trips used to be long at the time. It happened so that the tsar was expecting the heir at the same time as my grandfather was expecting a son.

Coat of arms of the Prittwitz family



In 1998, the International Pushkin Society awarded Natalia Pritvits for the poem *The Doliniad*

We sing about the pioneers
Who were the first to settle here
And about buccaneers
Disdaining kitchen-silk comfort,
About those who forward science,
And also sing that
– What a bummer! –
Novosibirsk is not Colorado…
Not Colorado but who cares?
It doesn't matter a hoot to us!
If Siberia is not Colorado,
Colorado is worse!

"The Doliniad" by N.A. Pritvits

Drawing by Kseniya Arkhipova

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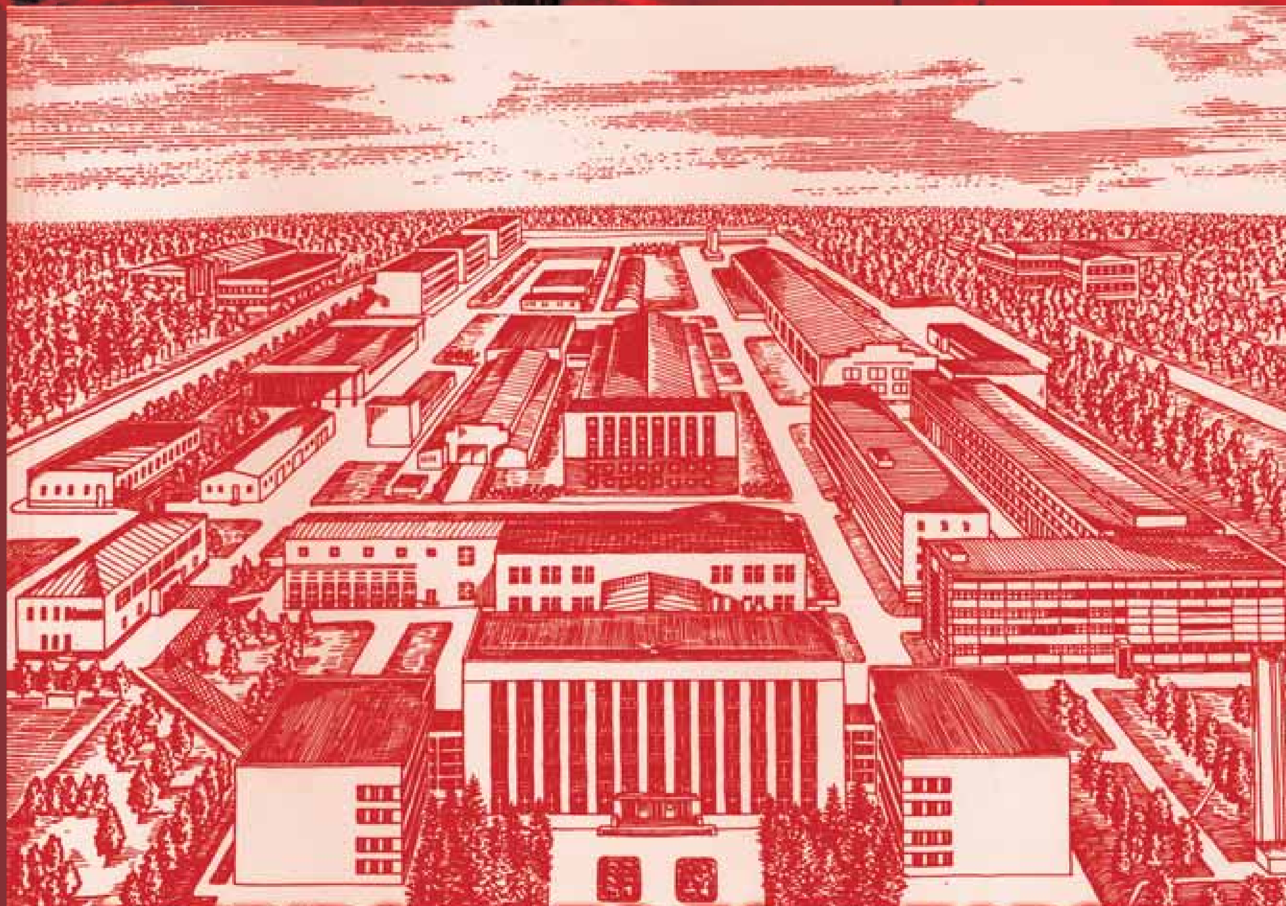


BINP grew in a forest, like a mushroom

In the mid-20th century, physicists began to talk about the colliding-beam accelerator. Back then, a sweeping majority of scientists around the globe saw it as a fantasy and remained skeptical. However, Andrei Mikhailovich Budker, then a researcher at the Institute of Atomic Energy in Moscow, got inspired by the colliding beams idea after the Geneva high-energy physics conference in 1956. A team of young scientists was put together to devise the VEP-1 electron–electron collider. The construction works on the collider began in Moscow, but VEP-1 delivered its first colliding electron beams later, when Budker and his team had moved to Siberia and established the Institute of Nuclear Physics in Novosibirsk

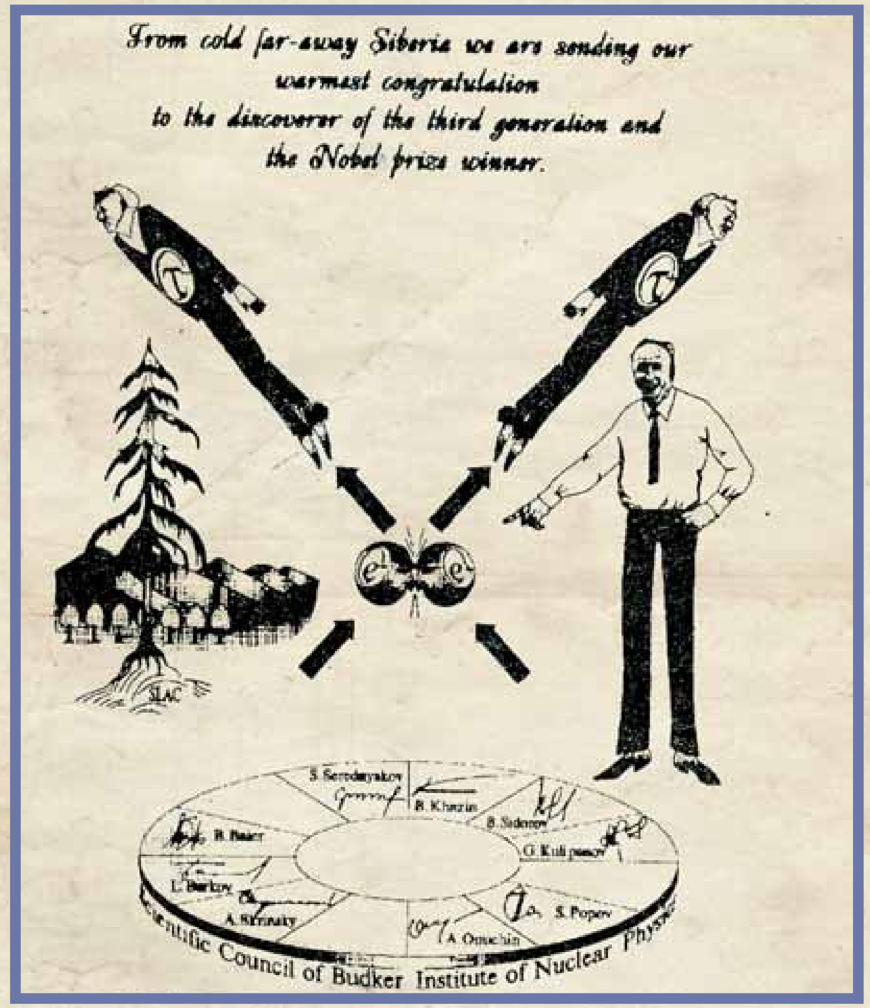
Key words: Institute of Nuclear Physics, Budker, particle accelerators, VEP-1, VEPP-2, Large Hadron Collider, CERN

A. N. SKRINSKY

I first heard about Andrei Mikhailovich* Budker and his lab – the Laboratory of New Acceleration Methods at the Institute of Atomic Energy in Moscow – when I was finishing my fourth year at the Physics Department of Moscow State University. It was time to decide where to apply for pre-graduation practical training. The parents of a girl in my study group were on friendly terms with Prof. I. I. Gurevich, who advised me to choose Budker as a supervisor of my degree thesis.

Academician A. N. Skrinsky

* Budker's real first name and patronymic were Gersh Itskovich, but his close friends and colleagues called him Andrei Mikhailovich

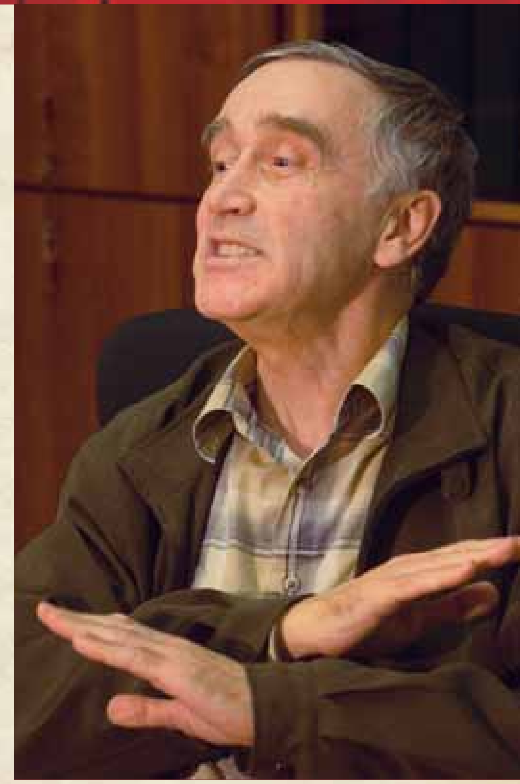


"From cold far-away Siberia we are sending our warmest congratulations to the discoverer of the third generation of leptons and the Nobel prize winner," the Scientific Council of the Institute of Nuclear Physics sent their congratulations together with a drawing by Efim Bender to an American physicist Martin Perl, who discovered several elementary particles, including quarks

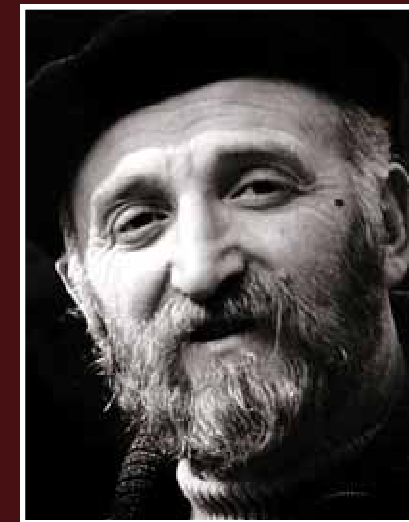
I decided I would go to an interview with Budker at his lab at the end of the summer and went on a hike with friends to Lake Baikal. The hike was very demanding, lasting three weeks, so I barely made it to the interview on time. But they accepted me to the lab as a trainee.

I'd worked with Boris Chirikov as my mentor for three months when Budker invited me to join a microgroup that investigated colliding electron beams. At that time he was recruiting young scientists to design the world's first colliding beam accelerator. So, I and a few others flung ourselves into all kinds of scientific tasks associated with colliding beams.

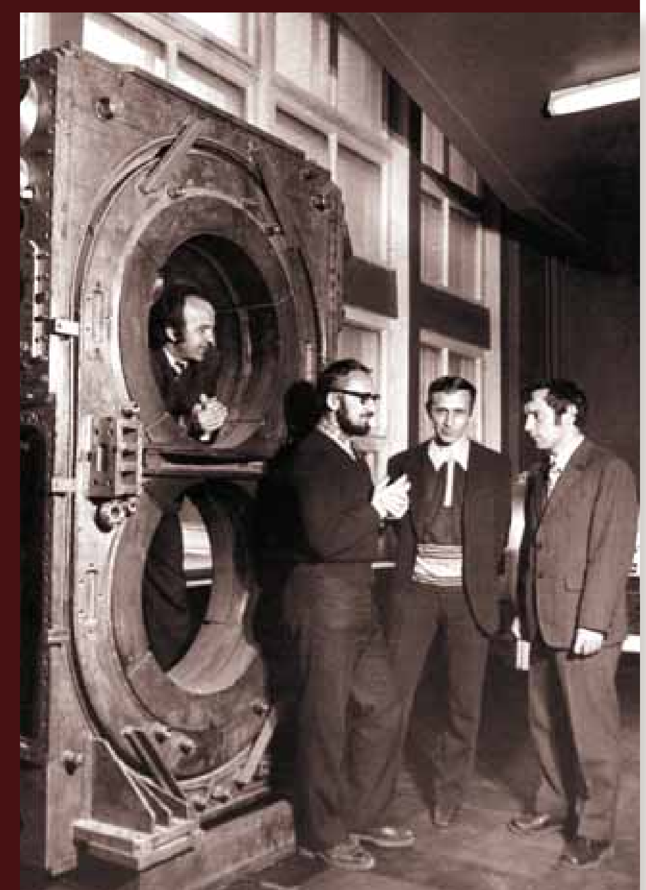
Back then, a dozen labs around the world attempted to develop a colliding beam accelerator, but only two of them – we and Stanford University – reached the finish line.



Alexander N. SKRINSKY, Member of the Russian Academy of Sciences; Doctor of Physics and Mathematics; Scientific supervisor of the Budker Institute of Nuclear Physics, SB RAS (Novosibirsk). Fellow of American Physical Society and invited member of Royal Academy of Sciences (Sweden). Prizes awarded include the Lenin Prize (1967), the State Prize of the USSR (1989), the State Prize of Russia (2001 and 2006), the Demidov Prize (1997), the R.R. Wilson Prize of the American Physical Society, and the A.P. Karpinsky Prize of the Toepfer Foundation (Germany). Medals and orders conferred on A. Skrinsky are the V.I. Veksler Gold Medal of RAS (1991), the P.L. Kapitza Gold Medal of RAS (2004), the Red Banner Order (1975), the October Revolution Order (1982), the Order for Services to Motherland, IVth degree (1996), the Order for Services to Motherland, IIIrd degree (2000), the Order for Services to Motherland, IInd degree (2007). Author and co-author of over 300 works on accelerator physics and high energy physics. Likes classical music and ski races



Academician G.I. BUDKER, outstanding physicist, founder and first director of the Institute of Nuclear Physics of the Siberian Branch of the USSR Academy of Sciences



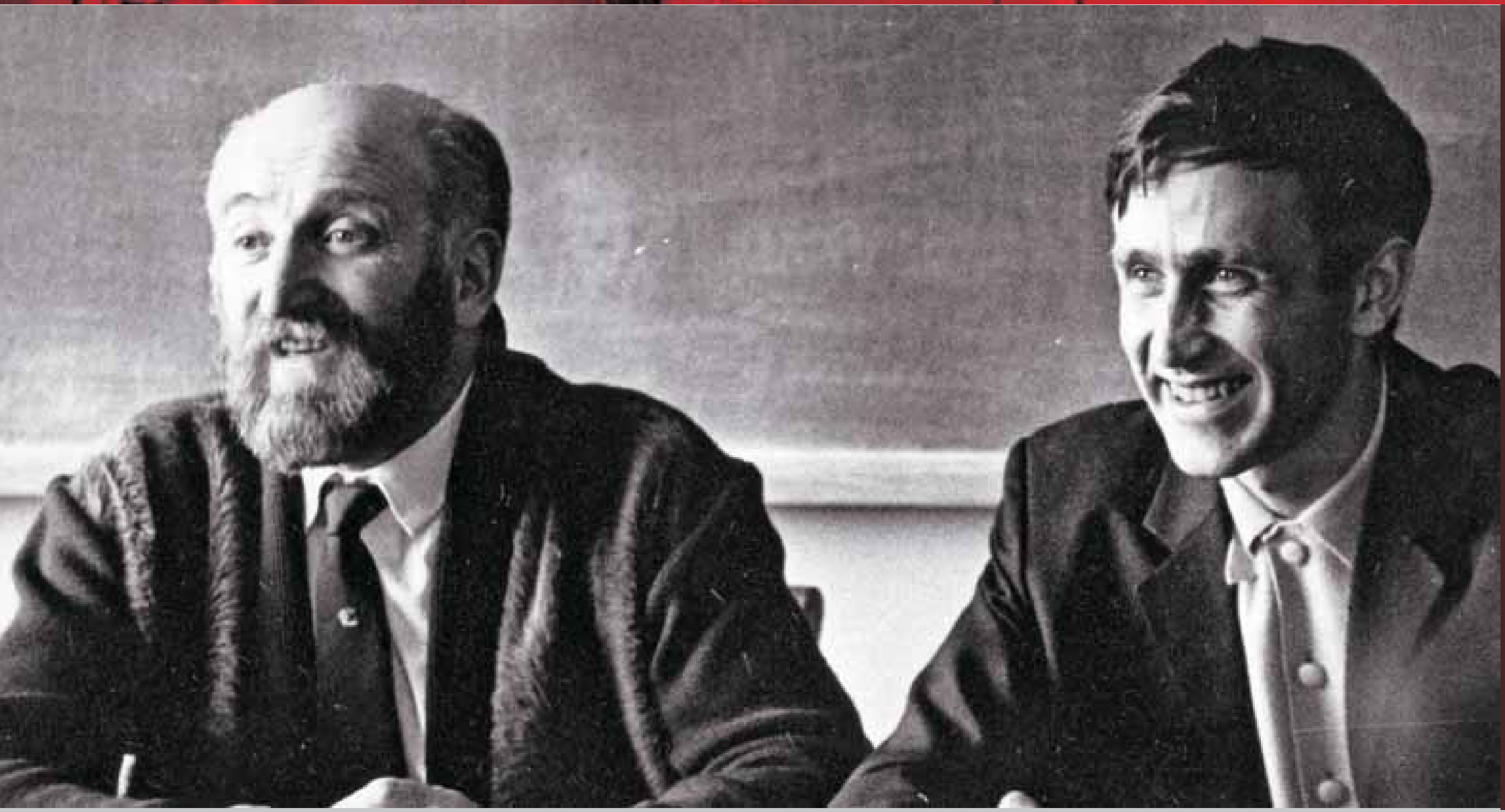
VEP-1, now a relic. Participants of the launch (*from left to right*): G.N. Kulipanov, S.G. Popov, A.N. Skrinsky and G.M. Tumaikin

One of the major tendencies in the development of modern physics is the obtaining of higher and higher energies in charged particle accelerators to increase the energy of the interaction reaction of particles. Since the times of Rutherford, the scheme of such experiments has not changed; a fixed target is bombarded by a bunch of fast particles. This scheme, however, is not efficient at high energies when particles are accelerated to near light speeds. At such a speed, the mass of "particles-projectiles" abruptly increases and becomes much greater than the mass of target particles. When a heavy "projectile" hits a light particle of the target, only an insignificant part of its energy obtained with such difficulty is used by the reaction itself. The "lion's share"is merely spent for the motion of both particles.

We followed another path, making the target mobile and colliding two particle beams accelerated to the same energy. In this case, the masses of the "projectile" and target remain equal, and they can turn all their energy into the energy of interaction.

It is very important that at particle velocities close to the light velocity, the effect of interaction of colliding particles increases much more than by a factor of four (in accordance with Newtonian mechanics). For instance, at the collision of two electrons moving towards each other with an energy of a billion of eV, the effect of interaction is the same as that of a conventional accelerator with an energy of 4000 GeV. The very idea of colliders is not new; it is not a scientific discovery. This is a mere consequence of Einstein's relativity theory. This idea was expressed earlier but, as a rule, the possibility of its realization was viewed pessimistically. This is understandable. After all, the density of a mobile target, i.e., a beam of particles in conventional accelerators, is by a factor of hundreds of trillions (number with 17 zeros) less than that of a fixed target. The problem of colliding two particles is about as complex as that of "arranging" a meeting of two arrows, one of which is shot by Robin Hood from the Earth and the other one by Wilhelm Tell from the planet revolving around Sirius. However, the advantages of colliding beams in comparison with conventional methods are great, so that we decided to overcome the difficulties. This required increasing the density of beams and making them pass many times through each other.

Newspaper "Za nauku v Sibiri", January 14, 1970



Gersh I. Budker and Igor V. Kurchatov (*standing, left to right*) at the signing of important documents in Moscow in 1957. *SB RAS Photo Archive*

Andrei Mikhailovich burned with the desire to embark immediately on the realization of all these ideas. However, the ideas were too complicated, almost fantastic, and he himself was only a theoretician. At this time he took probably the most important step in his life, a very bold and unusual one, not a step, but rather a jump into the unknown – he decided to place himself at the head of a group of enthusiasts, experimenters and engineers, who were prepared to transform his ideas into reality. Andrei Mikhailovich did not take this step without internal hesitation and even dread, but nevertheless he made up his mind, made up his mind in the face of insistent advice and exhortations of many close friends. Having no experience in organization of experimental research, but also unfettered by tradition, Andrei Mikhailovich advanced his original ideas also in this area: how a creative scientific group should live and develop. Thus was born the Budker school. At first, in 1953, this was a small group of only eight men. However, the results were not long in coming – in the first few years he built an accelerator of the betatron type with a current up to 100 A, which exceeded by two orders of magnitude the currents of the best accelerators of that time. Andrei Mikhailovich's small group grew into one of the largest laboratories (The Laboratory of New Acceleration Methods) of the Atomic Energy Institute, and in 1958 it was converted into the independent Nuclear Physics Institute of the young Siberian Division of the Academy of Sciences of the USSR. Nevertheless, it turned out to be impossible to produce a stabilized beam – the technical difficulties turned out to be insurmountable. This problem still awaits its solution in the future. Andrei Mikhailovich understood this, probably, sooner than others did. What should be done? Quite a large group had been working intensively with total devotion. Where should this flux of creative energy be directed? He found the solution – colliding beams!

From: Academician Gersh Itskovich Budker (Obituary) by Aleksandrov A.P. et al., 1978

After hot science – to cold Siberia

Soon afterwards, Andrei Mikhailovich insisted that we all should move to Novosibirsk. In Moscow, authorities kept scientists on a short leash while Siberia promised more scientific freedom and autonomy. Still, the most part of the lab chose to stay in Moscow – very few dared to leave for Siberia.

At that time, a young physicist Veniamin Sidorov returned to Moscow after a year at the Nielson Bohr Institute. Andrei Mikhailovich offered him the position of the head of the Moscow laboratory while he himself would set off with a small team to Novosibirsk for yet unknown prospects. Sidorov retorted, however, that he had no desire to get stuck in Moscow doing old stuff while Budker's team was doing real science in Siberia. Eventually, Sidorov became head of laboratory at the future Institute of Nuclear Physics, and I became his deputy.

However, most of our colleagues didn't side with us: they thought that moving to Siberia was utter stupidity – Moscow was a city of opportunity and we were about to leave "for woods." One very good physicist with an acid tongue told me, "You're going to Novosibirsk? That's just nuts. Okay, give it a try, and in two or three years, when all of you go under, we'll take you back." In 3 years we obtained the first colliding beams, and in 15 more years this physicist came to Novosibirsk to defend his doctor-of-science dissertation. I didn't gibe.

Our institute soon became the leading center of elementary particle physics in the Soviet Union. So, we grew in a forest, like a mushroom.

As early as during the construction of VEP-1, Budker contrived an idea of a facility with electron–positron colliding beams, a far more complex and exciting project. Budker went to Moscow to meet with Igor Kurchatov and showed him a "project description" on a few sheets of paper. Kurchatov sent those papers to the three leading physicists of the Soviet Union for a review. One of these physicists was Vladimir Veksler, an Academician of the USSR Academy of Sciences. All the three sent back their very similar opinions: an electron–positron collider was a brilliant idea, but impossible to implement – neither now, nor in the future. Budker drooped his head, but Kurchatov stroke his famous beard and said: "Well, let's now draft a resolution for the Central Committee and the Council of Ministers." He thought it more important that the reviewers considered the idea interesting, and implementation was, in his view, a secondary issue. Kurchatov dared to bet not on high-class physicists but on a team of vealy enthusiasts (the oldest guys in our group were recent university graduates, and Budker himself was only 37 years old).

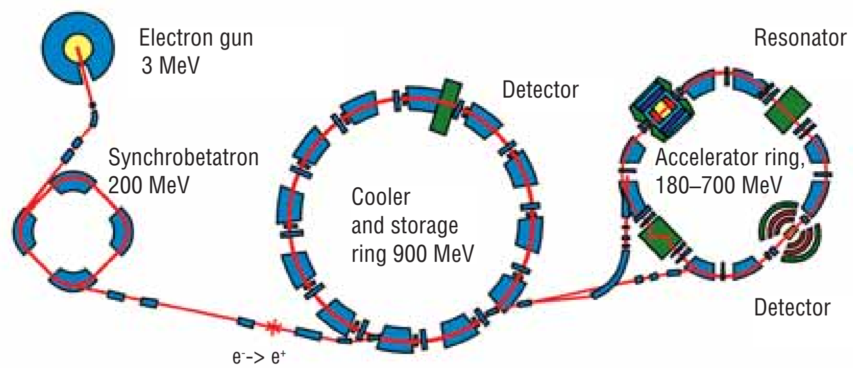
So, the Laboratory of New Methods of Acceleration transformed into the Institute of Nuclear Physics, Siberian Branch, USSR Academy of Sciences. By the way, only one of the three reviewers later admitted that he was wrong. Veksler came to Novosibirsk when VEP-1 had generated the first beams and VEPP-2 was under construction. He saw, with his own eyes, the synchrotron radiation from the beams; he saw the beams accumulate, shrink crosswise,

on page 34

1964 Launch of VEP-1, the first colliding beam accelerator

The first colliding beam accelerator VEP-1

1965 Launch of the VEPP-2 electron–positron collider

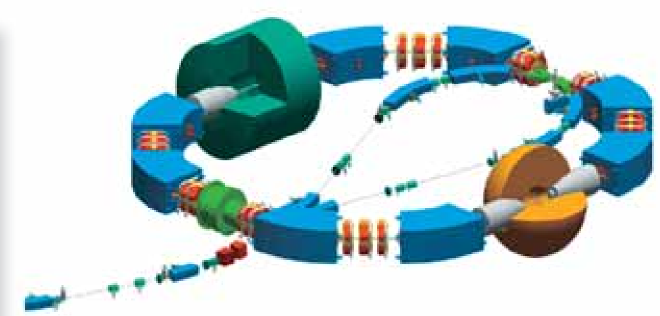


The VEPP-2 facility operated in the energy range 0.4–1.4 GeV. The maximum luminosity achieved at VEPP-2 was 5×10^{30} cm$^{-2}\times$s^{-1} at 510 MeV. In 1972, the institute launched a new VEPP-2M accelerator. *Below:* the VEPP-2 rotating magnet, now a museum exhibit

1971 Development of the VEPP-3 electron–positron storage ring

The B-4 booster synchrotron in which there occurs initial acceleration of electron (positron) beams to the injection energy (360 MeV) into the VEPP-3 storage ring

1999 Modernization of VEPP-2M—development of VEPP-2000



SND (Spherical Neutral Detector), a detector of elementary particles, in the experimental gap of the VEPP-2000 booster ring

shine brighter and brighter... With increasing energy, the beams changed their color from orange to blue, and they lived long! Veksler came to a roundtable meeting at the institute and said: "I gave a negative review on the project, and I was wrong. My congratulations on your success!"

When we obtained the first electron–positron beams, it was unbelievable! No words would describe our emotion. Now it all seems to have happened fast, but back then we worked day and night and didn't see any progress. Things were always breaking down; we had to repair them again and again.

In 1967, we got the Lenin Prize for our experiments with colliding beams. A year earlier, in 1966, Budker and I made a tour of the United States, where we visited all the institutes and labs studying elementary particle physics. We toured the country for a month, talking about the behavior of particle beams at collisions.

This marked the beginning of a new chapter in our life: our institute became a world center of nuclear physics, and we began to teach vigorously at Novosibirsk State University and Novosibirsk State Technical University. Since then, 90 % of our staff have been graduates of these two universities.

1979 Launch of the VEPP-4 electron–positron collider

on page 38

Celebrating the birth of epsilon-mesons at VEPP-4. April 30, 1982

SR AT THE BINP

It is known that synchrotron radiation (SR) is the daily bread for many users; for accelerator physicists, it is a parasite because it takes away a large part of energy pumped with great effort into the beam of charged particles accelerated nearly to the speed of light. Now the SR sources at the Institute of Nuclear Physics (INP) are VEPP-3 (created in 1972) and VEPP-4M (put in operation in the early 1980s and later modernized), on which studies in the field of elementary particle physics are conducted. Consequently, SR experiments take only 15 % of the total time of accelerator operation. Thus, although SR experiments have been carried out at the INP ever since 1973, they still use not sufficiently bright first-generation SR sources.

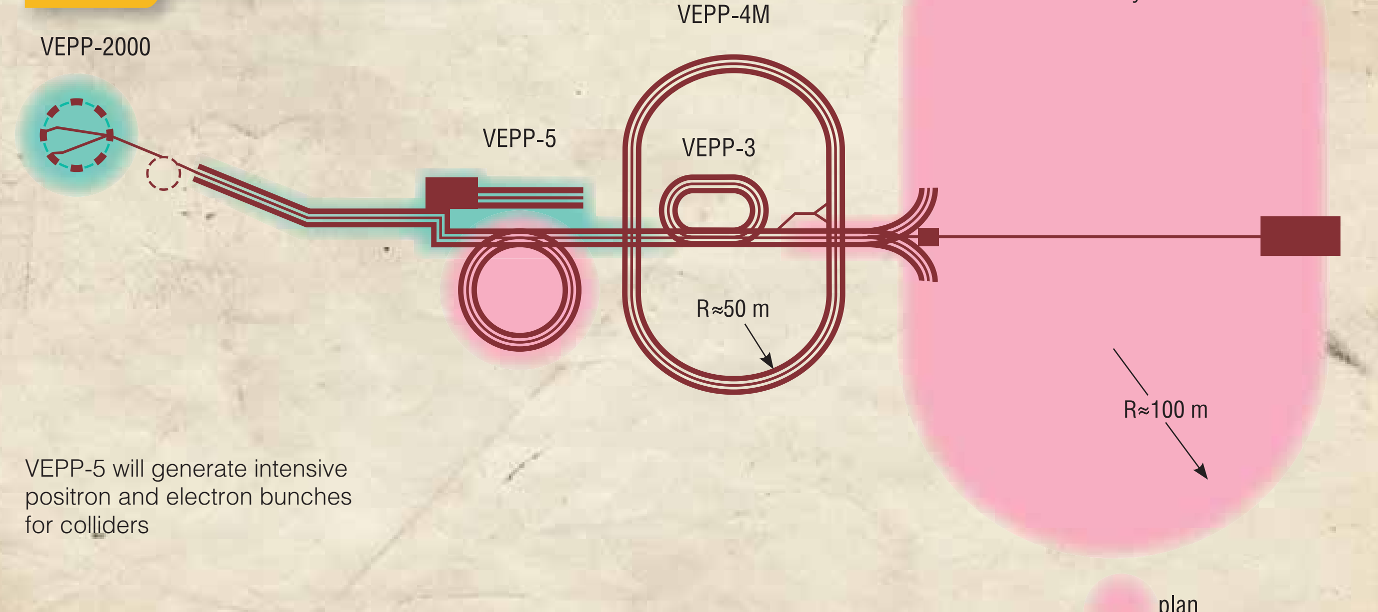
It is worth mentioning that the 2003 commissioning of the first line of a free electron laser system (a source of powerful terahertz radiation beams) principally expanded the INP's research potential; however, it is still necessary to develop a more powerful new generation SR source that will operate in the X-ray range.

Nonetheless, our sources have been heavily exploited for both research and routine technological aims. For instance, the researchers from the Institute of Catalysis SB RAS (Novosibirsk) are constantly analyzing samples of novel catalysts intended for industrial applications. Our main advantage is that SR at the INP has largely maintained its initially unrestricted status of a research tool; so, practically any scientist can use it to verify his/her idea (however crazy it may be). In this respect, it is very important that our SR sources are located in such an unusual infrastructure as Novosibirsk Akademgorodok, i. e. in a vast multidisciplinary environment. For instance, archaeologists, who work in the same neighborhood, can ask physicists to analyze any artifact they are interested in.

Moreover, we elaborate the procedures which in principle are difficult to develop at large SR centers, which, to some extent, is due to administrative restrictions. A good example is the study of detonation processes with a submillisecond time resolution in a special explosion chamber located at the SR output channel. The first experimental station, named Detonation, was set on the VEPP-3 storage ring, and later a second station started its work on the VEPP-4 storage ring: the new chamber made it possible to investigate the detonation of charges weighing up to 200 g. Here, we plan to study the effect of powerful laser plasma pulses on construction materials. The knowledge of these processes will be necessary for designing future thermonuclear reactors. The COSMOS synchrotron radiation station – a little "piece of cosmos" enclosed in a vacuum chamber where synchrotron radiation comes from the VEPP-4 storage ring. The combination of high vacuum and strong radiation fluxes creates volumes (in the experimental station conditions) that are similar to conditions in the near-earth space. COSMOS is now the only synchrotron radiation station in Russia that works for metrology needs in the soft X-ray and EUV ranges and can perform satellite equipment calibration.

(Zolotarev, Piminov, 2015; Nikolenko, 2015)

2015 Launch of the first part of the VEPP-5 accelerator complex



VEPP-5 will generate intensive positron and electron bunches for colliders

The Large Hadron Collider constructed at CERN has a circumference of the main tunnel of 27 km, and its name is fully justified. Connected to LHC will be a whole family of accelerators in which particles are successively accelerated to velocities maximally close to the speed of light

SKRINSKY'S PLAN

In the beginning of the 1990s, it became clear to me as well as to all my colleagues working in the field of high energy physics that the only chance for Russia to remain in the vanguard in this area was to become an equal member of the LHC project. No need to say, our government could not afford to invest over 100 million dollars of its budget in CERN, as other countries did. Then I came up with an unconventional plan of Russia's participation in the project, which was sure to satisfy all the parties interested.

The gist of this plan is as follows: Russia supplies high-tech research equipment whose cost, in world prices, is 150 million dollars. Russia's research institutes – contractors agree to make it for 100 million dollars, which they obtain, in equal parts, from the budgets of CERN and Russia. In this plan everybody wins: CERN gets the equipment for $100 million "net" as Russia's contribution in the project; Russia pays only $50 million for its participation in the most ambitious research project of our days and supports, with the same money, its own research institutes; and the Institutes get good money and guaranteed participation in the future experiments to be carried out at LHC. Despite the obvious pluses, virtually nobody believed that the plan would work. It seemed impossible that in 1994 we could agree about what we would do in Russia in the following ten years, at the beginning of the 2000s and, what's more, using such a sophisticated financial structure.

It took me two years to explain that the plan was beneficial for them, for us, and for the whole research community. The Ministry of Science gave us its support. We organized a Russia-CERN Committee consisting of CERN's five top executives and five members from Russia: director of the Ministry of Atomic Energy, three representatives of research community, and the Minister of Science as chairman. As a result, the CERN Council made a special resolution to finance our work. (European colleagues asked reasonable questions: why cannot their centers, their institutes, and industries do this work?).

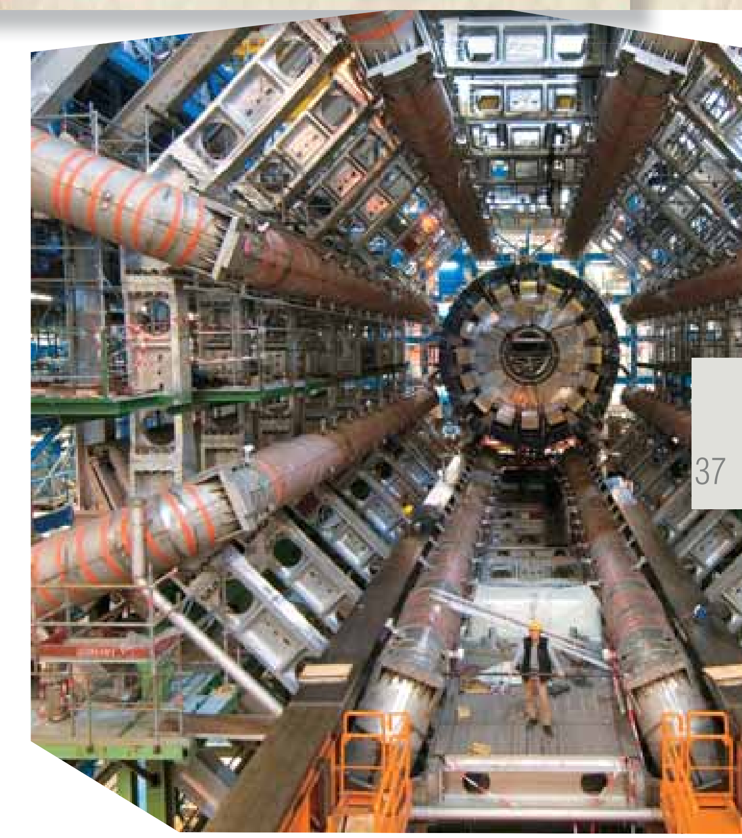
The plan (referred to as "Skrinsky's plan") proved workable. By the way, in all these years the Ministry of Science has received no similar proposal from other research fields.

Skrinsky, 2006

... INP SB RAS researchers have developed, manufactured, installed, and adjusted 360 dipole magnets and 180 quadrupole magnets for the collider injection channels, ultrahigh-vacuum facilities, an electronic cooler of heavy ions, and numerous other high-technology facilities with a total weight of about 5 000 tons!

The CERN management has repeatedly emphasized that the contribution of Russian scientists, specialists, institutes, and enterprises to the elaboration and execution of the Large Hadron Collider Project is invaluable. It covers not only the logistic support of some key positions, but also the use of the advanced ideas and achievements in particle physics and accelerator engineering presented and developed by our scientists earlier. Naturally, two streets in CERN are named after the Russian physicists V. I. Veksler and G. I. Budker, who made fundamental contributions to the world accelerator science

Bondar, 2009




Политические события, происходящие в России, действительно, наводят на грустные размышления. Но 1 апреля, к счастью, еще по-прежнему остается Днем смеха. И несмотря на то, что всем нам сейчас не до веселья, давайте хотя бы улыбнемся — оптимистам во все времена живется легче.

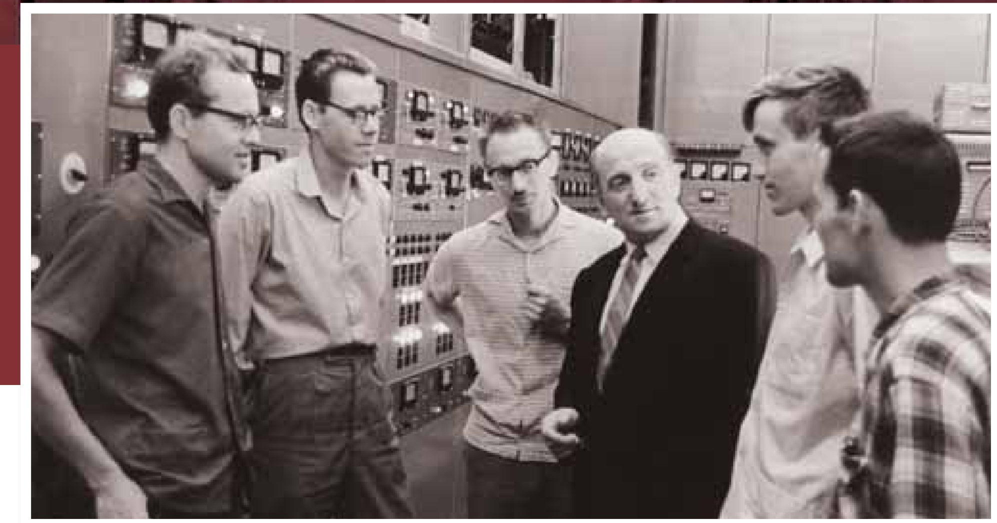
Made in the BINP

Andrei Mikhailovich Budker was designing an institute different from others. Everything was different – from career hierarchy to financing schemes. Just imagine: I became head of laboratory three years after graduating from university. In 1966, Budker negotiated a personal agreement with Alexei Kosygin that the government would issue a resolution allowing the Institute of Nuclear Physics, Siberian Branch, USSR Academy of Sciences, as an exception, to sign contracts not based on a preset cost calculation. At first we were an object of ridicule: "What an idea – to make money in Russia!" Then broke a storm of outrage: "They are allowed to make money, and we aren't?!"

However, a legal opportunity to make money isn't enough; one has to deliver a product that no one else can. We lived and worked in Novosibirsk yet built CERN in Switzerland and Brookhaven in the United States; we produced facilities for Japan and China. If we mark on the world map all the spots where our physicists and facilities have worked and are now working, we'll cover all the cities and countries, from Australia to Canada.

We go on living like this today – we participate in most diverse international projects. For instance, a considerable part of hardware in CERN's projects is made in the BINP.

Andrei Mikhailovich, who was very fond of sports and did some boxing and volleyball when he was young, always said that we were a team, rather than a lab, and our team should have a good captain. The institute was indeed a solid team and remained one even in the hardest of times – when Andrei Mikhailovich passed away and when the Soviet Union broke apart. We managed to save science and our place in it.



At VEPP-2 control terminal.
From left to right:
V. Sidorov,
I. Protopopov,
S. Popov,
G. I. Budker,
A. Skrinsky,
V. Petrov

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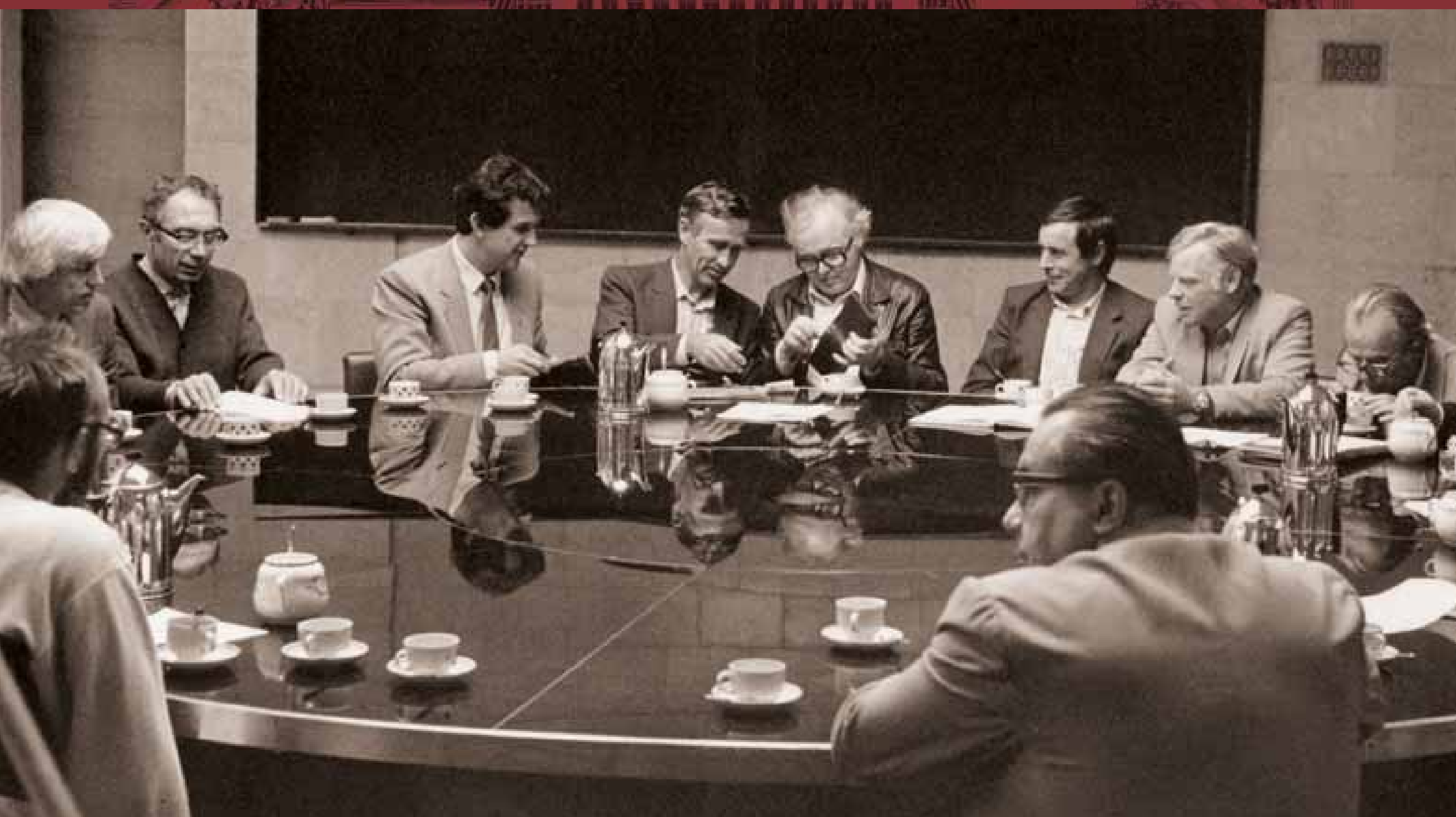
This article includes drawings by E. Bender

Akademgorodok: A MEETING Point

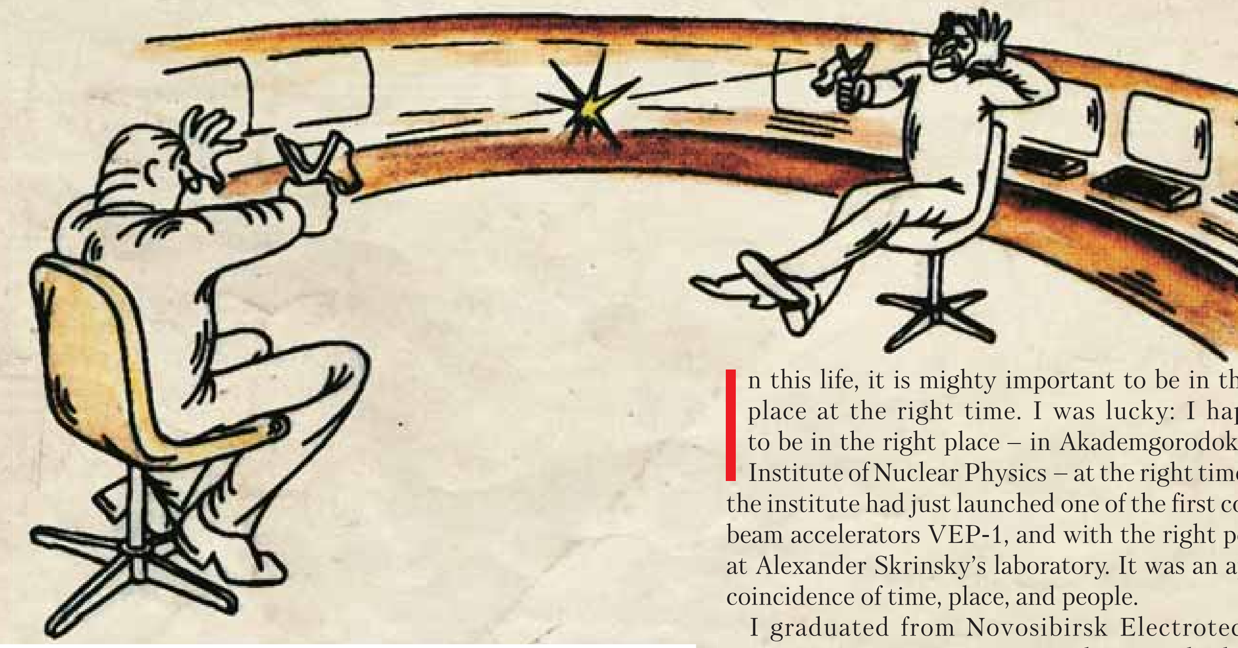


Akademgorodok once brought together most outstanding scientists, who created their own scientific schools and raised their "kids" and "grandkids." Therefore, the concentration of opportunity to meet with unique personalities here ran sky-high.

At that time, everyone wanted to visit Akademgorodok. Many of the meetings took place at the Institute of Nuclear Physics (INP). The traditional round tables at the INP gathered not only scientists but also writers, artists, film directors, poets. The INP round table served as a symbol of democracy—independent judgment with a cup of coffee. Alexander Solzhenitsyn, Evgeny Evtushenko, Bulat Okudzhava—all of them sat at our round table...

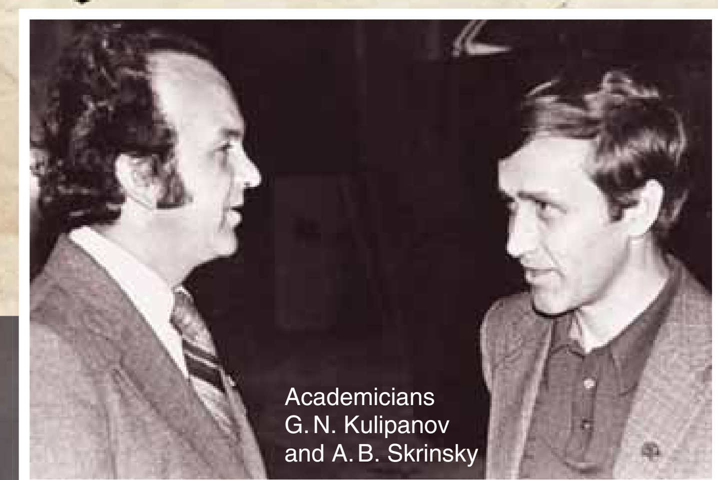
Key words: Institute of Nuclear Physics, Budker, particle accelerators, the Round Table, synchrotron radiation

G.N. KULIPANOV



In this life, it is mighty important to be in the right place at the right time. I was lucky: I happened to be in the right place – in Akademgorodok, at the Institute of Nuclear Physics – at the right time, when the institute had just launched one of the first colliding beam accelerators VEP-1, and with the right people – at Alexander Skrinsky's laboratory. It was an apposite coincidence of time, place, and people.

I graduated from Novosibirsk Electrotechnical Institute (NETI) in 1963. We knew as little about the Institute of Nuclear Physics as we did about Akademgorodok itself. Nevertheless, after my fourth year of studies, in the summer of 1962, I and four other students went to an interview at the INP. Three people came to see us: Alexander Skrinsky, Veniamin Sidorov, and Oleg Nezhevenko, a NETI graduate of 1961, who told us about the institute in the first place and suggested



Academicians G.N. Kulipanov and A.B. Skrinsky

Gennady N. KULIPANOV, Academician of the Russian Academy of Sciences, RAS Advisor, Director of the Synchrotron Radiation Center (Novosibirsk, Russia)

we should come. We had a talk in one of the rooms, beginning with technical questions, and then someone asked me why I, with my major in electronic instruments, wanted to work at the INP. I mustered courage and said, "Listen, nuclear physics is utterly impossible without the achievements of electronic technology."

All the five of us were accepted. I happened to take my practical training at Skrinsky's laboratory, wrote a degree thesis, and, after I received my degree, in September 1963, I began working at the institute.

The key element was Budker

The INP has always been an independent democratic venue, but not politically. When a scientist becomes involved in politics, nothing good comes from it. When the whole institute becomes involved, it is a sure death for the organization. However, the freedom of scientific creativity, freedom of discussion, freedom of scientific ideas – this is the INP's style, which has persisted till this day. Andrei Mikhailovich Budker started a wonderful tradition to hold scientific councils at a round table. The councils met without a prior approved agenda. At first, these were general meetings for all the staff of the institute, where everyone could take part in the discussion and present their research. As the staff grew bigger, a grand council appeared, which gathered laboratory and department heads and administration, while young researchers met at sectional councils. The latter focused, as a rule, on issues within thematic areas, such as accelerator physics, plasma physics, elementary particles, or synchrotron radiation. Budker always said that he needed to see the eyes of the young and understand the response of young researchers

***V. I. Kogan:* "Migdal had a washstand in his office. The water jet from the faucet diverted noticeably when one brought an electrified comb to it. I called this system a ratiometer (from the Latin word ratio meaning 'reason'). Budker demonstrated that the above effect from his trousers (on his lower back) was much stronger than from my head. This clearly showed the proportion between our physical qualifications. What can a man do?"**

Academician G. I. Budker. Essays. Recollections, 1988

to his words. At these councils Andrei Mikhailovich often "preached sermons." He walked around the table and spoke, for instance, about teacher-student relations or the relationship between fundamental and applied sciences, another age-old question he put a lot of thought into.

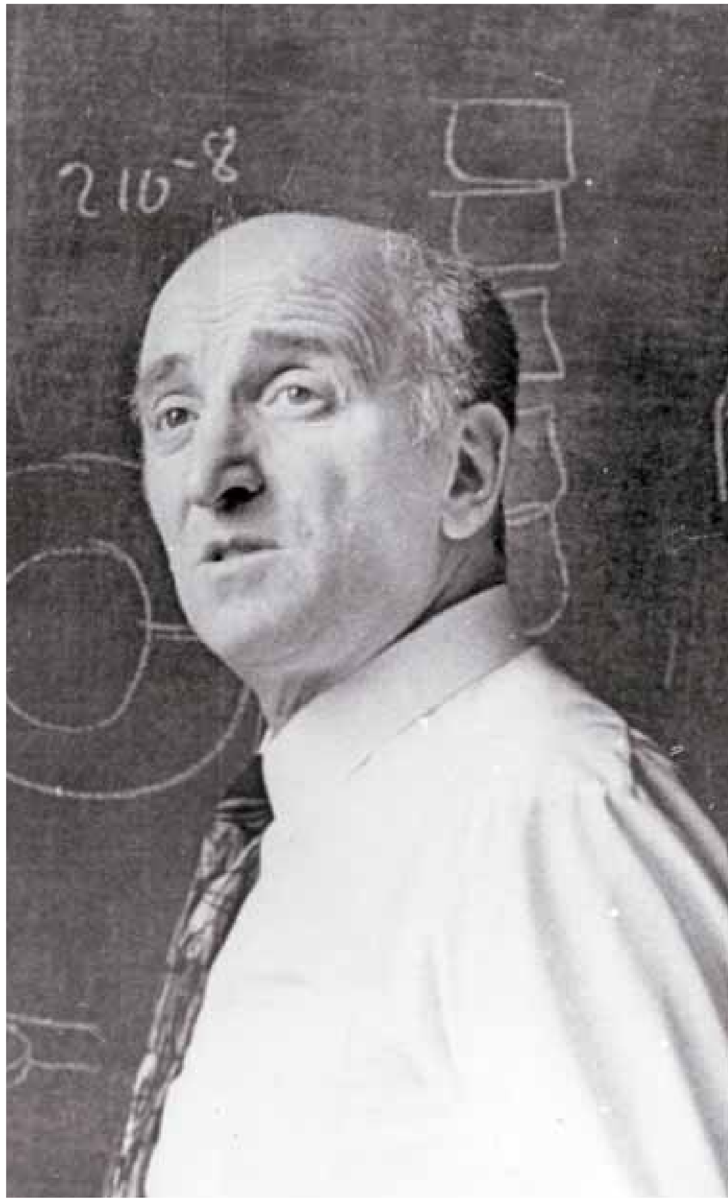
This tradition is still alive. Of course, today the scientific secretary sometimes e-mails us the agenda of the meeting – bureaucratic elements penetrate into the life of scientists too. However, the round tables with their freedom of speech and shiny coffee pots with freshly brewed coffee, all this remains unchanged.

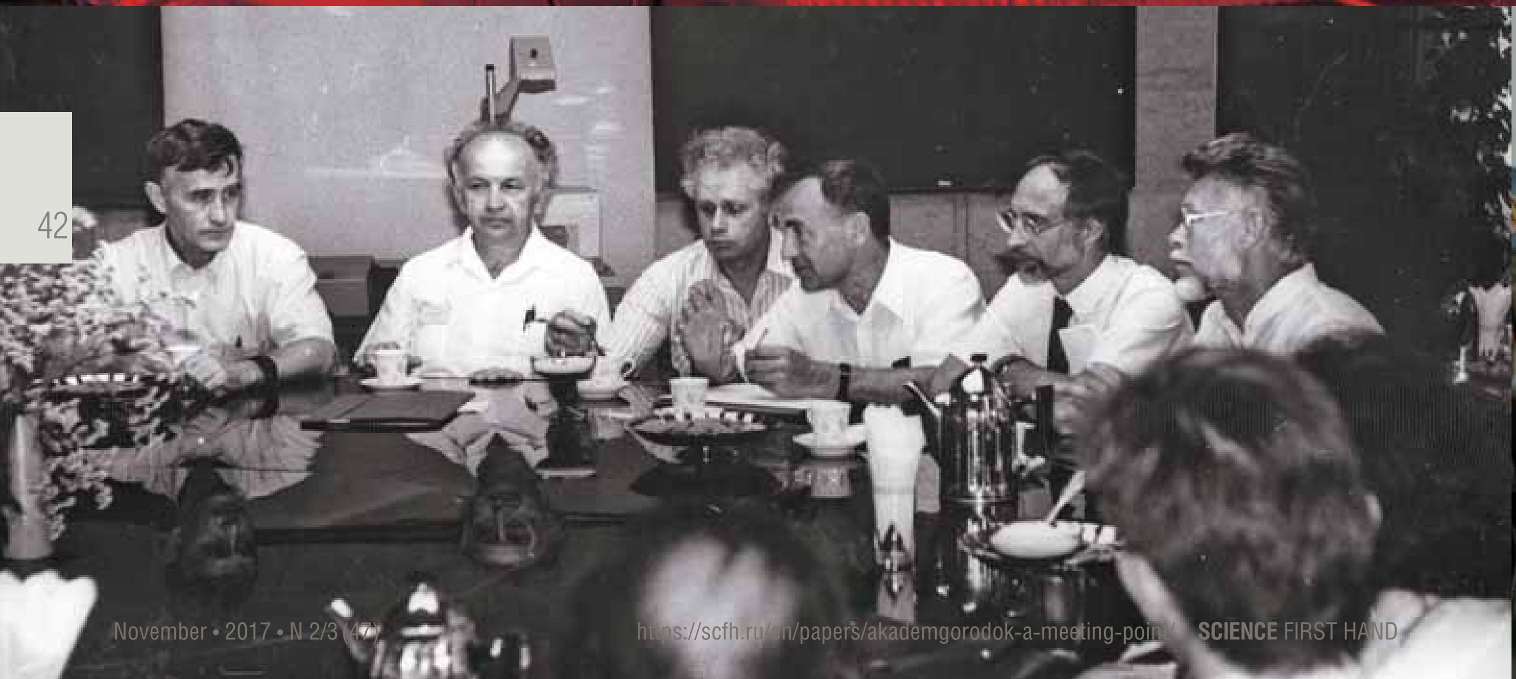
Good coffee has always been a necessary element of the INP round tables; we were very sensitive about it. Even when we could not find good coffee in Novosibirsk, everyone who went on a business trip to Moscow came over to a coffee shop in Kirov Street (now Myasnitskaya

A. M. Budker: "Does a scientist need students? This is a far-fetched question. It's like asking if people need children. It is our students who continue the work that we started and bring it to a logical conclusion. And their students will finish what they won't be able to. This is how science moves forward. A teacher becomes immortal in his students, like every person becomes immortal in their children… Without helpers, and students are, first of all, helpers, even a most gifted person will find it hard to do something in modern science. However, it's not only that. When we raise children, we, as a rule, think neither about the future of human race nor about providing support for ourselves in the old age. The same with scientists: when we educate our students, we submit to an instinct that is close to the instinct of procreation. We experience natural joy even when our students leave us for an independent scientific life. We only wish they were good scientists… Those making their first steps in science do not need proof how important it is to have a kind and wise mentor. Every scientist, if you ask them, will always remember to whom they owe their first, just awakened interest in knowledge, who gave them good advice in choosing their first area of research, without which one cannot learn to overcome setbacks, and many, many others, without whom no researcher will develop.

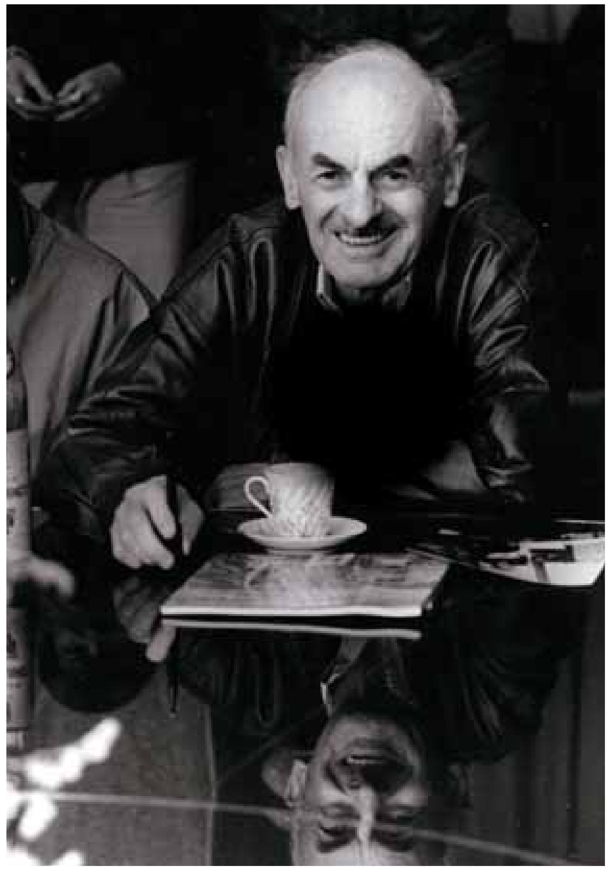
"Studying only by textbooks, monographs, and articles is like trying to master the secrets of the pianist's art from a teach-yourself book. <…> The same with science: without a good school, one cannot master the secrets of research craftsmanship. It is no accident that good physicists are born where there is a good school…"

R. K. Notman, Continuity, 2007





Round table at the INP SB RAS: discussion of the project to design a free-electron laser for photochemical studies in 1989 (*left*) and discussion of a new bright synchrotron radiation source project in 2015 (*right*)



At the famous round table of the Institute of Nuclear Physics—the writer and poet Bulat Okudzhava. September 6, 1993. *SB RAS Photo Archive*

G. N. Kulipanov: **"It is generally believed that a teacher is someone older than you. Yes, the first people who instilled in me a love of knowledge were my school teachers: M. I. Golov, my teacher of mathematics, and M. T. Migasov, my teacher of literature. My teachers at the INP were Alexander N. Skrinsky and Boris V. Chirikov. However, mature age is not a necessary attribute of a teacher. When I came to work at the VEP-3 facility, there was a great team of young scientists: N. A. Vinokurov, E. A. Perevedentsev, N. A. Mezentsev. I was lucky again to be at the right time in the right place, next to the right people. To learn from young people, especially talented ones, is a completely different learning experience, but it really is a learning experience"**

Street): what smells there were! We bought coffee beans and brought them to Novosibirsk; here we ground them and brew coffee. But those were just appearances, the key element was always Andrei Mikhailovich Budker – he set the tone of scientific discussions, creating an atmosphere of independence and freedom.

Everything that Budker did was filled with his personal philosophy. Even the jokes he liked to tell so much were not just funny but had a philosophical overtone. Andrei Mikhailovich was a great laugher and managed to bounce back with a smile from most awkward moments.

Guests of the INP

In the 1970s, we began to develop a new area of research at the INP, focusing on different ways of generation and use of synchrotron radiation. We looked for how to obtain very intensive beams of Mössbauer quanta using synchrotron radiation. We named the scheme *nuclear Bragg monochromatization of beams* and started experiments. Amidst that, I got a call from Academician Goldansky, the chairman of the synchrotron radiation commission of the USSR Academy of Sciences and an old friend of Rudolf Mössbauer. He said to me over the phone, "Gena, Mössbauer is coming over (he was already an Honorary Academician of the USSR Academy of Sciences) to Russia and he wants to go to Novosibirsk and visit the INP."

We received the guest, showed him the institute, and then I drove him to Novosibirsk Opera and Ballet Theater. On the way, I told him about the Trans-Siberian Railway and how it changed our city; I also told him how World

B. Sh. Okudzhava: "On the one hand, I'm a happy man: I witnessed how everything that plagued our life broke apart. On the other hand, I feel much bitterness because this collapse has led to tragedies and sorrows. Apparently, this is one of the simplest operations. I just do not know if we are breaking it or it is breaking apart by itself. I think that it's breaking itself, mainly in terms of time. For example, we keep saying, 'Gorbachev destroyed the Soviet Union.' But I have a vision of a big elephant led on a rein by a man. Everyone admires the animal and screams: 'Oh, what a giant elephant! The largest one in the world!' The elephant paces slowly, gets sick, burns, rots, and one day, it falls down. Then they all attack the person who led him, shouting: 'You killed the elephant!'"

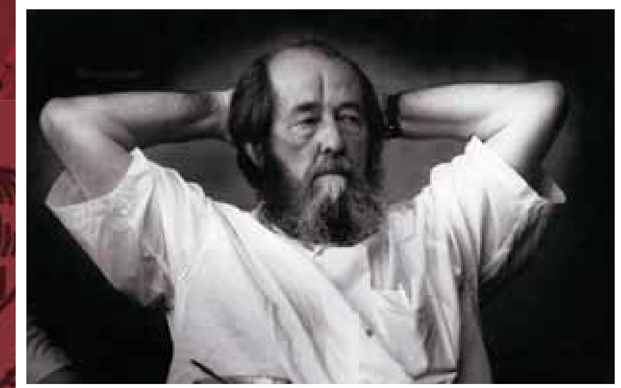
INP Meetings, 2015

B. Sh. Okudzhava: "Nonetheless, the psychology of independent thinkers was distorted differently. For example, a major on TV says, 'I belong to intelligentsia because I'm a major.' This is a very Bolshevik approach: If I'm wearing glasses and a hat, and even have a degree, I'm a member of intelligentsia. But I met intelligent people among laborers and vulgar ones among Academicians.

"Until we learn to define what freedom is, what intelligentsia is, until we see the difference between freedom and will and understand what democracy is, we will be an uncivil society"

INP Meetings, 2015

The writer Alexander Solzhenitsyn at the Institute of Nuclear Physics. June 28, 1994. *SB RAS Photo Archive*



A. I. Solzhenitsyn: "…Of course, time does not spare us, and our lives won't be long. One can only wonder how people in many places, like your institute, still manage to keep going. What have we turned into on the national scale, having lost twenty-five million people and not caring about this loss? At many meetings I heard, 'Oh, why did we start this perestroika? Everything was okay, more or less." But now we have to pay for many things at once.

"Our country went through an incredible psychological shock leading to a total destruction of concepts about how to live and what to do in 1930—1931. It was a blow that completely crushed the people's psyche, especially the intelligentsia. It was impossible to get through this poisoned zone; there was no hope. Many people experience this now, believing it's a unique case. No, it's not unique. It happens in the life of individuals, individual families, and, sometimes, individual nations that they get into so uncomfortable, adverse – words can hardly describe it – tense, impossible conditions that they must go through if they still live. One needs to find in oneself a source of emotional strength and resilience, and although science may suffer, but it has a lot of resilience, unlike in other places, where there is no strength to endure hardships. A very grave condition – it goes without saying"

INP Meetings, 2015

The famous film director Eldar Ryazanov at the Institute of Nuclear Physics. December 12, 1994. *SB RAS Photo Archive*

"A sincere and direct person, Eldar Ryazanov endeared everyone to himself from the very first minutes, when he said that he felt very uneasy in that room because he didn't know physics at all. When he went to school – this was the war years – there were simply no teachers of physics: his school-leaving certificate states N/A for this subject. This confession evoked compassion in the hearts of our physicists and immediately created a friendly and relaxed atmosphere. The INP Deputy Director Veniamin Sidorov made a traditional speech about the INP history and rules, about its fight for survival; our guest listened to him with sincere interest, and his unexpected questions cheered up the audience, who burst with approving laughter. So, Eldar Ryazanov asked whether it was possible to neutralize hazardous politicians, like hazardous beetles, with the help of our industrial accelerators. The INP physicists had to admit that they had not yet thought about such an application of their products"

INP Meetings, 2015

G.N. Kulipanov: "You work all day at the facility; in the evening you go to the kindergarten, take your son home and then go back to work. There, you switch on VEP-1 and keep working until late at night. Now it seems unbelievable that one person was enough to operate the accelerator: you switch on the facility and beams start running. Now the colliders are so gigantic that they accelerate for another two or three days after being switched on. Not to mention that one person alone would never handle them"

War I, the revolution, and World War II influenced the development of Novosibirsk. Here I added that the theater we were heading to was built during World War II, and the first opera premiered on May 13, 1945. Here Mössbauer rounded his eyes and asked in amazement: "You (Russians) were so sure you would win that war that you built a theater instead of tanks and aircraft?" This story about the construction of the theater got him so deep under the skin that during his entire stay at us, he kept telling it to everyone, when he gave a lecture at NSU, when he raised a toast at a dinner party, etc.

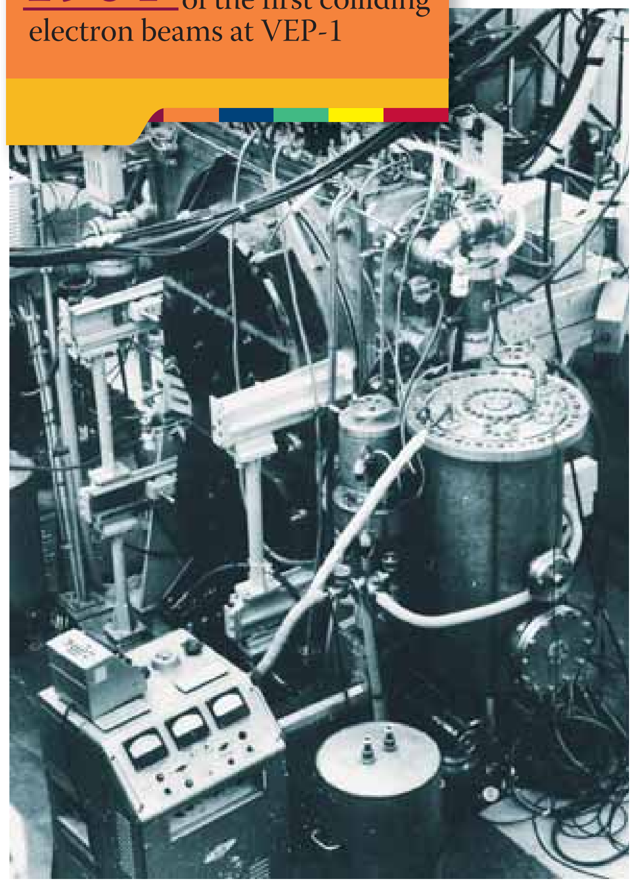
The story of my acquaintance with the Nobel laureate and his acquaintance with Novosibirsk Opera and Ballet Theater had a continuation. But for the theater itself.

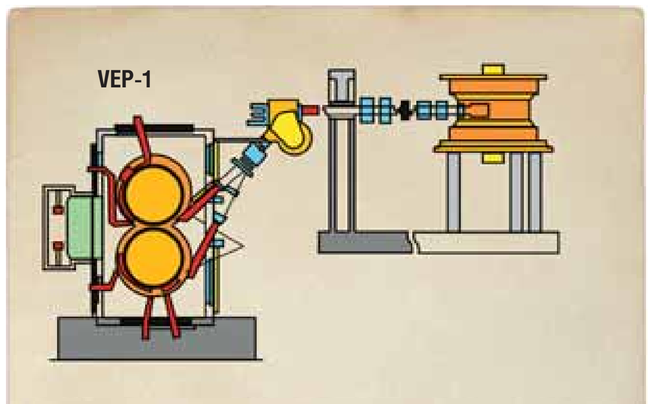
In 2003, Prime Minister Mikhail Kasyanov visited Novosibirsk. Our governor Viktor Tolokonsky had hopes about this visit, that he would obtain additional money for the restoration of the Opera and Ballet Theater. After visiting the theater, Tolokonsky brought Kasyanov to Akademgorodok. On the way through the forest from the Exhibition Center to *Dom Uchenykh* ('House of Scientists'), I told Kasyanov the story about the German scientist and his impressions. Then I said, "Mikhail Mikhailovich, how is it possible that today, when the situation in the country is not as catastrophic as during the war, the government cannot find money to restore our theater?" In the Concert Hall of *Dom Uchenykh*, I sat next to the Minister of Culture Mikhail Shvydkoy; he thanked me for telling that story at the right time, adding that he was confident in receiving the money. And Novosibirsk indeed got the funding to restore the theater.

On June 28, 1994, Nobel laureate Alexander Solzhenitsyn paid a visit to the INP. The writer was on his way from the United States, traveling along the Trans-Siberian Railway, making stops in every big city. We had a long round table discussion at the institute, talking about science, education, about Russia. I asked Solzhenitsyn why he decided to visit China. Could it be that he wanted to compare the Chinese version of the reforms with the Russian one? I also mentioned the social law stating that it was impossible to simultaneously reform the political and economic structures because, in my opinion, such a reform

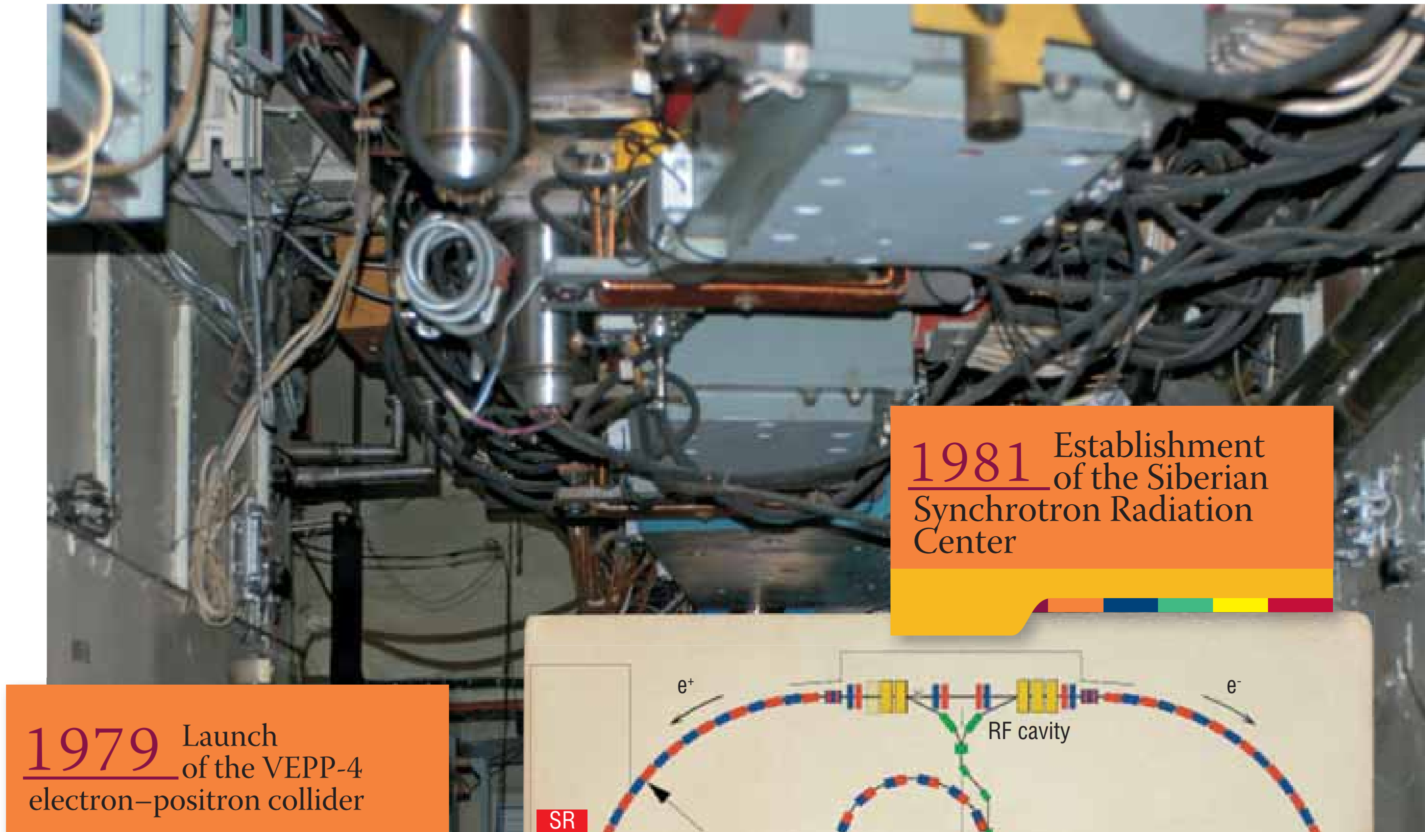
on page 50

1964 Generation of the first colliding electron beams at VEP-1



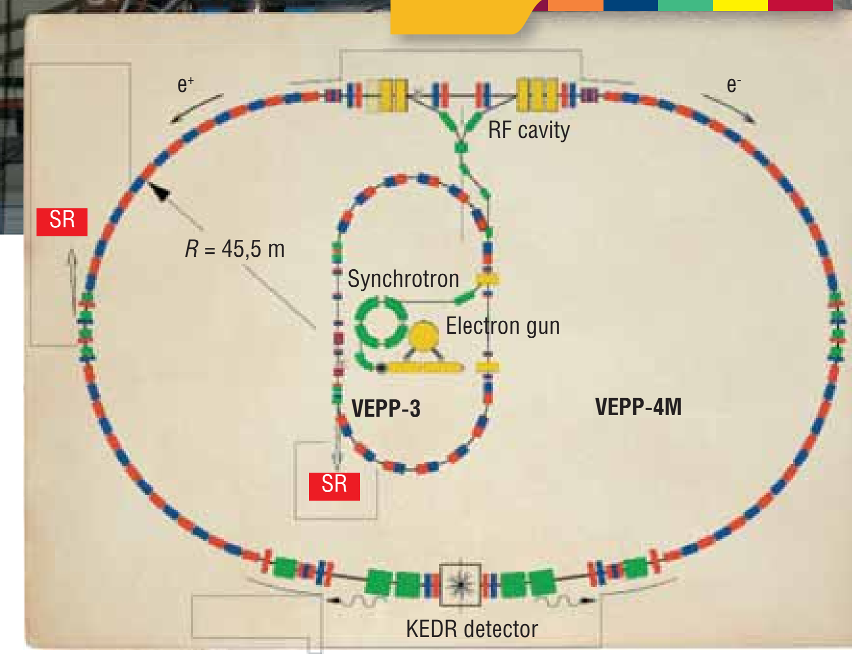


VEP-1, the first colliding beam accelerator, designed at the INP in 1964, had only two rings with a radius as small as 43 cm. However, its interaction energy was equivalent to that of the classical accelerator of 100 billion eV. None of the facilities of that time could generate such energy



1981 Establishment of the Siberian Synchrotron Radiation Center

1979 Launch of the VEPP-4 electron–positron collider



At the INP, VEPP-3/VEPP-4 are used in the acceleration storage complex for SR generation, VEPP-3 being a booster (intermediate) accelerator for the VEPP-4 collider (*diagram on the right*). Acceleration occurs in the range of energy from 360 MeV to 2 GeV; in the storage mode the accelerator can hold beams with an energy of 2 GeV and a current of about 100 mA for a long time (5—6 h). It is in this mode that the work using SR is conducted. *Upper right:* the rectilinear part of the VEPP-3 storage ring

On December 1, 1981, the Siberian Center for Synchrotron Radiation was organized in order to coordinate the efforts directed to developing SR studies, using SR sources efficiently, and improving the quality of research. The center was based on the acceleration equipment and laboratories of the Budker Institute of Nuclear Physics SB RAS. In 1991, it was reorganized into the Siberian International Center for Synchrotron Radiation, an open laboratory for Russian and foreign organizations and individuals. In 2003, the first line of a free electron laser was put in operation. In 2005, the Center was renamed the Siberian Center for Synchrotron and Terahertz Radiation

SR AT THE INP: TODAY

At present, the Siberian Center for Synchrotron and Terahertz Radiation has 12 SR stations and 4 terahertz radiation stations. The major aims and tasks of the center are fundamental and applied studies in physics, chemistry (including catalysis), biology, medicine, ecology, geology, materials science, and also the development of new methods and technologies as well as the creation of new specialized radiation sources and experimental stations.

However, the INP in the SR world is not just a participant: the Institute is also an active developer. The INP is practically a monopolist in producing superconducting wigglers (multipolar magnets generating a sign-variable periodic magnetic field), which are installed in rectilinear spaces of electron storage rings to increase radiation intensity. Novosibirsk physicists and engineers control the whole production cycle of these complex devices: from designing and manufacturing to testing and assembly on site. All over the world, from Australia to Brazil and North America, more than 20 wigglers made in Novosibirsk are currently in use. The INP researchers have developed, produced, and installed superconducting devices practically in all world SR centers, including Spring-8 (Japan), ELETTRA (Italy), CLS (Canada), synchrotrons in Brazil and Australia, and the only Russian specialized SR source at the Kurchatov Institute in Moscow.

At present, the research group dealing with wigglers is engaged in producing undulators, i.e. superconducting devices with a large number of poles and a low magnetic field. In contrast to wigglers, in undulators the radiation from separate poles is coherent, which provides monochromatic radiation with a substantially higher spectral brightness. All modern centers are interested in these devices. For instance, there is a tentative agreement on collaboration in this field with DLS (United Kingdom)

In the bunker for SR from the VEPP-3 storage ring, the work is organized as in a famous Russian fairy tale: the more, the merrier. In an experimental hall there are ten user stations located in an area that is only 90 m^2; so, the room is overflowing with equipment. *Upper right:* the unique first station Detonation, which consists of an explosion chamber and a detecting unit, where it is possible to operate with explosives weighing up to 50 g

This is the living history of accelerator physics: the B-4 booster synchrotron in which there occurs initial acceleration of electron (positron) beams to the injection energy (360 MeV) into the VEPP-3 storage ring. It is likely to be the only "antique" working synchrotron in the world

2017 Operation of 12 SR fasilities and 4 terahertz radiation facilities

Рис. Е. Бендера

“Budker’s school would have lost much without the personal charm of its founder. He endeared himself instantly, at the first meeting. He easily attracted people. I doubt that it was his smarts alone. He charmed people by his unexpected thinking, beautiful speech, instant response to a thought or joke. In my opinion, he was as good in humanities as he was in physics. I heard one of his impromptus at a meeting with foreign journalists. Someone asked what it was like to live in Russia... for half-breeds. The question was strange for that time and had some vague hint to it. Budker responded instantly, saying, ‘Not every Métis is a Matisse.’ Everyone laughed, and the question passed us by”

R. K. Notman, Continuity, 2007

would cause feedbacks that would destroy both systems. Solzhenitsyn said, “I wanted to see with my own eyes a piece of China, especially in comparison with Blagoveshchensk. Apparently, the city opposite Blagoveshchensk is growing fast economically. As for the social law you mentioned, I’m afraid it’s true. No matter how much we want to get rid of our old system, it probably would be wiser to start with reforming the economy alone. This issue rose up as far back as in 1946—1947, in prison discussions, which I attended as a young officer. Back then, we all knew that communism would fail. In those discussions, we focused on how to get out of it. Wise people with life experience said, ‘We need to revive only the economy, without shattering all this terrible, ridiculous, reckless system. We need to start from the bottom, through small plots of land, small workshops, small stores so that people could get enough food and clothes, recover their health; then they would gradually revitalize the system from the bottom up.’ We had no one to give this advice to. The ones who said those words have long passed away. I have remembered this advice and ascertained over time that it was right.”

Science works out in different ways

An ingenious inventor, Budker could come up with utterly unique solutions, such as open traps for thermonuclear reactor or a stabilized beam. However, his crazy and ambitious ideas, for example, a linear collider, did not give results immediately. Projects lasted for years. Budker understood that well and insisted that the institute should do applied research, for example, the construction of industrial accelerators. He invested in these projects and forced each laboratory to think about applied research because without it, there would be no institute. The government funding was 20 % of the institute’s budget; the rest was contracts. Under Budker, those were contracts for the Soviet defense industry; then we began to work for foreign customers (there was a time when foreign contracts were the main source of funding, making 75 % of the budget). The current situation is as follows: 25 % comes from foreign contracts; 75 % from Russian ones.

In 1992 (maybe in 1990?), we launched a large classified project to design a free-electron laser (FEL). We worked on that project by resolution of the Central Committee of the Communist Party and the Soviet Government; the project also involved industrial plants. But then the year 1991 came down upon us, followed by 1992 and 1993... and the money was gone. By that time, the plants had made some “semi-finished” products for the facility (about 30 %). We had to complete the project on our own: using the institute’s resources and the money earned under foreign contracts. The first generation took place more than 10 years later, in 2003. Even with financial support from the government, the implementation of modern physical projects involving the development of large physical facilities normally takes about a decade (the construction works on the Large Hadron Collider lasted more than 15 years). Mössbauer began his work in 1956, discovered the effect in 1959, and in 1961, the scientist received the Nobel Prize. Science works out in different ways.

Рисунок Е. Бендера

A. M. Budker: **“I already said somewhere that everyone wishes a fair wind to those embarking on a long journey. However, if a ship has a strong steering wheel and an experienced steerer, it can sail not only by the wind but also across the wind and even against the wind. Moreover, if the wind blows aft all the time, you should stop and think: Are you sailing where you need to be? Or you just sail where the wind blows? In science, it is very dangerous to sail by the wind: you always have an illusion that you are moving, but in fact you are carried by the wind...**

“The most dangerous thing for a ship is a calm sea. In this case, you can only move in tow. So, one should beware of calm sea only. Don’t be afraid of side and head winds: when they blow, you can always move forward towards your goal. Beware of a calm sea!”

Age of Learning, 1974

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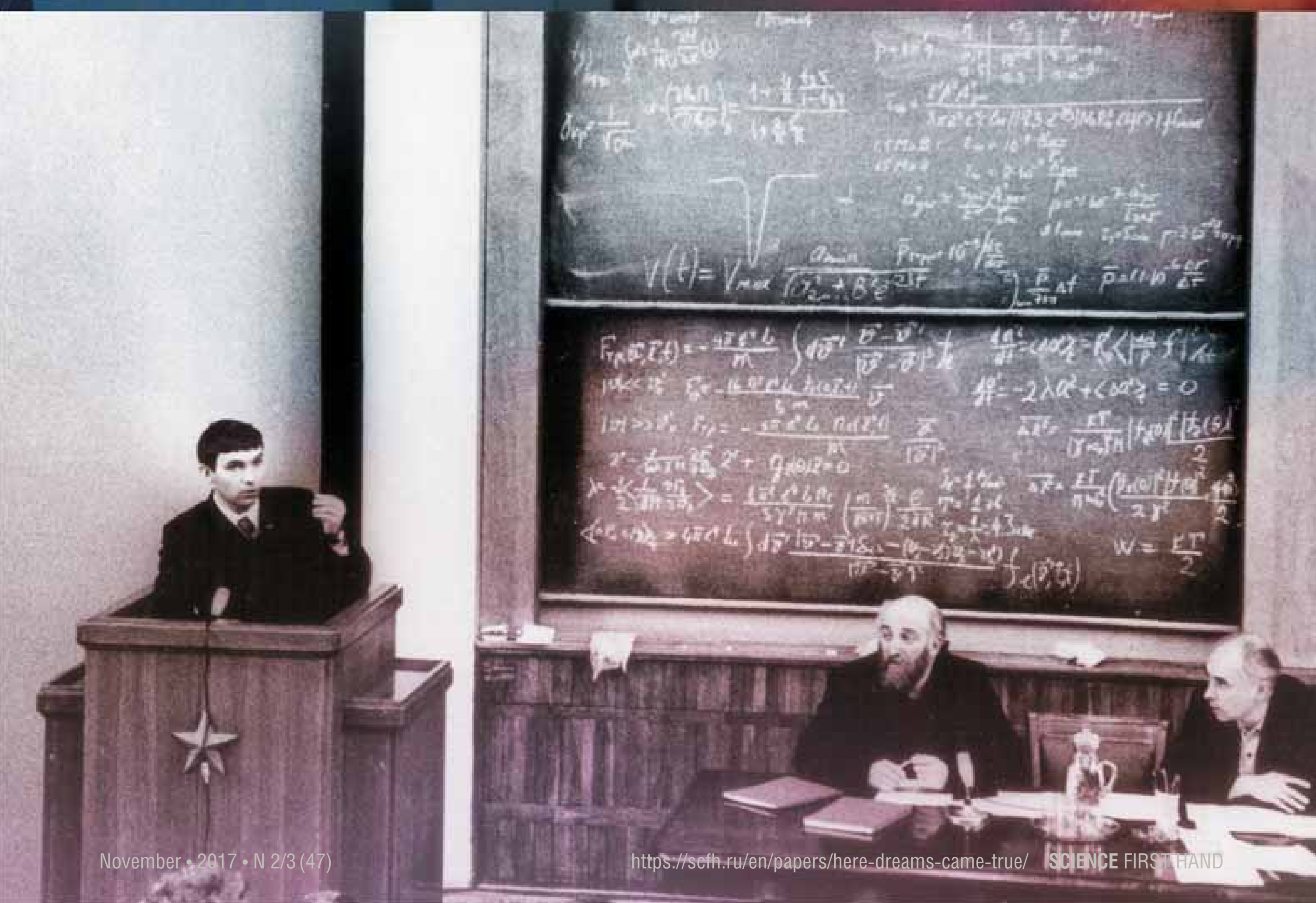
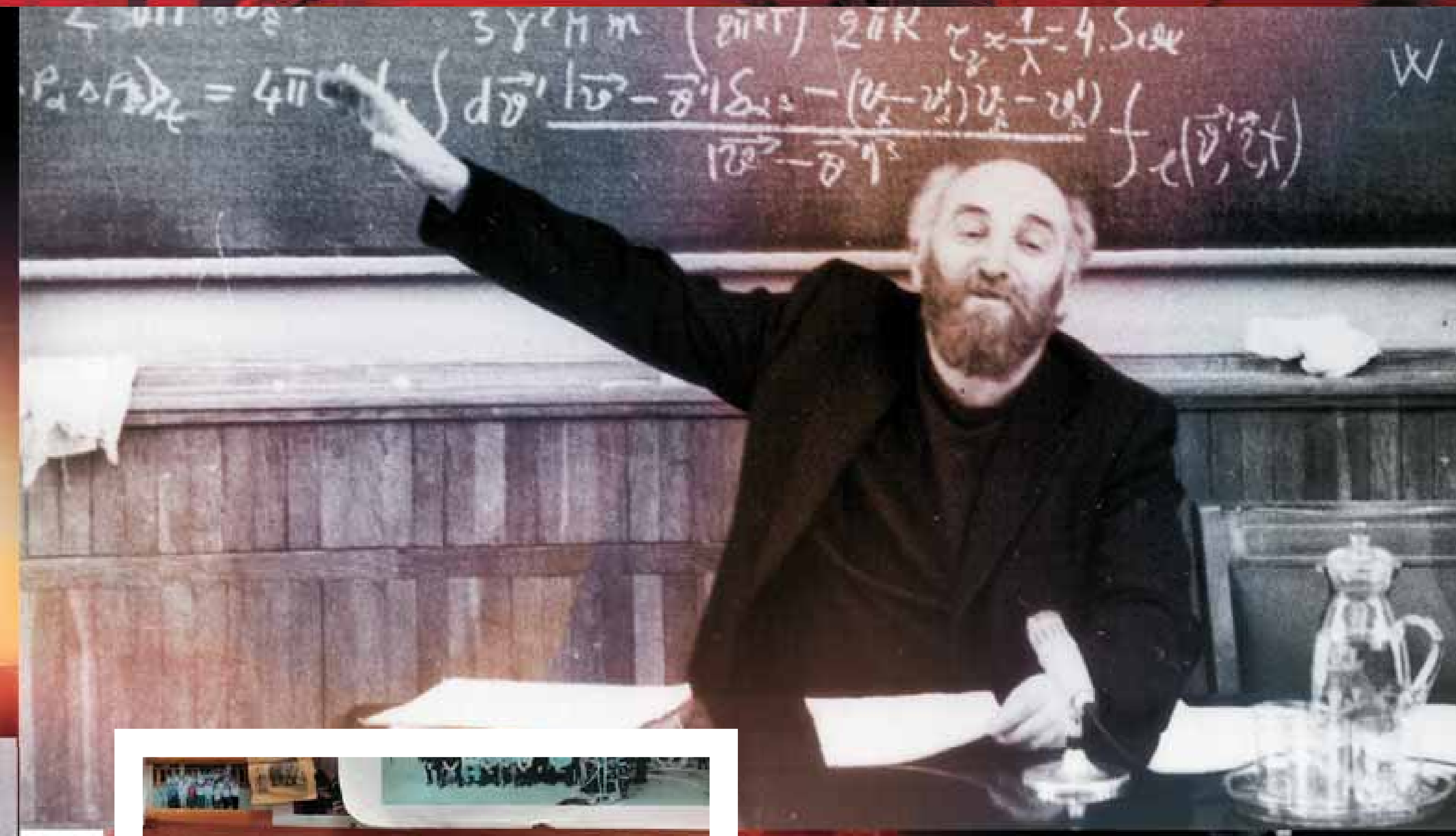
This publication includes drawings by E. Bender

V.V. PARHOMCHUK

HERE DREAMS CAME TRUE

The beginning of construction of Novosibirsk Akademgorodok coincided with a period of renewal in our country. World War II was just over, followed by a revival of freedom and initiative—we moved into the unforgettable 1960s. One could sense renewal everywhere: in art, literature, science. Obviously, it was a perfect time to build a science town in Siberia—if not now, when then? Perhaps, if it had been a different time, Akademgorodok would not have appeared at all, or it would have been totally different. In those years, many scientists grasped on an opportunity to move from Moscow to Siberia, sensing it as salvation—in Moscow, authorities would always want to clip their wings. One can hardly imagine that A.M. Budker, the first director of the Institute of Nuclear Physics in Akademgorodok, could have implemented his "crazy" projects in Moscow on such a broad scale





Vasily V. PARKHOMCHUK – Academician of RAS, Doctor in Physics and Mathematics, Head of Laboratory at the Budker Institute of Nuclear Physics of the Siberian Branch of the Russian Academy of Sciences (BINP SB RAS), Professor at Novosibirsk State University. Winner of the State Prize of the Russian Federation (2001), the Robert R. Wilson Prize (2016) Author and co-author of over 200 academic publications

Key words: charged particle accelerators, colliding beams, electron cooling

I first came to Akademgorodok when I was a schoolboy. Together with my friend Vovka Balakin (a future Corresponding Member of the Russian Academy of Sciences), we went to the first Summer School in Physics and Mathematics. We rode by train from the village of Rodino in the Altai Krai. It was the first time we had ever traveled on our own, so we decided to get everything that we could out of that journey: we even took a ride on a car deck. Our faces were black from mazut, but we reached our destination safely. We arrived at Novosibirsk Railway Station late in the evening and decided to sleep on a bench and then, in the morning, go to the Presidium of the Siberian Branch of the USSR Academy of Science, which then resided at the center of Novosibirsk, at 20 Sovetskaya Street. A local militiaman roused us from sleep: he thought he stumbled into a pair of street urchins, but they were, as it turned out, "future scientists." We showed him our invitations from the SB USSR AS, signed by Budker and Lyapunov themselves, and he even let us inside his booth, to keep warm.

High school graduates from Group 11 B of the High School of Physics and Mathematics.
Photo from the author's archive

Vasily Parkhomchuk in his home village of Rodino (Altai Krai) in 1960. The most likely profession that awaited him in the future was a driver, like his father.
Photo from the author's archive

Academician Andrei Mikhailovich Budker: "There is one thing young people should know: if they ever run into pettiness, stupidity, narrow-mindedness – it's just bad luck. They should always remember: in science there definitely are bright, intelligent, highly intellectual people. A young scientist may become disappointed in his scientific supervisor, but not in science as such. He or she should know that they've made a mistake and the sooner they correct it, the more chances they have to find their temple of science."

From (Age of Learning, 1974)

I fell in love with physics when I went to school in my home village. We had a brilliant teacher Konstantin Krivenko: he was passionate about his subject and roused this passion in us too. He also ran a children's radio engineering club, where we crafted transmitters and receivers like professionals. We even could talk over radios, like modern mobile phones, and we were very proud of it.

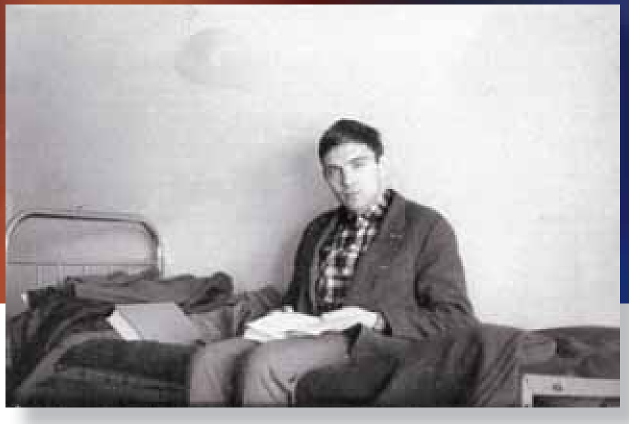
So, it isn't surprising that I got interested in the problem assignment of the All-Siberian Academic Olympics in Physics and Mathematics, about which I learned from a newspaper. I read the task description, solved the problems and mailed my answers. Soon I received an invitation to the next, written phase of the competition in the city of Barnaul. The main organizer at this phase was Dmitry Shirkov, a physicist who worked at the Institute of Mathematics in Novosibirsk Akademgorodok. I did well on the task and got an invitation to the first summer school. However, one episode spoiled this happy moment: Shirkov told me they would cover my travel costs should I have money issues. I took it as an offense and asked why he thought I was poor. In reply I heard, "Well, it's your trousers and boots..." He got confused over my looks, and I thought I was most fashionably dressed.

Our teachers at that summer school were Budker and Lyapunov themselves – seriously-looking, long-bearded professors. Back then, I could hardly imagine why these prominent scientists would waste their time time teaching us. Looking back now, I understand that they didn't know how to teach by the rules of pedagogy – they were themselves learning how to teach. So, the teachers and students "went to school" together, and it was one of the greatest cooperative projects in my entire life. Moreover, it was an opportunity to be part of the brilliant science development program implemented by Mikhail Lavrentiev and his colleagues. We, village kids, suddenly became a part of a great cause.

A few years ago, authorities almost closed the High School of Physics and Mathematics (HSPM) because most

Always being the first one: for participation in the All-Siberia academic competition in physics and mathematics for schoolchildren in 1962, Vasily Parkhomchuk was awarded with the first prize in physics

Cramming at the dormitory of Novosibirsk State University.
Photo from the author's archive



"To organize classes at the High School of Physics and Mathematics, Mikhail Lavrentiev encouraged the institutes to give away some of their scientific equipment for the school. They happily responded and brought us all sorts of stuff. Among those riches were large X-ray transformers with a voltage of several kilovolts. Using those "horns," we created spark gaps, fired up arcs and produced lightning strikes one meter in length. This was science that we did ourselves. By the way, it was rather dangerous—now I can't imagine how they even allowed us to do it. This example demonstrates that in Akademgorodok, scientists not only could explore their own field but also digress, taking part in most diverse experiments. Someone who is still searching oneself, whose scientific interests are only beginning to shape, could benefit greatly from that."

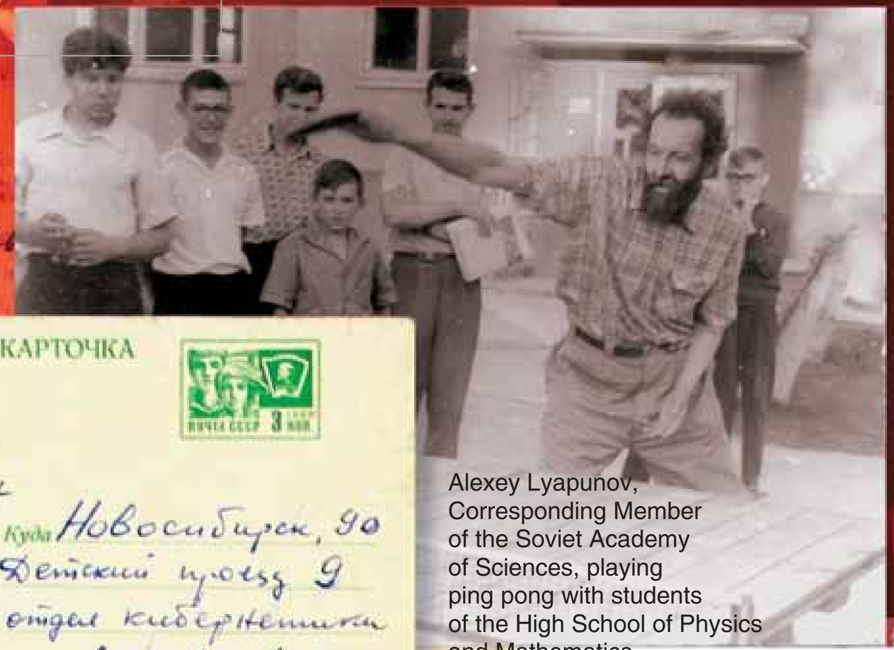
of the teachers on staff had no degree in pedagogy. When we went to this school, no one even thought about that, and still we got the best education in the world. The people who taught us weren't privy to modern teaching methods, but they had so much passion for science that they passed it on to us. Moreover, everyone who lived and worked in Akademgorodok tried, one way or another, to engage in science. One day, our janitor came up to me after the lecture and asked me what we were discussing. We were so proud that we were doing unusual things, things that most people knew nothing about, that we would always talk eagerly about physics.

So, the summer went by, and we went back to our homes: the order to organize the HSPM hadn't passed through yet. In half a year, I received a letter of invitation to Novosibirsk. I didn't have a single doubt that I should go.

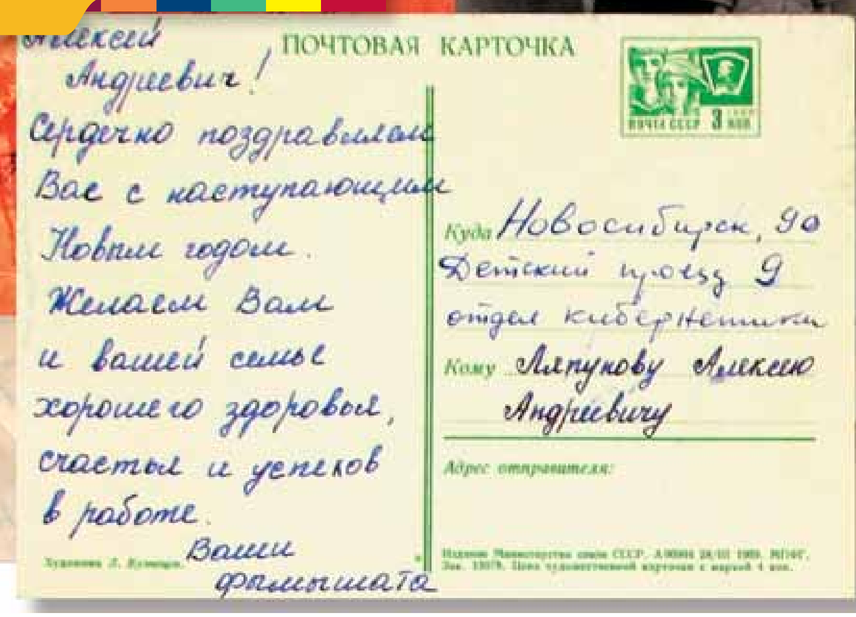
At that time, Akademgorodok looked like a giant construction site: there weren't any streets yet, and houses were only beginning to appear. The school didn't even have a building of its own, but we had absolutely no worries that something might go wrong. Our teachers were most outstanding scientists: Budker, Lyapunov, Rumer... We had lectures in open air at the NSU fountain and took part in experiments organized by research institutes (for instance, in an experiment to produce fireballs, which was held at the Institute of Hydrodynamics by Bogdan Voitsekhovsky). We fought with post-graduate students – threw sneakers at them from balconies using large DYI slingshots.

The construction of Akademgorodok went on; new people were coming. Many scientists saw it as a chance to break

1963 Organizing the High School of Physics and Mathematics



Alexey Lyapunov, Corresponding Member of the Soviet Academy of Sciences, playing ping pong with students of the High School of Physics and Mathematics.
Photo from the NSU Museum



A greeting card sent to Alexey Lyapunov from students of the High School of Physics and Mathematics.
SB RAS Archive

Alexey Lyapunov, "the father of Soviet cybernetics," was since his youth a brilliant teacher and popularizer of science, and he took ever more interest in education as he grew older. In his article "Mathematization of Knowledge," Lyapunov summarized his thoughts about the role of eduction in general and mathematical education in particular in societal development: "The extension of mathematical methods to new fields of science leads to a profound transformation of the entire system of human knowledge. This process necessitates an in-depth study of the very course of scientific development. This is a philosophical question. Perhaps, the main task of philosophy in science is to look into the future development of science and understand what we need to address now so that the results of our scientific work will be effective in the future. To this end, one needs to be well-versed in what is happening in science today. Therefore, special attention should be paid to the education system…" (*Nauka v Sibiri*, 1968)

Lyapunov's words were always consistent with his deeds. He became one of the "founding fathers" of the country's first specialized boarding school with concentration in physics and mathematics, which was organized in 1962 as part of Novosibirsk State University. He was the first chairman of the school's Scientific Council and a passionate lecturer. He also was among the organizers of the All-Siberian Academic Olympics in Mathematics and the Summer Schools in Physics and Mathematics in Akademgorodok.

From (Bogunenko, 2015)

away from the grip of Moscow, where authorities must have controlled them more tightly. Back then, I had little understanding of such things, but now I know the value of creative freedom for a scientist. In Akademgorodok, where dreams to do science freely came true, this spirit of independence became a propulsive force of scientific development.

Fourteen Russians and one American

As fate would have it, I've focused on the method of electron cooling throughout my scientific career. It was Budker himself who set me on this track. However, it took me some time to join in this project, also inspired by Budker. At first I worked in a different laboratory; then I even left for Irkutsk, to a new developing science center, to take a look. When I came back, Andrei Mikhailovich called me to his office. Barely had I stepped in when he blurted out, "Vasily, you've got nothing to do at our institute?"

It seems that at that point, Budker had already decided my fate. Of course, I didn't even think about Irkutsk after that conversation. Andrei Mikhailovich knew how to recruit people – today, one would call him an excellent headhunter. Indeed, he was one. At the same time, Budker was a very emotional person and his way of talking sometimes got him in trouble. However, when he channeled his temperament into the right area (which he mostly did), good things happened.

The ability to obtain funding and find the right people so as to put the entire intricate mechanism of scientific experiment into action and ultimately succeed – Andrei Mihailovich Budker possessed all that. You know, if your soul (or whatever we have inside) doesn't burn, you won't get things going. Budker succeeded in everything he set his mind to despite the mistrustful world that said, "We don't believe it," to his every idea. However, the very idea of science is to venture into the unknown and to do the impossible.

The development of the electron-electron and electron-positron colliders proves this point. And so does electron cooling. Not all of these ideas belonged to Budker himself, but no one else in the world, except him, dared to put them to practice. He had no fear, and he succeeded.

One of his ideas was to build a proton-antiproton facility in Siberia, but he couldn't implement this project for economic reasons. However, our students (S. S. Nagaitsev, A. V. Burov, and A. V. Shemyakin), who moved to the United States during the hard times for Russian science, were able to put this idea to life. In the earliest stage of the construction, I came to the United States as a consultant. Fifteen people sat around a big table, and all of them, except one, were from Russia. Why was that? Because the scientific school itself had formed at the Institute of Nuclear Physics; nowhere else in the world people did those things.

Young scientists usually choose their field of scientific interest with a helping hand from their scientific supervisor. Here, it is not only the novelty of the subject that matters but also the teacher's charisma. Budker always emphasized the great responsibility of those who raise the new generation of scientists; he urged them to be honest and forward-looking because their inner integrity would determine the fate of the young scientist. He saw the power of science in the development of strong scientific schools.

I first heard about electron cooling from Budker when I was a student – he told us about this method at his lectures. It was a new, unchartered area. I participated in the design and construction of an electron cooling facility from the very beginning.

We were building that facility for years. The construction went on, but not a single publication appeared. In other words, we made hardware, assembled it, did the testing, then reassembled, but we did not obtain any scientific results. Today, one would hardly let us finish this work: modern scientists get funding on a project basis and must report on their progress with published results. Back then, I also felt utterly discouraged and went for advice to Stanislav Popov, the academic secretary of the institute. He told me, "Vasily, don't worry, once you deliver electron cooling, you'll get a swarm of papers – get down to work."

So, the first thing was to breathe life into the facility. Here Budker helped us as well. He totally supported the idea and, where necessary, backed us with his authority. Of course, no one would take a post-graduate student seriously, but they would listen to Budker. Apart from authority, he also had a gut feeling for success, and succeed he did.

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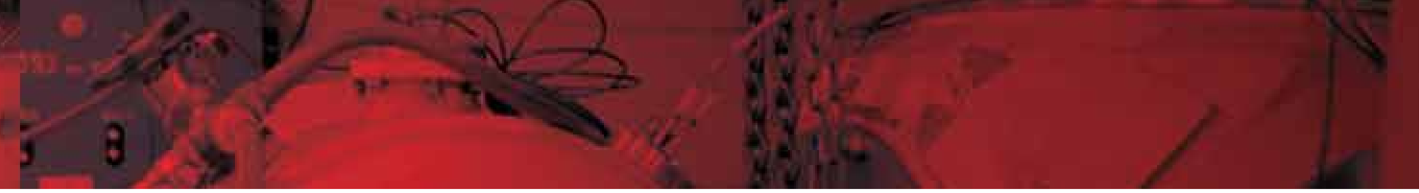


EXPERIMENTS WITH LOCOMOTIVES

Half a century has passed since I heard about the colliding beams from G. I. Budker during his lecture at the fountain during the first summer school for academic competition winners among schoolchildren. At that time, in 1962, G. I. Budker was very enthusiastic and told us about the method of collisions of the opposing proton or electron beams, aimed at studying their structure. To simplify the story for schoolchildren, he compared particles with locomotives rushing toward each other almost with the velocity of light. After such a strong collision, all internal elements of particles (locomotives) fly apart, and it becomes possible to consider them individually.

Even at that time, the capabilities of accelerators of elementary particles were so high that the effective mass of accelerated electrons increased by a factor of thousands in accordance with the relativity theory, and it was clear that the collisions of rapidly moving "heavy" electrons with "light" electrons of the motionless target were much less effective than the opposing collisions of high-energy "heavy" particles.

Like any boy, I thought that such experiments with "locomotives" looked funny, so I got into physics and stayed there for the rest of my life.

From: (Parkhomchuk, 2013)

Andrei A. Seryi, Director of John Adams Institute for Accelerator Science: «The research conducted by the INP electron cooling group was at the forefront of the world science. So, since my second year at the university, I began to work with world stars: the people who developed this method, demonstrated it experimentally and applied it to real-life projects. It was an unforgettable experience! This training was highly motivating and helped me come to the world level in science. I have always wanted to reach the level of such masters as Parkhomchuk and Dikansky. This bar, which was raised as early as in my student days, I have not yet reached, but I have a goal to strive for»

(Seryi & Seraia, 2016)

1974 The first experiment in electron cooling of a proton beam

Academician A. N. Skrinsky in the panel control room of the antiproton accumulator discusses the newly found phenomenon of super-rapid electron cooling with young researchers V. V. Parkhomchuk, I. N. Meshkov, and N. S. Dikanskii. *1978*

HOW TO SHOE A FLEA

It is known that electrons and positrons moving with acceleration (e. g., along a circular trajectory, as it happens in ring accelerators) emit electromagnetic radiation (the so-called synchrotron radiation), which makes them lose a large fraction of their energy, resulting in a rapid natural cooling of the electron beam and, correspondingly, in beam compression. This cooling technique could not be used for heavier particles (protons and ions) because synchrotron radiation becomes sufficiently intense only at particle motion energies of tens of teraelectron-volts, which could not be provided in the 1960s.

The essence of the cooling method proposed by G. I. Budker was based on the idea that the proton beam and electron beam moving next to each other with almost identical velocities start to interact by means of electromagnetic forces. Owing to this interaction, their temperatures become equalized, i. e., the energy of thermal motion is transferred from the proton beam to the colder electron beam. As the proton mass is greater than the electron mass almost by a factor of 2000, the velocity of thermal motion of the proton beam and, correspondingly, its angular scattering are much smaller than those of the electron beam.

This was a complicated problem, in terms of both science and engineering. The fact that this problem could be solved was not as obvious at that time as it is now, several decades later. For this reason, probably, nobody in the world was so courageous as to start these activities. It was only owing to the intuition of the older generation of scientists and enthusiasm of the younger researchers of the Institute of Nuclear Physics that many problems of design of an operational setup were solved and we finally succeeded.

The team involved in the development of this method included many researchers who were already famous at that time: Academician G. I. Budker, Academician A. N. Skrinsky, senior researcher Ya. S. Derbenev, Head of Laboratory N. S. Dikanskii, senior researcher I. N. Meshkov, researcher D. V. Pestrikov, Head of Laboratory R. A. Salimov, and researcher B. N. Sukhina. This important scientific achievement was highly appreciated by the Russian and foreign academic community. To verify the method, it was decided to construct a full-scale model of an antiproton accumulator (with the ring perimeter of 47 m) and perform experiments on electron cooling.

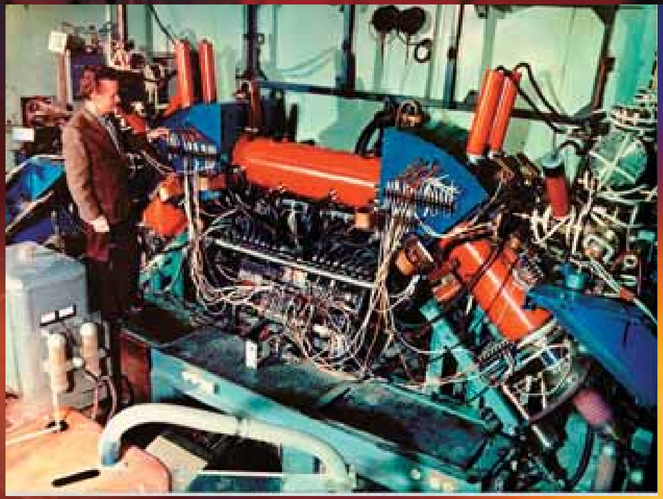
We started to put this idea into practice in 1971. We designed and fabricated the setup in the workshops of the institute and experimentally checked the elements of the pioneering accelerator with electron cooling. Using a special testbench, we generated an electron beam and studied its properties: density, charge, temperature, and all other factors that could affect the cooling process.

After all elements of the setup were assembled, we started our attempts to obtain cooling, which were not successful for the first several months for various reasons: first, because the vacuum was not sufficiently deep; then because of problems with oscillations in our electron circuits. It was only our enthusiasm, faith to the idea, and whole-hearted desire "to make a flea wear a horseshoe," i. e., to achieve proton beam cooling, that allowed us to overcome the various problems that we faced.

Once, when the internal ion pump was accidentally switched off, we suddenly saw that the beam lifetime increased, and I immediately recalled our experiments with the measurements of the electron beam field by using a sphere suspended on a filament. It turned out that the hot ions from the pump charged the electron beam, and the high value of the electric field "kicked out" protons from the accelerator instead of cooling them. Soon after that we modified the evacuation system and were happy to see that we did obtain cooling.

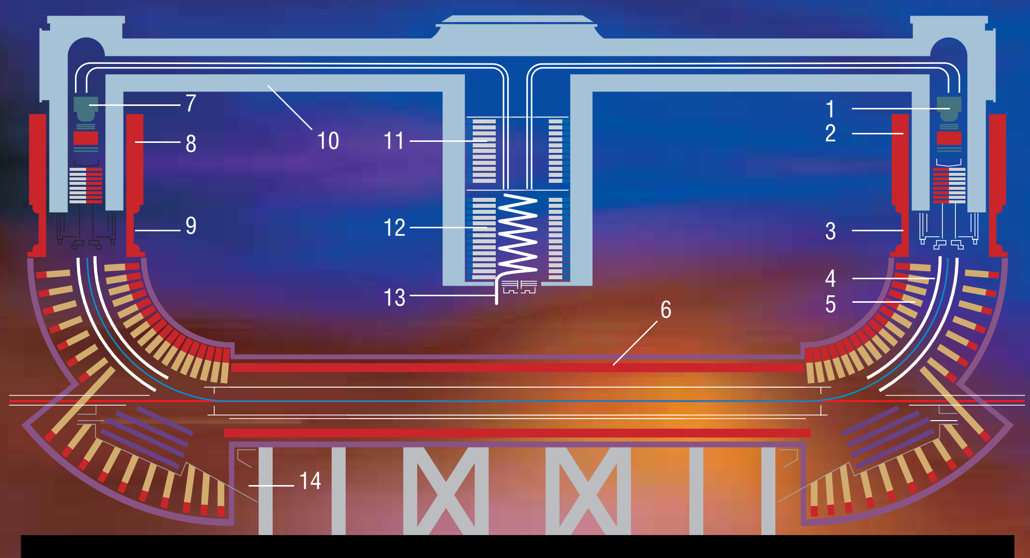
Thus, the Antiproton Accumulator NAP-M (M stands for model) was commissioned in 1974, and the first results on electron cooling were obtained.

From: (Parkhomchuk, 2013)



The heart of the HAP-M system is the EPOKHA setup based on the electron cooling method and one of its founders, V. I. Kudelainen. *1976*

Cooling system with an energy of 350 keV:

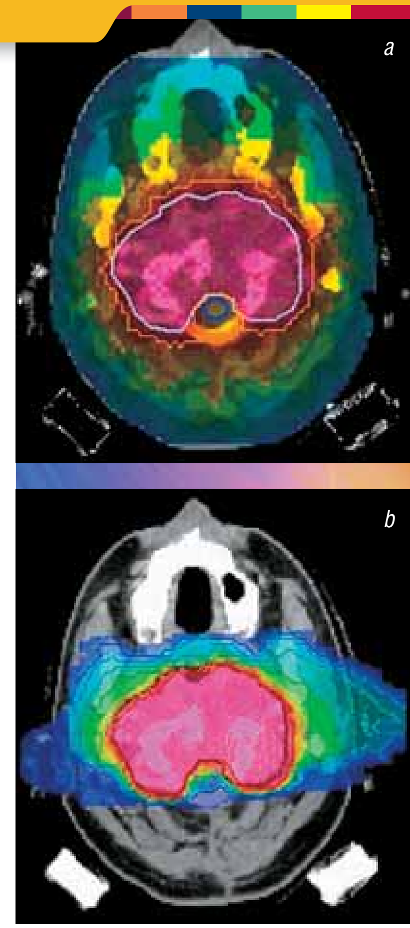


1 – electron gun;
2 – main magnet of the gun;
3 – additional magnet of the gun;
4 – electrostatic deflecting system;
5 – toroidal magnetic deflecting system;
6 – main magnet;
7 – collector;
8 – main magnet of the collector;
9 – additional magnet of the collector;
10 – elegas (SF6) feeder;
11–12 – rectifiers;
13 – power input;
14 – vacuum pumps

The electron cooler has a fairly simple structure. The electron beam is generated by an electron gun having a specially shaped cathode. After that, the beam is accelerated and directed to the channel of the main accelerator with the help of a deflecting system. Then the electron beam is directed outward (with the help of the same deflecting system), and electrons are collected in a collector

2009 The first testing of ion therapy in cancer treatment at the Chinese Science Center

Project of a carbon complex for treating cancer by the electron cooling method. Carbon ions are accelerated in a small linear accelerator and injected into the ring booster. From there they are directed to the main ring with electron cooling, where they are accumulated and then directed to distribution channels by means of cooling



Computer plan of dose distribution obtained by using X-ray therapy from nine directions (*a*) and carbon therapy from two directions (*b*). One can see that the dose received by healthy tissues is much greater in the case of X-ray therapy as compared with ion therapy. A clearer contour of the high dose in the case of ion therapy shows a good therapeutic effect owing to fast recovery of the tumor-adjacent tissues

IN THE SERVICE OF MEDICINE

Electron cooling in one of the few examples of a Russian invention developed within the country to such a level that these works are still in demand. We can be proud of that: within several decades, we moved forward in scientific research and solved extremely complicated engineering problems, which allowed us to make the next step in the field of physics of elementary particles. But application of the electron cooling method was successful not only in the physics of elementary particles. Extremely interesting results were obtained by this method in medicine, namely, in oncology.

In conventional X-ray therapy, the maximum radiation level is reached when the beam enters the patient's body, but it noticeably decreases as the beam moves toward the tumor. To compensate for this effect, the patient is irradiated from different sides; as a result, the tumor obtains the maximum amount of radiation, whereas health tissues are irradiated to a level below the dangerous limit, though this level is rather high as well.

If a high-energy ion beam is used, the situation is different. As the beam is decelerated in the patient's body, ionization is enhanced, and the maximum effect is observed in the tumor region. Owing to electron cooling, the size of the ion beam is small, and the beam can be easily focused and directed from various locations to the cancerous region. This procedure offers a possibility of concentrating high-density radiation only in the neoplasm and minimizing radiation in healthy tissues.

Experiments on treating patients with cancer by this method are performed at the Chinese Institute of Modern Physic (IMP, Lanzhou, China) on a large experimental ion setup with two systems of electron cooling designed and fabricated at BINP SB RAS. During the time of operation of this setup, hundreds of people have received a chance to extend their lives. The results of this treatment look very promising, and IMP launches a project of a specialized center for treating patients based on this method.

From: (Parkhomchuk, 2013)

In 2016, the American Physical Society awarded Vasily Parkhomchuk, Dr. Sci. (Phys. – Math.), Full Member of the Russian Academy of Sciences, with the Robert R. Wilson Prize "for crucial contributions in the proof of principle of electron cooling, for leading contribution to the experimental and theoretical development of electron cooling, and for achievement of the planned parameters of coolers for facilities in laboratories around the world." The international Robert R. Wilson Prize, established in memory of the founder of the famous American accelerator laboratory Fermilab, is awarded annually for outstanding achievement in the physics of particle accelerators. So far, only two Russian physicists have received this award, and both of them work at the Institute of Nuclear Physics SB RAS. In 2002, the prize was awarded to Alexander Skrinsky, Dr. Sci. (Phys. – Math.), Full Member of the Russian Academy of Sciences

The first successful experiments in electron cooling triggered a series of dissertations. Mine even had the title "The First Experiments in Electron Cooling." Budker was happy, but the rest of the world remained mistrustful. American scientists and journalists who came to the institute wrote that it might have been a hoax and, if it wasn't, then we had made an immense achievement.

The world didn't trust us also because, in a sense, we managed to rebut Budker himself. In his model, we could only cool electrons down to 1000 °C. Instead, we showed that the beam cools down to 1 K. The reason we could do it was the quality of our magnetic field. In our experiments, we sent electrons through a perfectly homogeneous magnetic field, which allowed them to cool so well. In the West, however, they didn't pay attention to this subtlety, and their magnetic field was so bumpy that the electrons acquired additional temperature. That is why they couldn't reproduce our results.

It is this subtlety – the ability to create a homogeneous magnetic field – that made BINP the world leader in magnetic electron cooling, and so far we've kept our leading position. Apart from us, no one in the world can build these facilities. There is a joke: Whatever Russians do they make a Kalashnikov rifle, because no one else can do it better. Our facilities are now working everywhere in the world: in Germany, China, Switzerland, at the Large Hadron Collider... The Chinese use our facilities to cure cancer: the cooling makes the beam so fine and precise that it easily hits the right spot without damaging the healthy tissue.

We sent the first such facility with a perfect magnetic field to Germany in 1996, and we made one for Russian science as late as in 2017. Two large coolers will be working in the NICA project in Dubna. We have already delivered one of the facilities; the other one will be ready by 2023. It's a long shot, but we are building a big facility, and we need time to make it.

Many years had passed from the birth of the electron cooling idea to its implementation in our country, but it was a happy story. Now I understand my mother who wept when she sent me away to Novosibirsk to the High School of Physics and Mathematics. I had the same feeling when I sent our facility to Dubna, it way like saying good-bye to my own child. And this is true.

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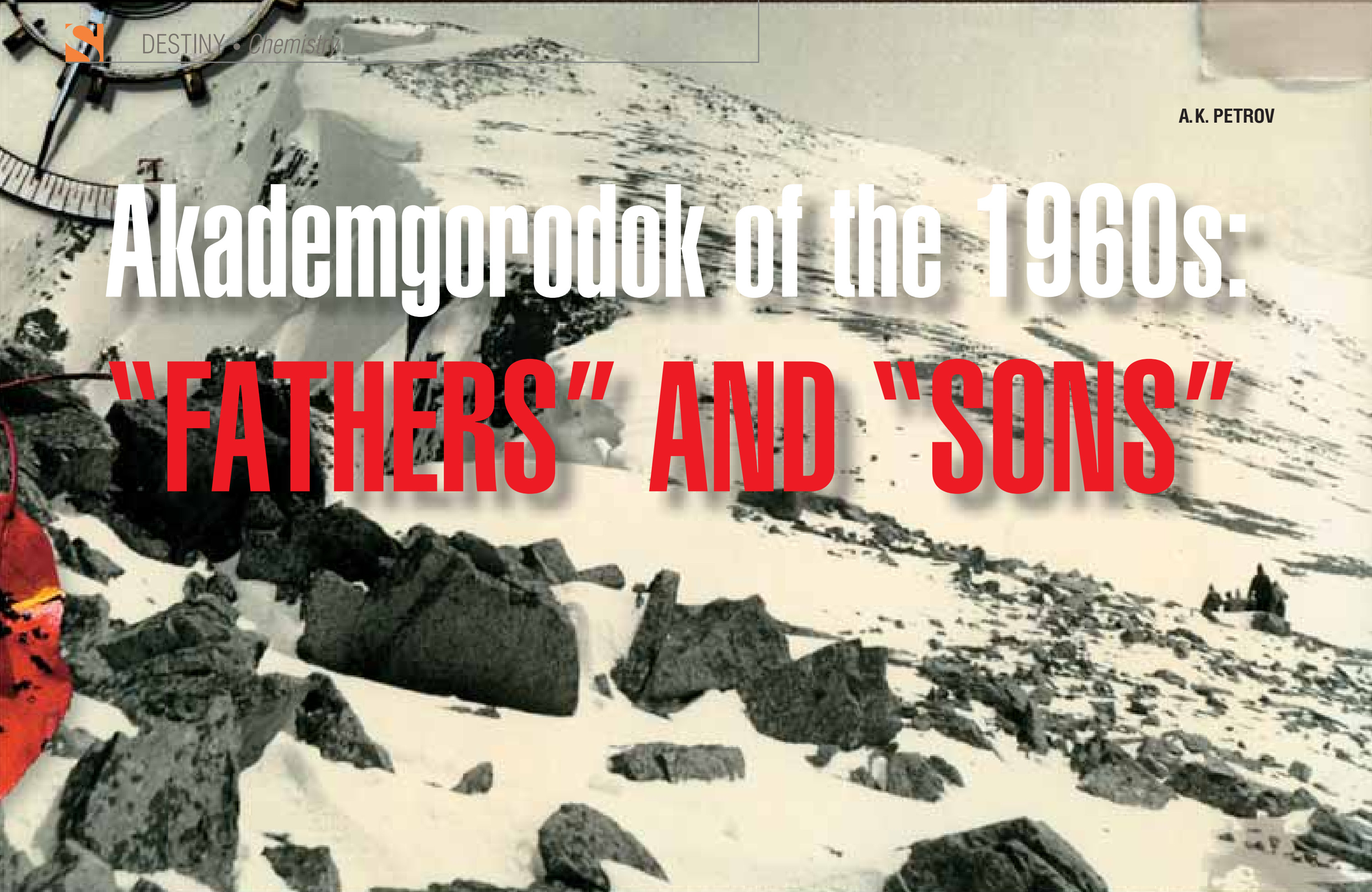


A.K. PETROV

Akademgorodok of the 1960s: "FATHERS" AND "SONS"

The establishment of the Siberian Branch of the USSR Academy of Sciences in the mid-1950s turned out to be one of the most successful projects in our country in the second half of the 20th century. The men who ventured into the multidisciplinary research center in the Siberian taiga were not born with a silver spoon in their mouths—the pioneers of Akademgorodok were most daring and enthusiastic scientists in their fifties. They arrived from all over the country, bringing a dozen gifted students each. The development of Akademgorodok went on, and five years later, the science center went through another phase of natural selection: the time had come for a new generation of scientists—the so-called Sixtiers, graduates of universities of Moscow and Siberian cities, who came here to become part of the amazing scientific families that had formed in this scientific center

Key words: free electron lasers, charged particle accelerators, synchrotron radiation

Science must be simple, fascinating and fun.
The same applies to scientists.
Pyotr L. Kapitsa

In the Soviet era, Moscow sucked out, as it always did, talented people from the entire country – it took to itself the best scientists, artists, writers, sportsmen. Not a single talented person was left in the peripheral lands although these regions, especially Siberia, had always been to this country a great source of value. No wonder that back then everyone believed science did not exist beyond the Garden Ring.

However, three prominent scientists – Sergey A. Khristianovich, Mikhail A. Lavrentiev, and Sergey L. Sobolev – approached the Soviet government with an audacious project to establish in the Asian part of the Soviet Union a new branch of the USSR Academy of Sciences. The mighty triumvirate succeeded: only 12 years had passed since a most devastating war, but the Soviet government suddenly believed in Mikhail Lomonosov's vision that "Russia's power will grow with Siberia and the Northern Ocean."

In 1957, the government issued a resolution to establish the Siberian Branch of the USSR Academy of Sciences. This stupendous project attracted the most creative scientists (Professors, Full or Corresponding Members of the Academy of Sciences), who felt confined in capital cities, who had their own ideas and, most importantly, their own students. When they set out for Novosibirsk from Moscow, Leningrad, Kiev, Kharkov, Kazan, each of them took a small stable of their kids-in-science, ten to twenty years younger. These youngsters were given a free hand. And all of them, young and old, believed that "doing science meant doing the impossible."

Still, the majority of researchers in the new science center belonged to the generation of the Sixtiers, who graduated from universities in the early 1960s, while the first graduates of Novosibirsk State University received

Alexander K. PETROV, Doctor of Chemistry, Professor, Chief Researcher at the Laboratory of Laser Photochemistry, Voevodsky Institute of Chemical Kinetics and Combustion SB RAS (Novosibirsk). Author and coauthor of over 160 scientific papers and 5 patents

During a meeting of the General Secretary of the CPSU Central Committee Nikita S. Khrushchev with scientists of Novosibirsk Science Center in March 1961: N.A. Chinakal, M.A. Lavrentiev, N.S. Khrushchev, G.I. Voronov, D.S. Polyansky, P.Ya. Kochina, S.L. Sobolev, G.K. Boreskov, E.N. Meshalkin, V.V. Voevodsky, G.I. Budker, I.N. Vekua, T.F. Gorbachev , A.A. Kovalsky, Yu.N. Rabotnov, N.N. Vorozhtsov, A.V. Nikolaev, E.I. Grigolyuk, I.I. Novikov, S.A. Khristianovich, A.T. Logvinenko, V.K. Shcherbakov, V.S. Sobolev, G.S. Migirenko, V.N. Saks, G.A. Prudensky, A.I. Cherepanov, N.M. Ivanov, V.A. Smirnov, Yu.B. Rumer, and P.V. Pyrinov. *SB RAS photo archive* their degrees in 1964. Take me, for example. I finished Kemerovo State University in 1961 and received an invitation to join the Institute of Organic Chemistry from its director, Nikolay N. Vorozhtsov himself, who then was a Corresponding Member of the Academy.

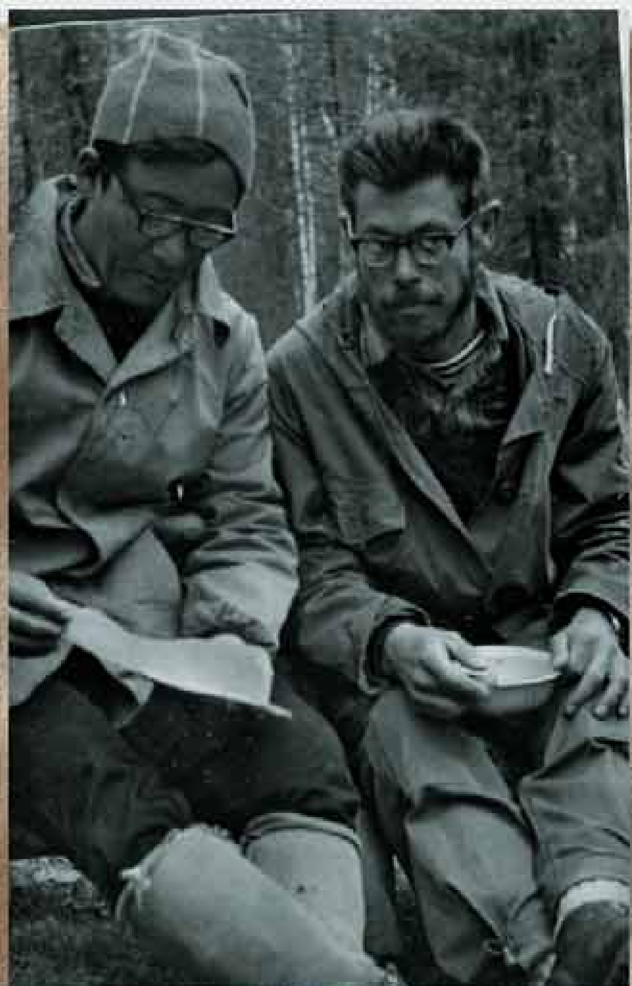
Our generation could be called the grandchildren-in-science of the pioneers. In science, the time period between generations is twice as short than in life, where the difference between "fathers" and "sons" is about twenty years. A candidate of science "grows up" within a decade; then he or she is ready to pass on their knowledge to a new generation.

Alexander Petrov: "In the 1960s, we had a motto: Doing science means doing the impossible, even if no one believes in what you're doing. For instance, when I proposed to use the infrared quantum of the laser to stimulate chemical processes, my opponents argued, rightfully, that it was impossible because the infrared quantum is a vibrational excitation, which cannot break a chemical bond.

"But instead of breaking the bond, we can force it to vibrate vigorously, and in some cases, that will be enough. If we use a lot of quanta, we can selectively influence the processes. As a result, in 1985 we published a book Infrared Photochemistry, and I defended my doctor-of-science dissertation on this subject. Today, I am still choosing to do the impossible..."

Knee deep in kids

Only one epithet can best describe the relations between "fathers," "sons," and "grandsons" in the young Akademgorodok – these relations were amazing. Any parent who meets their first grandchild falls under the impression that they had devoted so little attention to their own kids that now they should make up for their neglect by caring for their grandchildren. So, we, the Sixtiers, enjoyed this full attention and care from the founding fathers, the first generation of Siberian scholars. In those very best years, we could easily approach any scientific savant, ask a question and get an answer. Everyone was available; there were no hierarchies. It was an invaluable experience not only for science but also for ethics, for human existence itself.



Two Alexanders—Petrov and Kim (from the Institute of Organic Chemistry)—on a hike in the Altai Mountains. *1971*

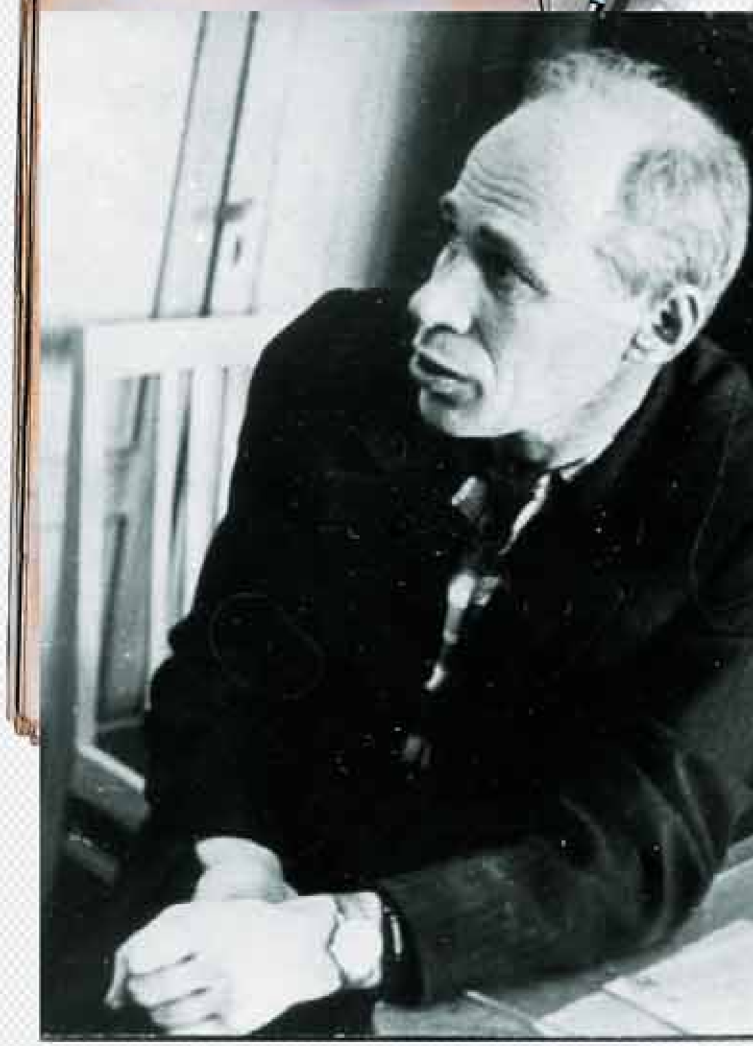
Mikhail Lavrentiev, Sergey Khristianovich, Vladislav Voevodsky and many others regularly held weekend scientific workshops at their cottages, always followed by a lunch or dinner. Everyone took part in molding Russian meat dumplings – *pelmeni*. This was also a way to feed the young scientists. The "fathers" lent us money when we needed it and then refused to take it back. They also organized kindergartens: one institute provided a three-room apartment; another one hired the nurses, purchased a fridge, made a playpen.

When my family got a one-room apartment in Akademgorodok, the director of our institute Nikolay Vorozhtsov called on us himself to check how we were. He came in and saw our meager belongings – a cot, a stool, a box instead of a table – that was all. He brought me to his place, gave me a basin and cloth to tidy up my new home – I indeed had nothing to do it with – and then gave me 400 rubles to buy new furniture! By the way, when we later moved into a new apartment, I gave the furniture bought with Vorozhtsov's money to my students, the first candidates of science that I raised. However, one stool, on three legs, I kept to myself, as a memory.

Every Thursday, Vorozhtsov would make a "tour" around the institute and talk personally to everyone, calling them always by their first name and patronymic. This way he could communicate throughout the year literally with everyone on staff. He would enter the room, stroke his beard and ask people about their work, salaries, living conditions, health. If anyone managed to do some interesting science, he would look closely at their work and say, "Look, that's great, but no way that nobody has ever thought about that and made it." In response to "I've ransacked all sources, sifted through all issues of the abstract journal," he would advise, "Academician Nesmeyanov created the abstract journal in 1953, that's too short a timespan for science. How about looking through *Berichte* [a German scientific journal] for the past century? Call on me if you find something." And indeed, in 1895, some German professor described the same mechanism but only as an assumption, while I had proof. "Quote this author," said Vorozhtsov, "and write an article. I will present it to *Doklady Academy of Sciences*." And he would decline coauthorship, a totally unthinkable thing nowadays.

Here is a telltale story about Academician Sergey Sobolev, one of the greatest mathematicians of the 20th century. In May 1972, we went on a hike to the Fann Mountains in Tajikistan. In a remote *kishlak*, we asked to stay overnight in a local school. A young lad came in, Sergey Sanginov, a son of the schoolmaster and a student at the Pedagogical Institute in Dushanbe. When he found out where we were from, he asked if we knew Sobolev. I told him that in summer I regularly met Sobolev in the street in the morning when I took a run to the beach. The boy said, "I'm a mathematician, and I really need his book, but there's nowhere I can find it. Could you ask him for his book?" Two weeks after I came back home, I met Sobolev and told him this story. He laughed and said that he would certainly help that Tajik boy, who happened to have the same name as himself. He invited me to his house, climbed up a ladder – he had bookshelves rising from the floor to the ceiling – pulled out the book and asked me to send his regards to Sergey. The book reached its destination, and I received a thank-you letter with a photograph.

In 1974, me and an NSU student Natasha Rubtsova (now a doctor of physics and mathematics) measured the temperature distribution in a cell filled with gas under the action of CO_2 laser light and discovered clear signs of convection. I decided to look deeper into this issue, took a book by Samson Kutateladze. But I found no answer in that book. Fortunately, me and him lived in the same apartment building, took out the garbage together, exchanged newspapers. Kutateladze invited me to his place, looked through our results and said that it was all very interesting but nobody could describe convection yet. Just imagine: such a savant in thermal physics as Kutateladze was not ashamed to admit that he did not know something!



Academician Vladislav Voevodsky, a specialist in chemical kinetics *© NSU Museum*

FEL: A GENTLE TOUCH OF THE LASER

The mass-spectrometry technique, now widely known, made a real revolution in chemistry. At present, a mass-spectrum can be recorded for any substance that can be transferred to the gas phase. The molecular weight of the substance can be determined from the parental peak of this spectrum, and its molecular structure can be obtained by the analysis of the mass spectra of fragments. The method was prevented from being used in biology not so much due to very large weights of biological macromolecules as due to the impossibility of transferring them to the gas phase.

Therefore, it would be extremely tempting for researchers to have at their disposal a method that would allow a "soft" (i.e., without destruction of an object) laser ablation of biological macromolecules, which could then be recorded in the form of gas-phase aerosol particles. This idea was implemented at our Siberian Center for Photochemical Research with the launch of the free-electron laser (FEL) developed at the Institute

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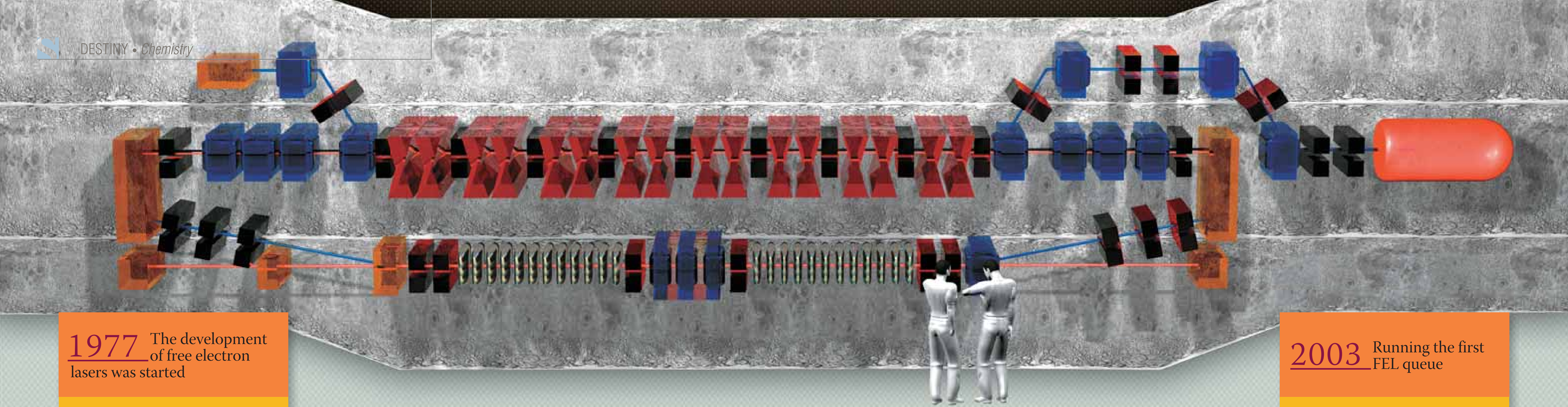


1977 The development of free electron lasers was started

2003 Running the first FEL queue

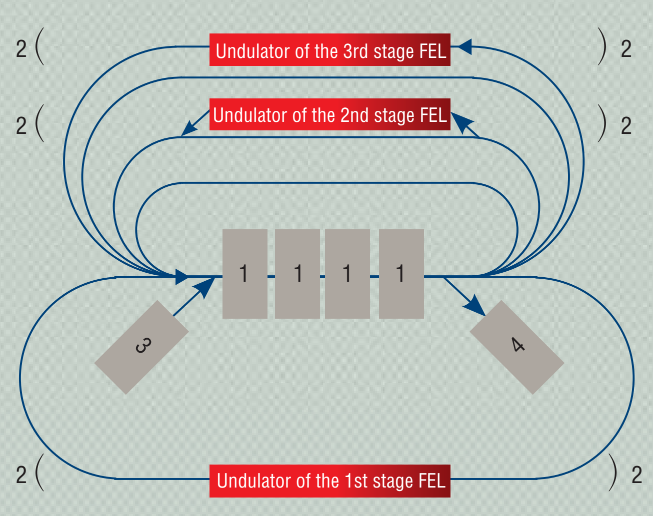
of Nuclear Physics (INP) of the Siberian Branch of the Russian Academy of Sciences.

The history of the center began in 1992, when Academician Skrinsky, director of the INP, invited all the interested parties to a traditional round-table discussion and told them about the project to create a FEL whose radiation could be smoothly tuned over wavelengths in the huge infra-red range from 2 to 200 microns (μm), which overlaps the range of vibrational and rotational spectra of almost all existing molecules.

By that time, our Laboratory of Laser Photochemistry had a 20-year experience in researching the reactivity of molecules excited vibrationally by monochromatic CO_2-laser irradiation. Unfortunately, the laser generated radiation in the narrow range of wavelengths of about 10 μm; therefore, researchers had to select molecules vibrating in exactly that range. Obviously, a universal source of monochromatic radiation would make it possible to selectively influence any vibrations in any molecular systems. It was the time when no research was conducted in the specialized building of the Institute of Chemical Kinetics and Combustion housing a 50-meter accelerator hall protected by three-meter-thick concrete walls. That is when the idea emerged to create, on these premises, a shared center for fundamental and applied research in physics, chemistry, biology, and medicine.

Today, looking back on the past, we would like to sing a hymn to the heroic staff of the Institute of Nuclear Physics, who continued to work during hard times for the Russian science and invested an appreciable portion of their earnings in the creation of the free electron laser. Difficulties pulled us together. On April 4, 2003, our Siberian laser produced the first generation of light with wavelength tuning in the range from 100 to 200 μm. This was the achievement we had been working towards for 10 years! The participants of the FEL launch organized an improved celebration in the panel room and drank champagne right from the teacups…

(Petrov, 2006)



Plan and general view of the full-size facility at the Siberian Center for Photochemical Research. Closed lines show electron-optical channels of electron transport. Arrows show the trajectory of electrons

1 – radio frequency cavity;
2 – optical cavity mirrors;
3 – source of low-energy electrons;
4 – absorber of decelerated electrons

ON FAST ELECTRONS

Devices that transform the energy of electrons moving almost at the velocity of light to the energy of electromagnetic radiation got the name free electron lasers (FELs). A universally recognized advantage of this device, which distinguishes it from other lasers, is the ability to obtain monochromatic radiation at any wavelength in an extremely wide range, from 0.1 nm to 1 mm. In this case, relatively fast switching of the laser from one wavelength to another in an interval of up to a few tens of percent is possible. The major application area of such facilities is investigations in the sphere of material science, chemistry, crystallography, solid-state physics, and molecular biology.

The process of radiating an electromagnetic wave by an electric charge can be presented as separation of a part of its electric field. This means that in empty space, only those charges that move with acceleration can radiate. For an electron to radiate, it must be made to move in a wave-like manner. Such motion can be caused, for instance, by a static electric or magnetic field. As early as 1947, the Soviet physicist V. L. Ginsburg proposed that a periodic field be used to enhance the radiation intensity of a fast charged particle, and calculated the parameters of such radiation. Later, a device called undulator was created. The undulator creates a periodic magnetic field to organize specific motion of electrons in a wavy trajectory along the longitudinal axis of the device. The resulting enhancement of electromagnetic radiation forms the basis for the operating of a free electron laser, which is an electromagnetic radiation amplifier.

The return of radiation from the amplifier output to its input can cause self-excitation of the amplifier, transforming it into a generator. In the case of a FEL, it is transformed to a generator with the help of an optical cavity, i.e. two mirrors located to the left and to the right of the undulator on its longitudinal axis. An electromagnetic wave circulates between the mirrors, intensifying each time it passes through the undulator. To compensate the diffraction divergence of radiation, the mirrors are often concave.

The development of free electron lasers was started by the Institute of Nuclear Physics SB RAS in 1977, when A. N. Skrinsky and N. A. Vinokurov proposed a FEL modification (an optical klystron), which considerably increased the device amplification in comparison to the classical scheme. While new FELs were being developed, a permanent magnet undulator with control of the magnetic field amplitude by changing of the gap was implemented for the first time in the world. Several years later, there emerged hybrid undulators on permanent magnets. Now, both the variable gap and the hybrid construction of undulators are universally accepted and used in all synchrotron radiation sources.

The original long undulator of the the optical klystron on the VEPP-3 storage ring, which was made in 1988, was so good that it was used more than 20 years at Russian and US facilities. It allowed us to obtain radiation of a record short (for FELs) wavelength of 0.24 micron in the ultraviolet range and of an unprecedentedly narrow (10^{-6}) spectrum. This record was not broken for over 10 years

"SASHA, PLAY THE GUITAR FOR US"

In those days, we thought about Akademgorodok as our property and responsibility: we built, with our own hands, sports grounds, basketball courts, tennis courts. We also spent our vacations not like other people. We didn't go to summer resorts or recreational facilities; instead, we went on hikes – mountaineering, rafting, skiing. We booked whole cars on trains heading to Biysk and Leninogorsk. In the 1970s, I was for three years the chairman of the hiking route assessment board for Akademgorodok and know for certain that 90 % of all the registered hikers in Novosibirsk, a city with over a million residents, lived in the small Akademgorodok. My old friend and a dedicated hiker Academician Dmitry Knorre, who recently celebrated his 90th birthday, always asks me, even these days, when we come together: "Sasha, play the guitar for us." When we went on long hikes, we arranged ourselves ingenious letters on an institute letterhead. The letters read roughly as follows: "To the Head of the Air Detachment at Lake Sobachye. The institute requests the assistance for a group of researchers… Nikolay N. Vorozhtsov, Director of the Institute of Organic Chemistry, Siberian Branch, USSR Academy of Sciences, Corresponding Member of the USSR Academy of Sciences." Vorozhtsov was greatly amused each time he signed those letters and asked us to send him telegrams when our hike was over. The letters always worked: we got a helicopter or a car, for money, of course. But then, all of a sudden, our papers lost their power. The reason was, as it turned out, that Vorozhtsov got promoted to an Academician while the rank of Corresponding Member looked much more formidable in the eyes of local bosses. We began to write "Corresponding Member" again; Vorozhtsov roared with laughter but signed the letters

I should add that in those days, virtually all of our Academicians regularly published articles in the newspaper *Za nauku v Sibiri* ('Science in Siberia'). They committed themselves to science popular style, displaying the full scope of their talent.

Science reigned over it all. We worked from 9 a.m. to 9 p.m., sometimes till morning, but one needed a permission for that. Back then, there was not such thing as grant support programs for scientists, and we worked for very little money. As a senior laboratory assistant, I earned a salary of 83 rubles per month; after a year, I got promoted to an engineer with a salary of 105 rubles; only when I got the position of a researcher, I began to earn 120 rubles per month. When I visited my home city of Kemerovo and met with my classmates, they would wonder, "Petrov, how do you live on this money? I work as a machine operator at a chemical plant and earn three times as much. And you were among the top students in our class." I would retort, "You will work on the same machine all your life and earn the same salary. That's not for me. I'm doing what interests me. Moreover, I know that I have prospects in my job." I knew exactly what my life would be if I went on working, and I was right.

Why was our Academy of Sciences so popular in the times of the Soviet Union? The reason is that it brought together the smartest people, who had done a lot for the nation and became Academicians because of real discoveries and achievements. In those times, it was a generally accepted practice that all important national programs must get a "blessing" of science: the Academy bore a status of a major expert and a key actor of progress.

In the mid-twentieth century, the Soviet economy produced no fertilizers, no plastics, not even pharmaceuticals. We purchased all that for "staple product," quoting Alexander Pushkin, i.e., for wood, oil, gas. In 1956, the USSR leadership announced a national chemization program. And who became the head of the Academy of Sciences? Of course, Academician Nesmeyanov, a born chemist. By the way, it was him who designed the first synthetic food and even contributed to selling to the Americans a license for the production of artificial black caviar. Although Nesmeyanov himself was not involved in the chemization program, he knew what task to assign to which institute. After a decade, we became a totally different country with our own fertilizers, plastics, caprons, nylons, etc.

When the conquest of space rose to the top of the agenda, Academician Mstislav Keldysh, a major expert in applied mathematics and mechanics and one of the ideologists of the Soviet Space Program, became the head of the Academy. You know the result. Our achievements in chemistry did not surprise anyone: we simply caught up with the West, but we did spurt into the lead in conquering outer space.

Alexander Petrov with a peer hiker K. Richter from DDR, a postgraduate student of Academician G.K. Boreskov. 1971 г.

When the leadership announced an atomization program, the country soon had a widespread network of nuclear power plants; we were the first to make a nuclear icebreaker, nuclear submarines. Again, one of the organizer of the atomic industry, an atomic physicist Anatoly Alexandrov, a right-hand man of Igor Kurchatov, became, in 1975, President of the USSR Academy of Sciences.

Then we moved into the unforgettable 1990s, and global projects were relegated to a back burner. Now we have import substitution on the agenda. Is it not a good task for the country and the Academy of Sciences, considering that the number of its members has grown severalfold over the past half-century?

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Big CHALLENGES generate BIG people

V.N. PARMON

Catalysts of IC-GO series (*above*), developed at the Institute of Catalysis SB RAS, are designed for fine hydrotreating of diesel fractions and vacuum gasoil

Valentin N. PARMON, Academician of the Russian Academy of Sciences, Doctor of Chemistry, research advisor of the Boreskov Institute of Catalysis SB RAS (Novosibirsk), full professor with Physical Chemistry Department of the Natural Science College, Novosibirsk State University. From 1995 to 2014 was director of the Boreskov Institute of Catalysis SB RAS. Awards: Order of Honor (1999), Order of Merit to the Fatherland, IV class (2007), and Order of Lomonosov (2007). Recipient of the EFCATS Award for innovations in catalysis (2005), State Prize of the Russian Federation in Science and Technology (2009), and Global Energy Prize (2016). Author and co-author of over 800 research publications including 7 monographs, 7 textbooks for universities and over 100 invention certificates and patents

The author's statement which is the headline of this contribution may seem as controversial as the notorious chicken and egg problem. The most important of all, however, must be bringing these two things together. It is there, at these meeting points, that history is made. An illustrative example is the Akademgorodok of Novosibirsk, a backwater town that has turned into a forefront of super activists striving to push forward the frontiers of knowledge and make the world around them better

Key words: catalyst, photocatalysis, chemical engineering, catalytic process, hydrogen energy

I first came to Akademgorodok in January 1977, as a "travel companion" of Kirill Ilyich Zamaraev, who later became an Academician and Director (after G. K. Boreskov) of the Institute of Catalysis SB RAS. It was bitterly cold, and Kirill Ilyich got his face frostbitten when we went skiing at −26 °C. Till his dying day, he had the habit of rubbing the frostbitten cheek.

I am from Minsk, and by that time I had graduated from the Moscow Institute of Physics and Technology (MIPT). In those years, the new research areas, bionics and biophysics, were very popular and I was dreaming to become a biophysicist. The MIPT had an appropriate department but the meetings of its professors with undergraduates seemed so boring that I decided to transfer to the Biology Department of Moscow State University. I studied up on all the textbooks for the first two years and went to the Dean's Office to take back my documents but they did not give them to me...As a result, I had long-doubts about my future occupation until the upper-year students advised me to decide on the director of diploma first and called my attention to K. I. Zamaraev, who gave us workshops on chemical kinetics in English.

By the way, the MIPT, which at the time was considered to be on a par with Harvard, offered an unconventional education: a comprehensive training in mathematics, physics, chemistry and technology plus up to four languages including Japanese. I graduated as an engineer-physicist specializing in the chemistry of high-speed processes, and I was eager to work in any area.

"I am as much interested in technical and engineering problems as in basic research. This is attributed to my backstory. At the time of Khrushchev, polytechnic education was introduced in high school, and twice a week we worked at a factory. After three years' experience as a metalworker at the Minsk Automobile Factory, I was straightaway awarded the third skill-category out of the five existing. In addition, having worked in a student construction brigade, I officially obtained a carpenter's skill grade and a glassblower's grade during my studies in the Moscow Institute of Physics and Technology. As a result, when I moved to Akademgorodok, I happened to be one of the few people in the Institute of Catalysis sharing a common language with the workshop supervisor."

Valentin Parmon with his radio-controlled model at a republican (Belorussian Soviet Socialist Republic) competition. *Minsk, 1964*

It was Zamaraev, who was not only an brilliant experimentalist in physical chemistry but also a remarkable personality literally catching the people around him with his ideas and way of life, who to a great extent defined my future. Later, he became a co-supervisor of my postgraduate thesis at the Moscow Institute of Chemical Physics together with G. M. Zhidomirov, a specialist in quantum chemistry.

It is little wonder that when Kirill Ilyich invited me (after I had defended my Candidate's thesis) to go to Novosibirsk with him, where he had been several times as a postgraduate of V. V. Voevodsky), I readily agreed. By that time, I had taken up a new topic – the use of solar power through chemical processes. The Akademgorodok of Novosibirsk offered much better opportunities for these studies than our Moscow institute of ripe age with tough competition for diploma students. When I made the decision to leave Moscow, many of my friends twisted a finger at a temple: in those years, the Moscow registration that I got as a junior researcher of a research institute was hard currency...

We finally moved to Akademgorodok in the May of 1977, with a galaxy of eight high-achieving MIPT graduates, mostly "recruited" by me. Now, forty years later, I feel so happy that I had left Moscow.

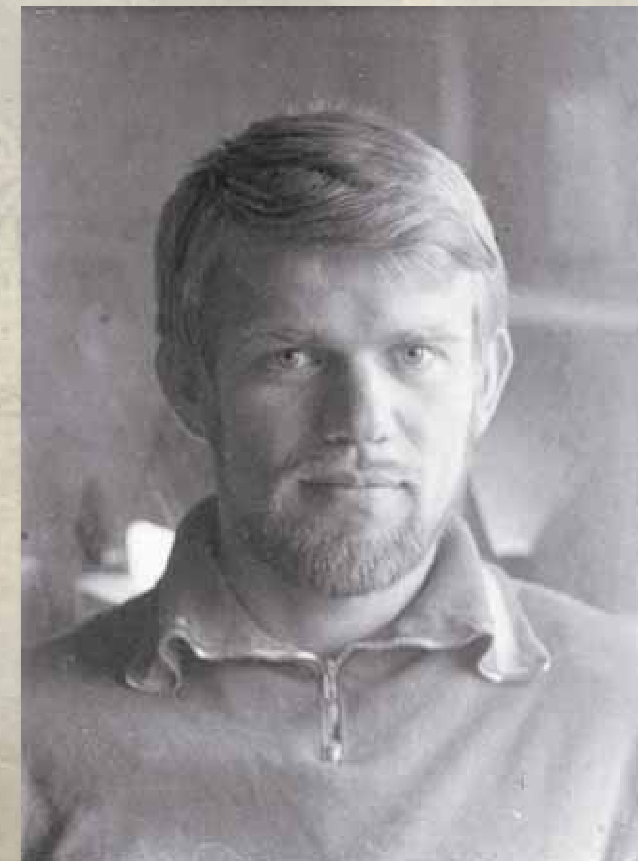
Town of super activists

In the capital, my office was near the Leninsky Prospekt, which was a regular route of foreign delegations, and we were often drawn away from our work and asked to greet them by waving flags. In Novosibirsk, you could just do work and relax when you felt like it. The matter is that the Siberian Branch had united not mere amateurs of science but those for whom science came first. All those people had left their comfy old haunts and came to Siberia with the express aim to do science.

According to a classic of history, Lev N. Gumilev, any country and society go through several development stages. One of them, the most interesting, is "passionary." It is marked by the emergence of a great number of people with an irresistible achievement drive and hands-on approach to altering life for the better. When we arrived at Akademgorodok, it was at the peak of passionarity; the Siberian Branch of the USSR Academy of Sciences was twenty years old. Afterwards, to be honest, this attitude began to wane for different reasons but I do hope it is going to return some time later: according to that same Gumilev, all processes are cyclic.

When we were young, we would often leave the institute after ten p.m., and the lights in all the rooms were still on – now, you can see lights in only two or three windows.

Honor students of the year 1966, school # 85. *Minsk*



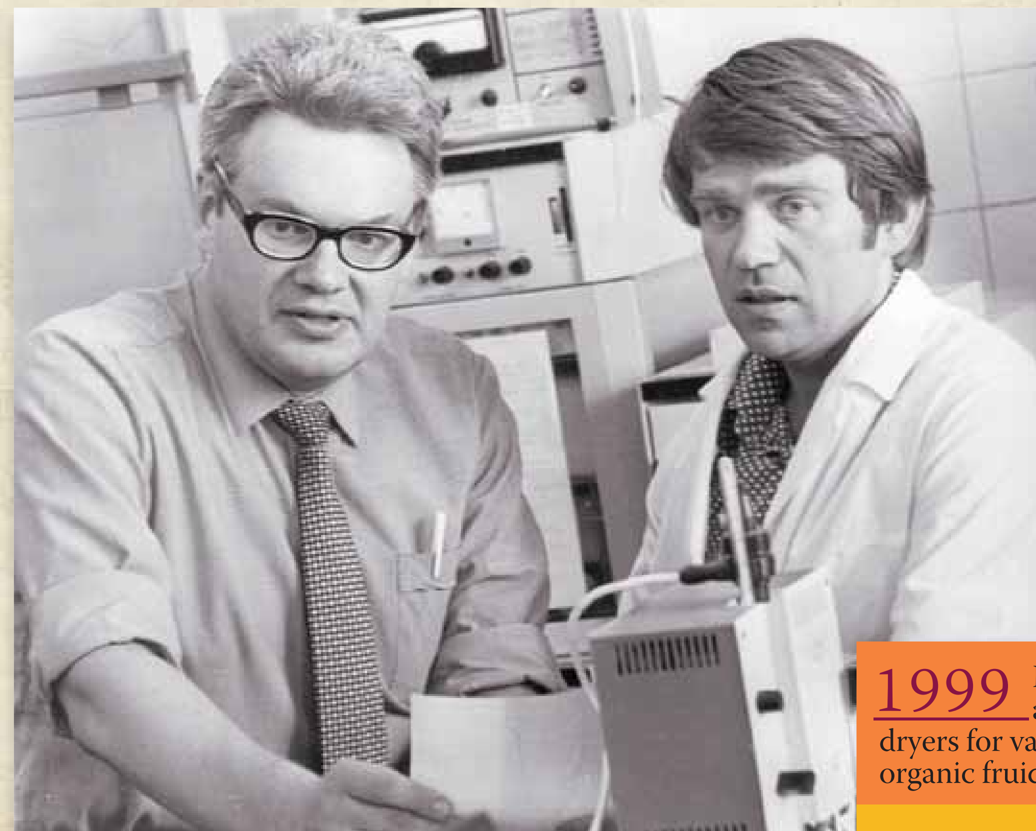
4th year student of the Moscow Institute of Physics and Technology. *1970*

"I must be the only certified diver in Akademgorodok: in Moscow, I graduated from a military diving school. Later, worked as a diver in many scientific geological and biological expeditions. In Akademgorodok, I quickly made friends with the members of the Neptune Diving Club and have kept company with them ever since; we have been going on expeditions together for over 40 years."

Big changes have taken place not in the quality of specialists (I think it is even better now) but in the personal interests and driving force. The inner spring that holds you is different now. And I'm happy that my spring was made back then.

...The first months after our arrival we stuck together. It was not an easy time because, though catalysis was a buzz word, the MIPT did not virtually deal with it. The good thing was that we were free to search, did not have to fill in many papers and had an opportunity to receive the equipment needed. My team within the laboratory led by Zamaraev was mostly involved in research into the artificial reproduction of natural photosynthesis.

The first steps in using SCUBA. *Moscow Region, spring 1969*



1999 High performance aluminum oxide dryers for various gases and organic fruids developed

A scientist with the laboratory of catalytic reaction mechanisms, V.N. Parmon with his boss K.I. Zamaraev in a laboratory of the Institute of Catalysis, SB USSR AS. *Novosibirsk, 1979*

At that time, nobody knew how to do it. The very word "photocatalysis" was not taken seriously whereas today almost a third of all publications is dedicated to catalysis.

I believe that the most interesting thing for a professional is to develop an entirely new topic, when you do not depend on equipment or research techniques. We had quite an achievable aim: if nature has created plants, people can create functional analogs of living systems. And so it was. Moreover, there are now four companies in Russia that make special-purpose appliances based on photocatalysis for cleaning indoor air.

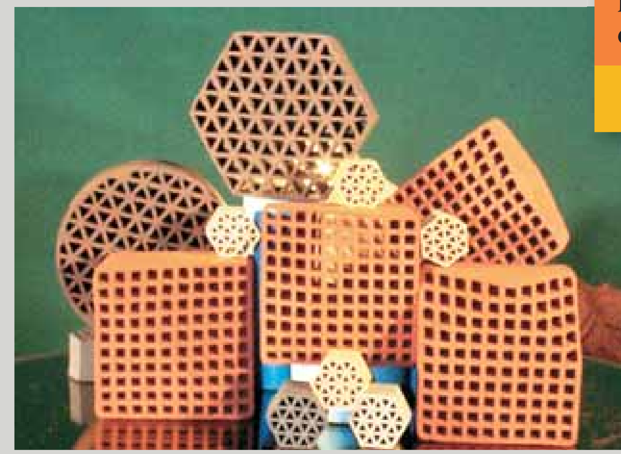
My team was mainly interested in energy conversion based on catalytic processes; at some point, an independent laboratory was set up to investigate the catalytic methods for solar energy conversion. It appeared with time that, apart from solar energy, nontraditional catalysis conceals other interesting things. This is why many specialists from my team detached themselves to form their own units but the laboratory has preserved its historical name.

Science as the basis for practice

Nearly all of the SB RAS research institutes were established not only for the purpose of pure theoretical studies but also in the best interests of the nation. The new research center, remote from the western border, was also viewed as a standby base of defense science. Virtually all the first research institutes (the Institutes of Hydrodynamics, Applied and Theoretical Mechanics, etc.) focused on defense; on top of that, there were chemical institutes serving the interest of atomic industry, geological institutes aimed at the development of Siberia's mineral resources, and so on.

Our Institute of Catalysis was formed a year later than the Siberian Branch by a special resolution of the Plenum of the Central Committee of the Communist Party of the Soviet Union, which promoted the development of chemical industry in the USSR. In line with it, the largest chemical plants of petroleum refineries were constructed and commissioned, 17 sectoral research institutes and 3 academic research institutes were launched. The Institute of Catalysis was tasked with the implementation of research results in chemical industry.

The science of catalysis is the most exciting area of chemistry since it is a mix of physical, organic



Monolith non-platinum oxide catalyst for ammonia oxidation used in hydrogen nitrate production

1995 Aluminum-palladium catalyst for high-temperature nitrogen oxide reduction developed

In April 1965, the Novosibirsk Chemical Plant started to make an experimental-industrial catalytic reactor for the production of formaldehyde (not from methanol) based of iron-molybdenum catalysts. The original design of the tubular reactor and new catalyst were developed by the researchers of the Institute of Catalysis in collaboration with the specialists of the plant. This was the beginning of a fruitful cooperation between the young research institute and industry

CHEMICAL WAVES

It is known that the so-called critical phenomena may arise in catalytic systems under certain conditions. These phenomena include:

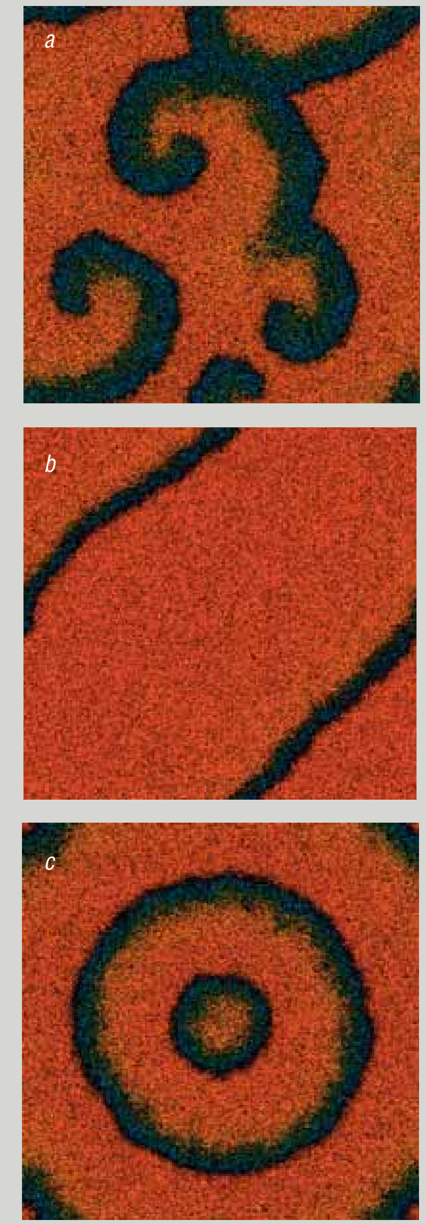
hysteresis, a process with an ambiguous dependence of the reaction rate on the external factors, e.g. temperature or pressure; and

auto-oscillations, periodic changes of the reaction rate and reagent composition on the catalyst surface in time under constant external parameters – pressure, temperature and gas leakage. Under certain conditions, even more spectacular phenomena can be observed in the autooscillation mode. These are periodic in time and space dissipative structures, also called chemical waves. Investigation of these phenomena provides a deeper insight into the mechanisms of chemical reactions.

As a rule, chemists attribute oscillations during CO oxidation on palladium group metals to the formation of two forms of oxygen: active and less active. According to the "oxide" mechanism, a drop in the catalyst surface activity is attributable to the blocking of the "sites" for oxygen and carbon monoxide adsorption by the formed oxide. The reduction of the active sites takes place due to slow CO interaction with the inactive oxygen, which is part of the metal oxide. Thus, the fast oxidation and slow reduction of the catalyst surface causes transitions between the two steady states of the reaction rate generating the oscillations. It is also assumed that the oxide phase does not form under low pressures and the reaction transition to the oscillation mode is related to the formation of a "subsurface" form of oxygen.

Experiments using X-ray photoelectron spectroscopy conducted at the Institute of Catalysis SB RAS have revealed that the oxygen atoms do penetrate into the metal forming a special "subsurface" layer. Palladium oxide, however, does not form. The oxygen-180 isotope and molecular-beam technique have helped the researchers to prove that the atomic form of the oxygen adsorbed on the surface is more reactive than the "subsurface" oxygen. The periodic formation and consumption of the latter gives rise to the critical phenomena: hysteresis, auto-oscillations and chemical waves

From: (Matveev, 2009)



The diversity of space-time structures observed on the palladium surface in the oscillation mode with the variation of the oxygen pressure: spirals (*a*), bands (*b*), "targets" (*c*)

Among the results of the pioneering work done by the researchers of the Institute of Catalysis that have found practical use is the vanadium catalyst which has replaced expensive platinum and made a significant breakthrough in sulfuric acid production. In collaboration with specialists from the Catalyst Special Design and Technology Bureau, technologies for the commercial manufacture of the vanadium catalysts of SO_2 oxidation to SO_3 have been developed and tested. Their production was launched at the Minudobreniya Production Association based in the town of Voskresensk (Moscow Region), and today these new generation catalysts are made at the Samara Catalyst Factory

and inorganic chemistry with material science and engineering. The two founders of the institute, G. K. Boreskov and M. G. Slinko, were not only outstanding chemists but also chemical engineers. From the very start, large production facilities were launched – pilot chemical departments, which lacked the Moscow institutes. Ten years later, the institute established a partner for the purpose of the industrial implementation of its research results – the Catalyst Special Design and Technology Bureau, which belongs to the Ministry of Chemical Industry.

After G. K. Boreskov's unexpected departure from life in 1984, K. I. Zamaraev became the director of the institute and I became his deputy for science. In the mid-1980s, the institute was awarded the status of the parent organization of the Catalyst Cross-Sectoral Research and Technology Center. This was something like a miniature ministry that supervised a subsector of the Soviet economy: 25 research institutes and plants engaged in catalyst production. I became deputy general

ON THE WAY TOWARDS HYDROGEN POWER

There is every reason to believe that in the 21st century the fossil energy-carriers (coal, oil, and gas) will be substituted for hydrogen – a new environmentally sound fuel. The major obstacle to using hydrogen as an energy-carrier is that this gas in a free state is virtually unavailable in nature.

In order to switch to hydrogen energy, it is necessary, first of all, to develop efficient technologies for the large-scale hydrogen production, storage, transportation, and, second, to create new-generation power plants fueled with hydrogen. Another issue is the cost of hydrogen since its production so far is exceptionally material-intensive and energy-consuming. Therefore, it is critically important to find in the near future efficient ways to produce hydrogen and synthesis-gas, which contains hydrogen, from cheap and immediately available natural gas.

All highly efficient processes designed in the world for hydrogen and synthesis-gas production from natural gas inevitably involve catalysts. Even though focused research on the portable units for hydrogen production ("hydrogen processors") started in Russia 10 to 15 years later than abroad, the national science is no doubt competitive in this area.

To illustrate, the Boreskov Institute of Catalysis, SB RAS, has developed highly efficient structured catalysts for the reaction of partial oxidation of methane. The catalysts are in the shape of strips or monoliths made of thermostable metal alloys and ceramics. Based on these catalysts, compact reactors for natural gas conversion have been developed, which allow a throughput of ca. 4 m^3 of methane per hour per 1 litre of the reactor volume.

Another promising development concerns the process of methane steam reforming. Since this reaction is endothermic and proceeds at high temperatures, it requires heat supply. To deal with this problem, a shifty design has been proposed: on the one side of a metal catalyst plate, the reaction of methane oxidation goes with heat release, and on the other side, the steam reforming of methane. The metal plate readily transfers the heat; as a result, the reactor productivity considerably increases. Based on this idea, the first fuel processor for high-temperature fuel cells has been developed in partnership with the Boreskov Institute of Catalysis, with financial support from Norilsk Nickel JSC MMC.

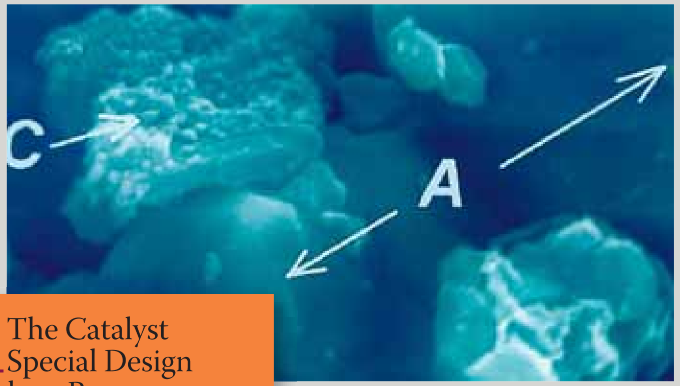
A promising fuel for portable fuel cells is sodium borohydride, from which hydrogen is generated in a catalytic reaction. The Institute of Catalysis has developed monolith and granulated catalysts for this reaction, which are on a par with the best foreign counterparts. In cooperation with the State Research Center of Chemistry and Engineering of Organoelemental Compounds (Moscow), pilot cartridges based on these catalysts have been made for feeding portable fuel cells.

Low-temperature fuel cells require exceptionally pure hydrogen, free of both CO and CO_2. The idea proposed by the Siberian researchers is simple: to use an adsorbent that adsorbs CO and CO_2 during the steam reforming of hydrocarbon fuel and obtain pure hydrogen at the outlet. If we use a pair of reactors-adsorbers, one of which operates in the adsorbing mode, and the other in the regeneration mode, the process will be continuous. The idea has been already put into practice.

Among other promising developments of the Institute are catalysts for methane pyrolysis with zero CO_2 emissions, membrane reactors for natural gas oxidation by the oxygen that penetrates into a reactor from the air through a special membrane, and many others

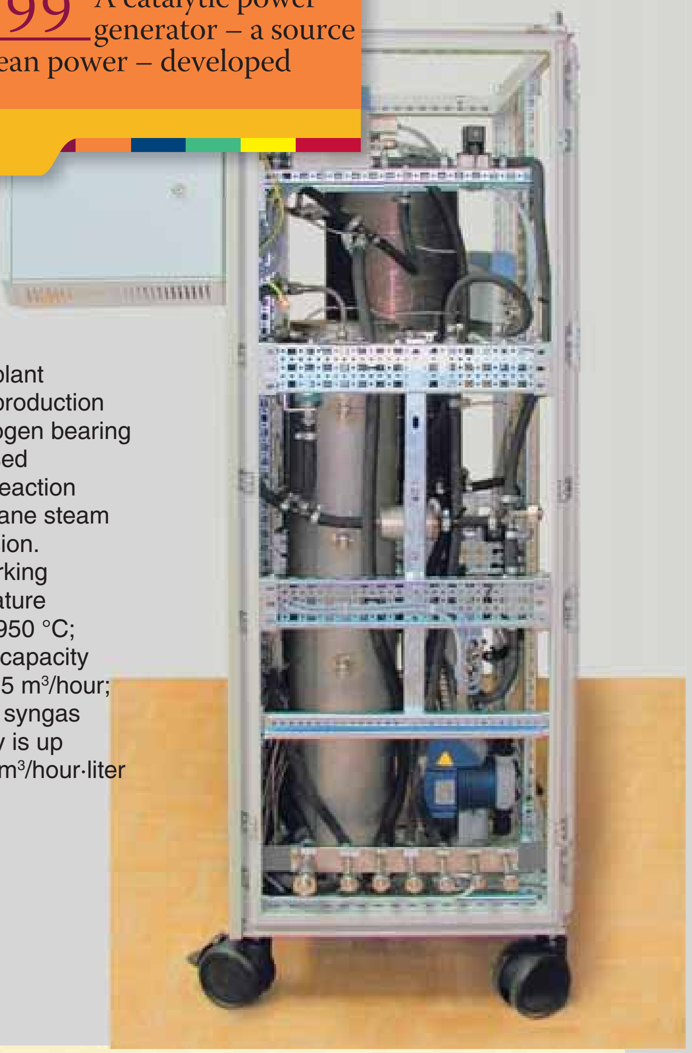
From: (Sobianin, Kirillov, 2005)

The microstructure of the thermally conductive catalyst for natural gas conversion to syngas:
A is a matrix of coarse nickel particles;
C is particles of the active component

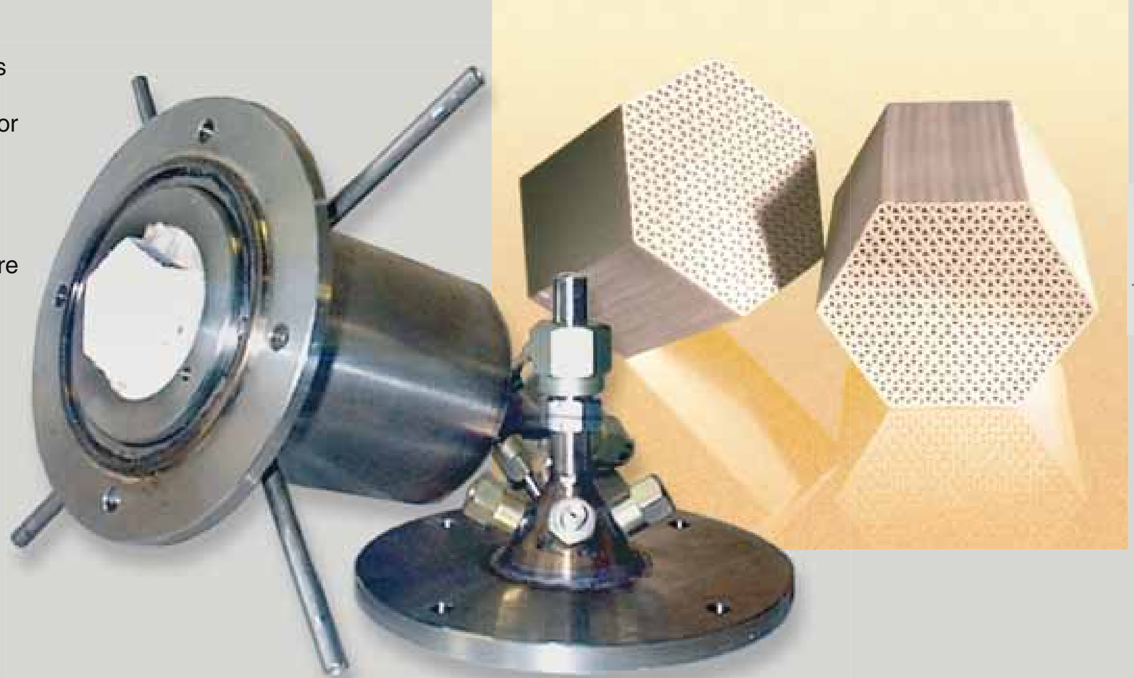


1975 The Catalyst Special Design and Technology Bureau founded

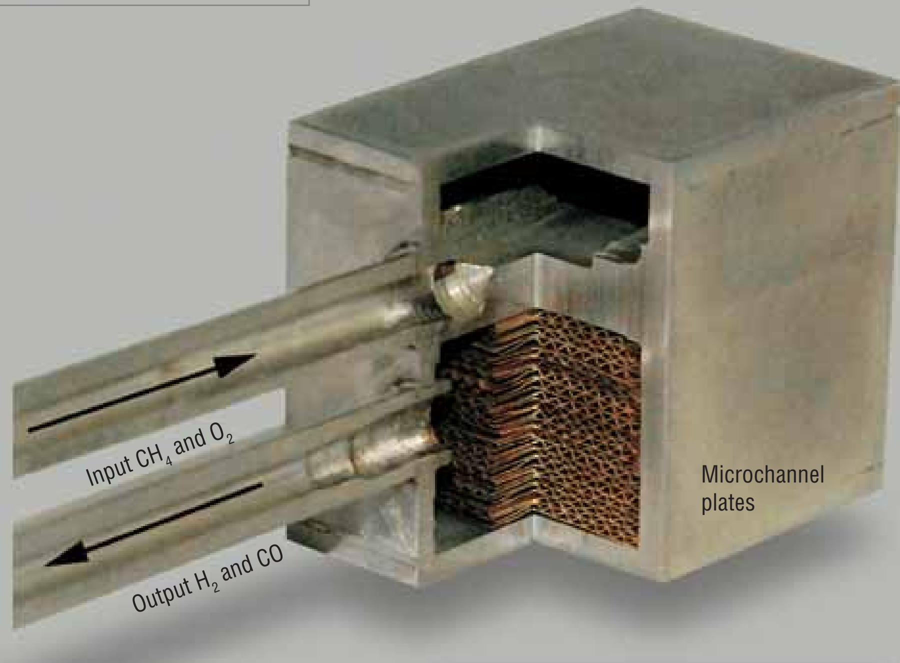
1999 A catalytic power generator – a source of clean power – developed



A mini-plant for the production of hydrogen bearing gas based on the reaction of methane steam conversion. The working temperature is 750–950 °C; syngas capacity is up to 5 m^3/hour; specific syngas capacity is up to 0.13 m^3/hour·liter



The reactor for methane oxidation to syngas using a monolith catalyst. The reactor volume is 300 ml, consumption of methane-air mix is 4 m^3/hour, working temperature is up to 1200 °C



Fuel processors for hydrogen production based on microreactors are among the most promising R&D areas in power engineering. These compact devices have a great number of microchannels with a catalyst attached to their walls. The volume of the microchannel plates of this reactor for methanol steam conversion is just 3.7 cm³, hydrogen capacity under the temperature 450 °C is 33.6 liter/hour

2008 A small-size unit for thermal shock processing of Ceflar® powder materials developed

director of the Center and had to get familiarized with applied problems – it was a steep learning curve.

In 1991 the former, "Soviet" life collapsed. Right before the New Year of 1992, Kirill Ilyich and I developed a strategy for saving the institute. Zamaraev supported my idea of focusing on the core of the institute, its promising researchers that would be able to raise funds (in any activity, as the phrase goes, it's all about the people) rather than trying to save the institute as a whole, which was utterly impossible.

We hit the mark: after the demise of the Soviet Union our research institute was virtually the only one within the Siberian Branch that continued its progressive development. Very illustrative was the year 1997. We got from the state only 17 % of the institute's budget but paid more tax than in the previous years. Until 2000, while our economy was down in ruins, we collaborated mostly with Western partners: for quite some time, the Western Europe made polypropylene using our catalysts. When the Russian economy began to revive, our focus shifted to the national industry. Curiously enough, we managed to save the All-Union Research Institute of Technical Carbon in Omsk by integrating it with our Omsk Branch; today, this is the Institute of Hydrocarbon Processing Problems SB RAS. At that time, K. I. Zamaraev was away on a business trip, and by the time he came back, we had had an addition to the family.

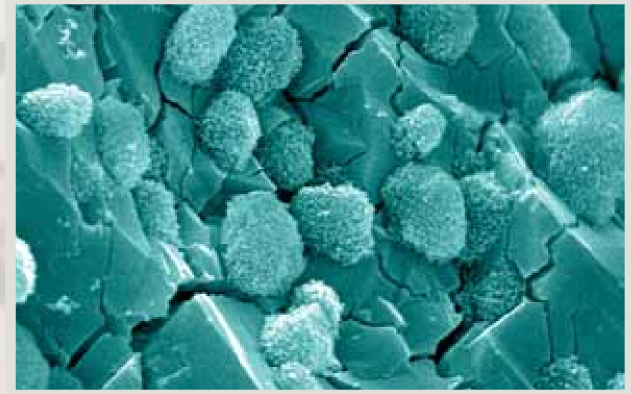
In the 1990s, I worked a lot with V. A. Koptyug including the period when I was director of the institute. In particular, the SB RAS rating and contract system was developed under his instruction.

NEW ZEOLITES: ALL INCLUSIVE

Today zeolites – natural and artificial minerals with a micro-porous crystalline structure featuring unique catalytic and adsorption properties – have a wide range of applications. A most promising way to make zeolite-containing materials for catalysis is growing zeolite crystals on a specially designed carrier with a network of transport pores; the size of the crystals to be synthesized should not exceed a few nanometers. As a result, virtually all active centers of the zeolites become "surface" with respect to the zeolite structure, and since in the course of synthesis the crystals attach to the ready-made carrier with large transport pores, their active centers become accessible for big molecules.

The technologies for the synthesis of nanocrystalline and "hierarchical" zeolites developed at the Institute of Catalysis SB RAS make it possible to create catalysts for the petrochemical industry. These catalysts allow for a selective removal of heavy hydrocarbons and increase in the number of light fractions, which are more in demand, in particular, for aircraft and diesel fuel production. The heavy residues can be decomposed into the lighter ones, which will yield more gasoline and oils. The associated gas, now burnt for nothing in immense amounts, can be catalytically "condensed" to benzene and other liquid "aromatic" compounds on oil-production sites.

From: (Yechevskiy, 2012)



Zeolite nanocrystals synthesized hydrothermally on a specially designed solid carrier – microspheric corundum with a developed network of transport meso- and macro-pores.
Electron microscopy

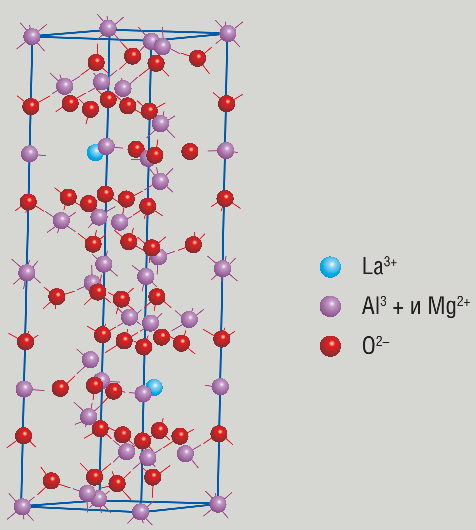
2016 Russia's first hydro treating catalyst developed by the Institute of Catalysis SB RAS has passed the tests

Zeolite catalyst IC-17-M is used for synthesizing aromatic compounds from accompanying oil-well gases, using the BICYCLAR technology

FUEL FROM OIL AND SAW DUST

The idea of making liquid fuels from renewable plant raw materials is not new. After the Second World War, however, a sharp increase in oil production resulted in cheaper costs of the gasoline and diesel fuel made using off-the-shelf oil-refining technologies. Yet, the switch to fossil hydrocarbons was not final or definitive. Today, about 80 % of the world's ethyl alcohol is used as a fuel – a partial substitute for gasoline. Diesel fuel also has a substitute – biodiesel, made from methanol and vegetable oils through transesterification (exchange of fatty acids radicals) involving catalysts.

The most ecologically-friendly way to produce biodiesel requires hard, so-called heterogeneous, catalysts, which can be easily detached from the reaction products. In contrast to the homogenous catalysts, conventionally applied for biodiesel production, heterogeneous catalysts can be reused. Another plus is that biodiesel is of higher quality. Also, no preliminary processing of vegetable oil is required, which minimizes liquid waste. These catalysts, however, should meet specific requirements. The developers of heterogeneous transesterification catalysts from the Institute of Catalysis SB RAS put a special emphasis on their job stability in real-life conditions. Most promising in this respect appeared to be barium, calcium and lanthanum hexaaluminates, which are relatively low active but highly resistant to leaching.



Lanthanum hexaaluminate, a heterogeneous catalyst used in transesterification for biodiesel production, was developed by the laboratory of catalyst preparation, Institute of Catalysis, SB RAS.
From: (Ivanova et al., 2008)

2017 Construction of the largest factory designed to produce the catalysts developed in the IC SB RAS started

A pilot unit for making bio oil from ground wood. Designed by the Institute of Catalysis and Design-Engineering Branch of the Lavrentiev Institute of Hydrodynamics, SB RAS

Catalysts developed at the Institute of Catalysis SB RAS for making bio fuels

Alternatives to transesterification in making biodiesel can be "soft catalytic cracking" (conversion of the feedstock hydrocarbons at high temperatures in the presence of catalysts) and "hydrocracking" (cracking in the presence of hydrogen). An advantage of hydrocracking is that it can be done in conventional petroleum refineries. In addition, since the composition and properties of the hydrocracking products of vegetable oils are similar to the hydrocarbons contained in standard diesel and gasoline fuels in combustion engines, they can be used together.

The hydrocracking of vegetable oils and fatty acids usually employs the commercial sulfided catalysts of oil refining. Because of the low content of sulfur in the plant feedstock, however, these catalysts are prone to a quick decay, and an intentional addition of sulfur compounds soils the target product. The Institute of Catalysis has developed a series of non-sulfide, nickel and copper catalysts that allow an efficient conversion of vegetable oils and their derivatives into hydrocarbon fuels at the same hydrogen temperatures and pressures as the commercial catalysts.

A typical product of wood waste processing is cellulosic ethanol. There is, however, a more efficient way of using the woodworking industry refuse as feedstock for fuel production if we depart from the usual choice between ethanol and gasoline. By means of rapid pyrolysis, a liquid product, conventionally referred to as "bio oil" (in Russia, this product has been known for ages as "tar"), can be produced from wood. Bio oil, however, is well-oxygenated and because of this cannot be used directly as motor fuel: oxygen should be removed from it and it should be saturated with hydrogen, i. e., hydrodeoxygenation should be performed. Within the framework of the international BIOCOUP project, specialists from the Institute of Catalysis SB RAS have proposed using for this purpose non-sulfided nickel-containing catalysts. The tests of nickel and copper-nickel catalysts developed by the Institute of Catalysis on model compounds and natural bio oil, conducted both in Russia and abroad, have clearly shown a distinct advantage of these catalysts in their basic parameters over the well-known commercial analogs.

From: (Yakovlev, 2012)

The greatest disadvantage of the latest R&D reform that took place in 2013 was the disruption of the coordination with other research institutes of the Siberian Branch. What is good about Akademgorodok is that all the institutes are literally within walking distance, and you can find specialists in nearly any research area. We used to have an efficient system of integrated projects, which now has to be restored.

Nonetheless, our institute has always been commercially viable, and because of it, we have a lot on our plate. Here are some of our achievements. Back in 2003 we were entrusted with one of the first mega projects and received from the state a vast amount of money – 500 million roubles. Our task was to develop modern domestic catalysts for oil processing. Using them, Russian industry produced, just within the three years of the project's duration, over 8 billion roubles of high-octane gasolines. In other words, per each rouble invested in our project the state got 15 roubles added to its GDP! As far as I know, no other project in Russia has had a commeasurable investment efficiency.

We have been the first in the country to make EHS (Extra High Strength) polyethylene. Our pilot production line has become the foundation for establishing an exclusive economic zone in Tomsk. Our technologies lie in the basis of five totally eco-friendly coal boiler houses that have been operating in Siberia for a few years. These may not be large projects yet but they are growing rapidly. And most importantly, the construction of the nation's largest catalyst-making plant is starting at the premises of the Omsk-based Gaspromneft factory. All the catalysts to be produced have been developed by Siberian scientists from our institute and our spin-off, the Institute of Hydrocarbon Processing Problems.

It is a common complaint now that academic science does not produce good results and that scientists have degenerated. Life shows that this is not true: challenge brings strong people to the forefront.

During the era of industrialization in the USSR, research went hand in hand with industry. The classics of Soviet R&D were brought to birth at the time of great challenges in geology and chemistry. When the country was getting ready for the war, specialists in defense appeared. After the war, when the task to develop atomic industry was set, there were people capable of dealing with it. Later came space exploration and development of oil and gas deposits in West Siberia.

Clearly, national science featured a very tough artificial selection. It was a selection indeed, and it had a system. But the tasks were set by the state itself, which, as a rule, listened to professional advice. If the state does not set such tasks, big people will not be there.

The problem with today's Russian R&D is that in the late 1980s the Academy of Sciences was left to its own devices; the state stopped deferring to the scientists' opinion. Now, when the state has resumed its viable interest in various research fields, the scientists, who have been disoriented for the last twenty years, appear to be not quite ready for it.

The conflict between one's own interests and the interests of the society derives from the logic of our "academic life." As scientists, we want to do the things that interest us. For example, I give lectures at University and think that my greatest recent achievement is the textbook *Thermodynamics of Non-Equilibrium Processes for Chemists*. However, this is my private research interest. Interest in major projects must be fostered by the higher-ups.

The Academy of Sciences is now asked to identify priority areas. There is no need to ask us: after sanctions against Russia were introduced, we are heaped with orders from our industry. Sectoral research institutes collapsed, therefore, academic research institutes have to deal with the tasks they were not meant for. The right time for feedback has been lost.

Another major flaw in the current situation with national science is the lack of research coordination. In the Soviet years, research was governed in a well-orchestrated manner. There was a pool for accumulating "academic ideas" and tasks of the country – the State Committee for Science and Technology. It was placed above all ministries to inform the higher-ups. There is no matching organization now. Fortunately, the recently adopted R&D strategy outlines proper objectives, though does not specify the mechanisms for attaining them.

What is the way to solve any problem? There is an objective and specific tasks to be handled, and mechanisms to be tailored to cope with these tasks. Today's system of national economy management looks very different.

A model for me is the legendary figure of Russian and Soviet chemical science, Academician V.N. Ipatiev (this year, we are celebrating his 150th anniversary). Lieutenant General in the tsar's army during the First World War, he rapidly raised Russia's military chemical industry to a high level and in this way supplied munitions to the country. After the October Revolution, he collaborated with the Soviets to restore the chemical industry of Soviet Russia, though he had never sympathized with the Bolsheviks. It was at that time, in 1921, that he made a statement in keeping with the current situation: "Production can be sustainable only if it relies on domestic raw material resources and national specialists."

For Academician Valentin Parmon, underwater diving is not just a hobby but the love of his life. *Diving on the Red Sea, 1994*

Diploma students and workers of the Institute of Chemical Physics, USSR AS: Candidate of Physics and Mathematics K.I. Zamaraev (*third on the left*); head of the radio spectroscopy laboratory, Doctor of Physics and Mathematics L.S. Lebedev (*fifth on the left*); and a fifth-year student of the Moscow Institute of Physics and Technology, V. Parmon (*third on the right*). *Moscow, 1971*

Ipatiev, who must have been an associate of Trotsky and who found himself in a political vacuum in the late 1920s, had to move to Germany and then to the USA, where he worked for the oil-processing industry. Eventually, Henry Ford admitted that Ipatiev had been the forefather of modern American civilization as he had created affordable technologies for the production of high-octane gasoline that underlie the development of automobile industry. These technologies gave the Alliance's aviation an edge during the next world war: American planes were worse than the German but they had better gasoline.

It is a striking fact that Ipatiev has made four (!) attempts to go back to Russia but he failed. The outstanding scientist was stripped of his rank of an Academician, deprived of citizenship and excluded from the USSR for good. Despite this, he continued to love his country and believed that the most important thing for a true scientist is to work for the benefit of his or her nation. I think this is still true today.

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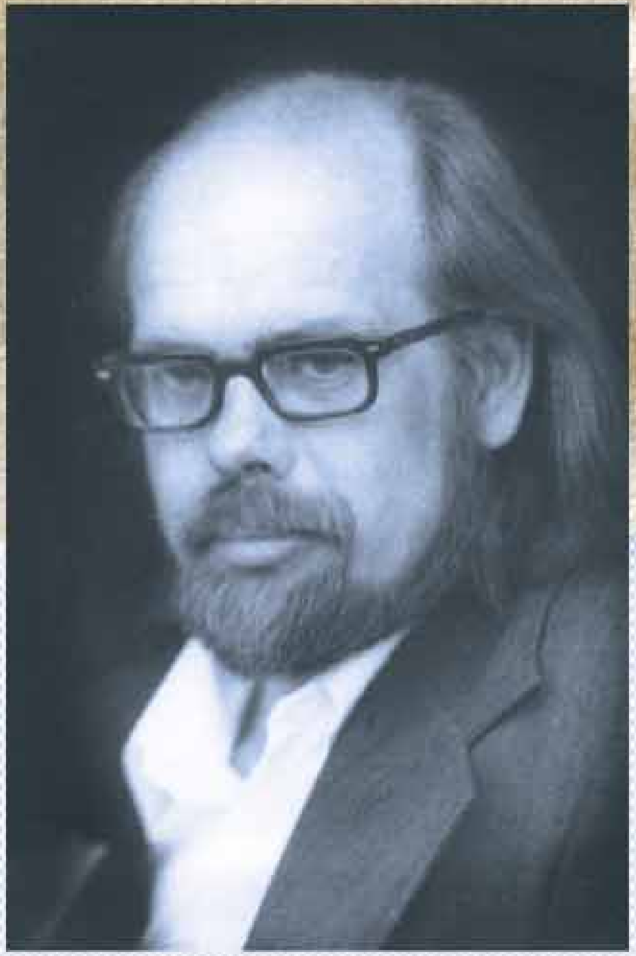
M.A. GRACHEV

50 years in Service, or Programmed Death

"So what?" that's what Sergey Kuzmin, the brilliant inventor of the famous Milichrom would say, hadn't he died in 1986, "normal devices, for example, watches, even mechanical ones, say, a cuckoo clock, work for 300 years unless a bomb hits them. Devices are made of iron, nickel, aluminum, tantalum, gold, Teflon. They would work for a hundred years if electronics didn't develop."
Dear Seryozha, that's true—and not very true. When engineers laid their hands on new electronics, they got naughty and decided to make machines smarter than humans. Remember when the old TVs had two switches, one to turn them on, which was also a volume control, and one to switch between the five programs. The rascals forged a monster of a TV, with a huge screen, which is good, but also with a huge remote control, which only a graduate of a music academy could master. Well, yeah, that's not the point.
Seryozha, all your devices, which escaped the hands of the rascals, still work for the mankind. Your Milichrom is still up and running, and the rascals were kept on a leash. The vacuum and solid-state electronics of today stagger imagination.
We tested it in Irkutsk—not a single Milichrom of the new generation needed any serious fix for 25 years after it was created by your followers: Grisha Shoikhet, Vitya Kargaltsev, Edik Kuper, Tolya Ledenev, Yura Bolvanov, Grisha Baram, and Misha Perelroizen, who, as you remember, was sent here in exile by Gersh Itskovich Budker.
Let's now look at the competition. Here, things are very complicated.
You see, we live in a consumer society, and we do not need many devices. You produce 50,000 liquid chromatographs of two dozen models, and that's it, the market is full. So you concoct new models and foist them on the consumer, but your consumer is smart and doesn't buy a new device because the old one works like a Swiss watch.
What is to be done? as said Chernyshevsky and Lenin. "Brilliant!" managers exclaimed, "we'll put a chip in each device and program it to short-circuit as soon as the guaranty ends. Or another idea. We impose a levy on consumers by taking annually 20% of the device's price 'for maintenance'." Don't you see?



S.V. Kuz'min, a leading design engineer with the Novosibirsk Institute of Organic Chemistry, was awarded a gold medal, a bronze medal, and a 1st degree diploma of the All-Union Exhibition of Economic Achievements for the development of MSFP-1 liquid microspectrophotometer. *1987. Photo by G. Baram*

Key words: Milichrom, *Acetabularia mediterranea*, spectrophotometer, chromatograph

M.A. Grachev. *1978. Photo by G. Baram*

Mikhail A. GRACHEV – Academician, Russian Academy of Sciences; Doctor of Chemistry, Director of the Limnological Institute SB RAS (Irkutsk, Russia) from 1987 to 2015.
The State Prize (1985) and Karpinsky Prize (1998) awardee.
Author and coauthor of over 200 research papers

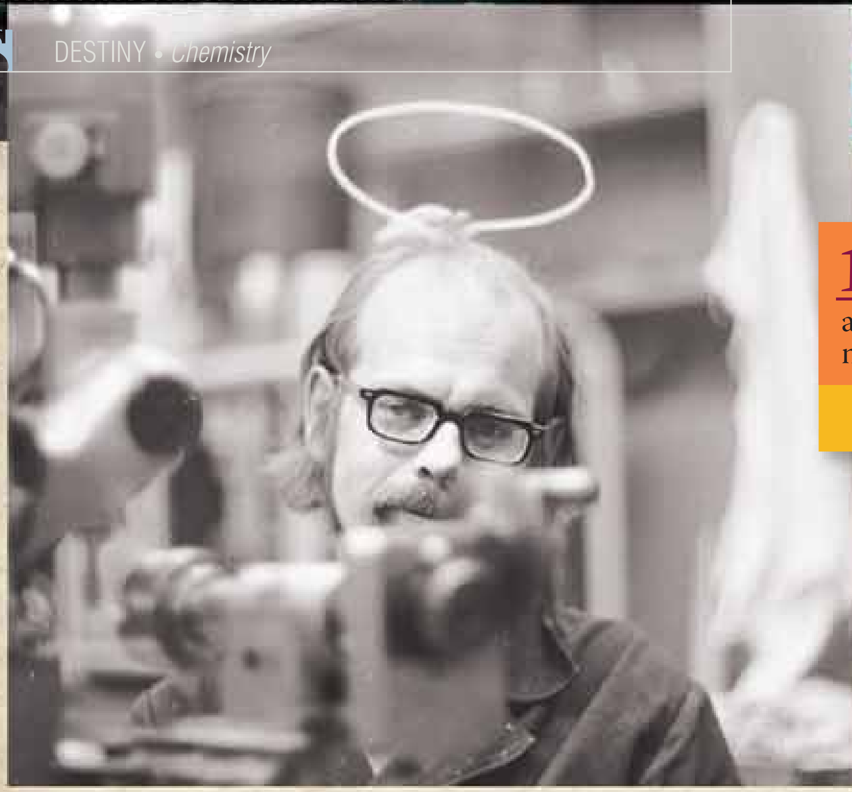
The idea to create a set of biochemical ultramicromethods struck Lev S. Sandakhchiev as early as 1966 when he bade farewell to his research into transfer RNA and suddenly decided to study the biochemistry of individual living cells of a Mediterranean alga, *Acetabularia mediterranea*.

The first microspectrophotometer designed in Novosibirsk, MSFP-1, made it possible to handle the columns with a volume of one-millionth of a cubic centimeter; correspondingly, all accompanying biochemical manipulations required a binocular microscope and micromanipulators.

However, histology appeared as early as the 19th century, and manipulations with individual cells had become a routine procedure by the mid-20th century. The cell contains very high concentrations of various compounds, such as nucleic acids, proteins, polysaccharides, and lipids; thus, their distribution in the cell is easily traceable with the help of specific dyes and microscopes, optical and electron ones. It is possible to stain substances and visualize them, but no one in the 1960s could even dream that the substances observable under a microscope could be isolated in a chemically pure form and their structure could be determined. I would venture to suggest that Sandakhchiev was undoubtedly among the first scientists who took up the challenge.

Freedom reigned in fabulous Akademgorodok in Novosibirsk, and everything seemed feasible. For this, we should thank not only Sandakhchiev, but also Mikhail A. Lavrentiev, the founder of the Siberian Branch of the Academy of Sciences, and Dmitry G. Knorre, our boss, who just did a very important thing – he did not interfere.

No sooner said than done. Young researchers did not waste their free time in the evening and played cards, especially the game of preference. This was how Sandakhchiev met Sergei V. Kuz'min, an optic technician, who was then famous for having crushed the kitchen card- table at one blow for the violation of the canon "No good lead? Don't whist." Well, Lev set Sergei a problem just as a bet: "I bet you cannot design a microspectrophotometer that would be 10 000-fold more sensitive than the best foreign analogs." Naturally, Sandakhchiev lost the bet. Sergei did the job in 3 months and won 210 rubles (At that time the monthly pay of an optic technician was 70 rubles). See the other details in the relevant research papers (Kuz'min *et al.*, 1969).



1969 The first paper on Milikhron, a the new liquid microspectrophotometer

S. Kuz'min, *1978*. The license to use S. V. Kuz'min's invention (*left*) was purchased by LKB (Sweden), the leader of instrument production at that time.
Photo by G. Baram

Sandakhchiev was interested in many things, for example, such extremes as speleology, the study of caves. One of his interests was the card game Preference. Fate brought him behind a card table together with Sergei Vladimirovich Kuz'min, a genius optician and designer, laureate of the USSR State Award and dissident, at that time a senior laboratory technician at the neighboring Institute of Thermophysics without any higher education and a salary of 70 rubles per month, and dreaming of becoming the world champion in bicycle racing (Grachev, 2004)

Future Academicians Lev Sandakhchiev and Mikhail Grachev. *1985. Photo by A. Polyakov, photo archive of the Siberian Branch of the Russian Academy of Sciences*

M. A. Grachev. Taking a break. *1978. Photo by G. Baram*

The differences are fundamental

Then everything was very simple. What is the fundamental difference? It is quite good when the device is 10 000-fold better than the world level. First, an ordinary biochemist had to use a micromanipulator, which was a major inconvenience, and, second, which is much more important, it was very difficult to record ultraviolet spectra. The photometer "cuvette" of the MSFP-1 was just the lower part of a microliter-scale chromatography column; light fell to its side, perpendicular to the column axis.

Here I am proud to say that it was my idea to make a microcuvette of fused quartz with parallel-sided windows. One window was a simple cylinder the size of a shirt button, and the other, an analogous thing with four holes. Polyethylene capillaries were tightly drawn into the holes and cut off on the inside with a razor blade. Then it was even simpler: we had just to assemble the cuvette by taking the first window, then placing on it a Teflon gasket seal half a millimeter thick, with two slits in it, and mounting the second window to hold the future microcuvette in clamps. Thus, the microcuvette was ready (Baram *et al.*, 1983).

You see, the solution was as plain as day. Now it was possible to drive a beam of light between the two slits and to construct a two-beam spectrophotometer based on this parallel-sided microcuvette (Kuz'min, 1974), as well as all the other key units of a microcolumn liquid chromatograph. This allowed the most precise recording of ultraviolet spectra and measuring the so-called optical density, i. e. the assigned problem was solved. Frankly speaking, the cost was a tenfold decrease of the sensitivity of the new device, Ob-4, the great-grandfather of Milikhrom. That is all.

My cuvette has been in service for 50 years. This has been verified, and the chromatograph Milikhrom is the best in the world market. Just believe me.

What was the fundamental difference of Milikhrom from the other spectrophotometers of that time? Just take the reference Cary (United States) spectrophotometer, still in use. It is a two-beam device with the light beam alternately directed to the sample and reference cuvettes. Then the reference signal is subtracted from the sample signal to get the precise optical density value at a given wavelength. The device has outstanding metrological characteristics. However, it is, first, rather unsuitable for microspectrophotometry and, second, it has a too intricate optical arrangement.

Let us refer to S. V. Kuz'min's invention titled "A two-beam spectrophotometer" (1974): it has only two mirrors, a small convex mirror and a large concave one, versus eight mirrors in the Cary spectrophotometer. This is a Cassegrain lens. Kuz'min's spectrophotometer utilizes the Cassegrain lens, but the beams are split between the sample and reference cuvettes by rotating the small mirror at a certain angle. That is all.

Reliability of this device is guaranteed, first and foremost, by the fact that is has only two mirrors instead of eight, which reduces the likelihood of its failure.

What is the current state of "Milikhrom building"? It is perfect if we forget about the absence of money. Milikhrom has been in service for 50 years. It has no programmed death and will never have.

"…I immediately wanted to apply this new method to ordinary, i.e., not unicellular, biochemistry, in which I was then involved. The workshops quickly manufactured a second such device. A year later, I and my colleague, Sasha Girshovich, sent out the first publication about the data collected through this device to the international journal BBA. They didn't take it. The reviewer had gotten to the root of the matter: he simply wrote "it's impossible to work on such a scale."

And he was right. Once, Sasha and I spent a couple of days working on the problem. Nothing came out of it. The reason turned out to be simple: the chromatographic microcolumn had to be placed deep within the device, and solvent had to be injected blindly. The column was so small that we simply lost it, and injected the solvent into the device without realizing that there was no column inside.

For ordinary biochemistry, in order to obviate the micromanipulator, we expanded the device's scale by ten times, and we still achieved a sensitivity level 1,000 times greater than what the rest of the world was capable of."

Grachev, 2004

Presentation of Milikhrom in the USSR State Planning Committee: Academician A. A. Aleksandrov, President of the USSR Academy of Sciences, V. P. Mamayev, Corresponding Member of the Academy, Director of the Novosibirsk Institute of Organic Chemistry, and Dr.Sc. M. A. Grachev. *Photo by R. Akhmerov*

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Editorial board thanks G. Filippova for assisting in the preparation of the paper and G. Baram for his photos

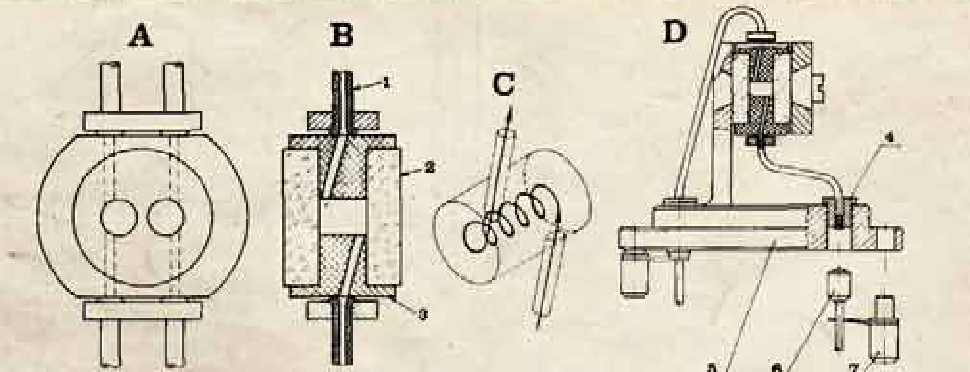


Fig. 3. Cell unit. A, Front view; B, side view; C, scheme of cell hydrodynamics; D, cell unit in holder, side view. 1 = Inlet tube; 2 = silica window; 3 = polyfluoroethylene gasket; 4 = immobile part of the liquid connector; 5 = body of the holder; 6 = mobile part of the liquid connector; 7 = spring of the liquid connector with handle.

Basic design of the liquid microspectrophotometer cuvette (Baram *et al.*, 1983)

FIRST OF ALL, GENIUS IS NECESSSARY

By the beginning of the 1990s Russia had manufactured 6,000 Milichroms, great-grandchildren of the first microspectrophotometer, for a multitude of applications: science, forensics, pharmaceuticals, environmental protection, etc. During the perestroika years, a private company in "poor Russia" managed to manufacture and sell about 100 A-02 Milichroms, assembled from components made in various parts of the world, but still based on S. V. Kuz'min's original microspectrophotometer, for $30,000 each. Why? The answer is simple: in a commercial laboratory, the use of this instrument covers the initial cost within a year after purchase. The Swedish firm LKB, the then world leader in scientific instrumentation, bought the license to use Kuz'min's invention. My knowledge of English and the genes of my "red merchant" father came in handy. Under the leadership of the Russian foreign trade agency LICENSINTORG, I passed a useful school of international trade in intellectual property. Later, this turned out to be very useful at Lake Baikal. We received $60,000 dollars and a wonderful Swiss milling machine, at which I later spent many months manufacturing new accessories for the Milichrom.

These days, people dream a lot about "innovation." Managers understand three things poorly. First of all, innovation requires crazy ideas, for example, growing a Mediterranean alga in the middle of Siberia. Second of all, talent is needed, and, better still, genius, which does not promise, but makes a workable object. As a rule, talented people and geniuses are very inconvenient and difficult to manage. However difficult it may be, one must tolerate them. Thirdly, the risk of failure is very high, and it's a long way towards application – usually about 10 years. But a single Milichrom covers the expenses of dozens of academic laboratories. Geniuses do not appear in a building simply because it has a sign that says "Technopark."

Grachev, 2004

With Academician D. G. Knorre at the Novosibirsk Institute of Bioorganic Chemistry. *Photo by V. Korotkoruchko*

MAGIC BULLETS

V.V. VLASSOV

I happened to join Dmitrii G. Knorre's team during my third year at Novosibirsk State University "on a tip" of my dormitory mate. As is known, it is in the third year when students should make up their minds as to where they are going to do their diploma work. After visiting several research institutes and failing to make any choice, we came back to our dormitory and got the fateful advice: "You know, guys, as for me, I won't go in for science, better to a tin plant. But you want to do science; so go to Knorre! He is a real scientist, future belongs to him."

Therefore, we came to Knorre and said, "Give us laboratory gowns! We are ready to help scientists, we want to do biology." But he replied, "No, guys! You won't just wash glassware for scientists and you won't have any biology. You are chemists and here you will do chemistry until you graduate the university and get your diplomas. Then you can do your beloved biology. You've made the right choice as chemists, and our goal is to advance from chemistry towards biology and farther towards medicine, and work with a human rather than with a drosophila." As a result, Knorre sent me to join the strongest chemical group, which at that time was beginning to design gene-addressed preparations. One week later, he sent for me and enquired in detail about my studies. He immediately stopped my attempt to play second fiddle and gave me an independent piece of work to do.

V. V. Vlassov, a follower of D. G. Knorre, future Academician, and director of the Novosibirsk Institute of Chemical Biology and Fundamental Medicine

D. G. Knorre with the first researchers of the Laboratory of Chemistry of Natural Polymers, Institute of Organic Chemistry, Siberian Branch, USSR Academy of Sciences (Novosibirsk). *1962*

1967 The first paper on gene-addressed oligonucleotides was published

Physicians have always dreamed of substances that would act on particular genes, i. e., on the root of many diseases. Indeed, such substances make it possible to create drugs, actual "magic bullets," capable of influencing the hereditary material of various infectious agents without any harm to the human body and inhibiting the activity of oncogenes responsible for malignant cell growth. The creation of such substances that would influence the genetic material in a directed manner is one of the main challenges in molecular biology, because they will allow the gene functions to be studied directly and, eventually, to be controlled.

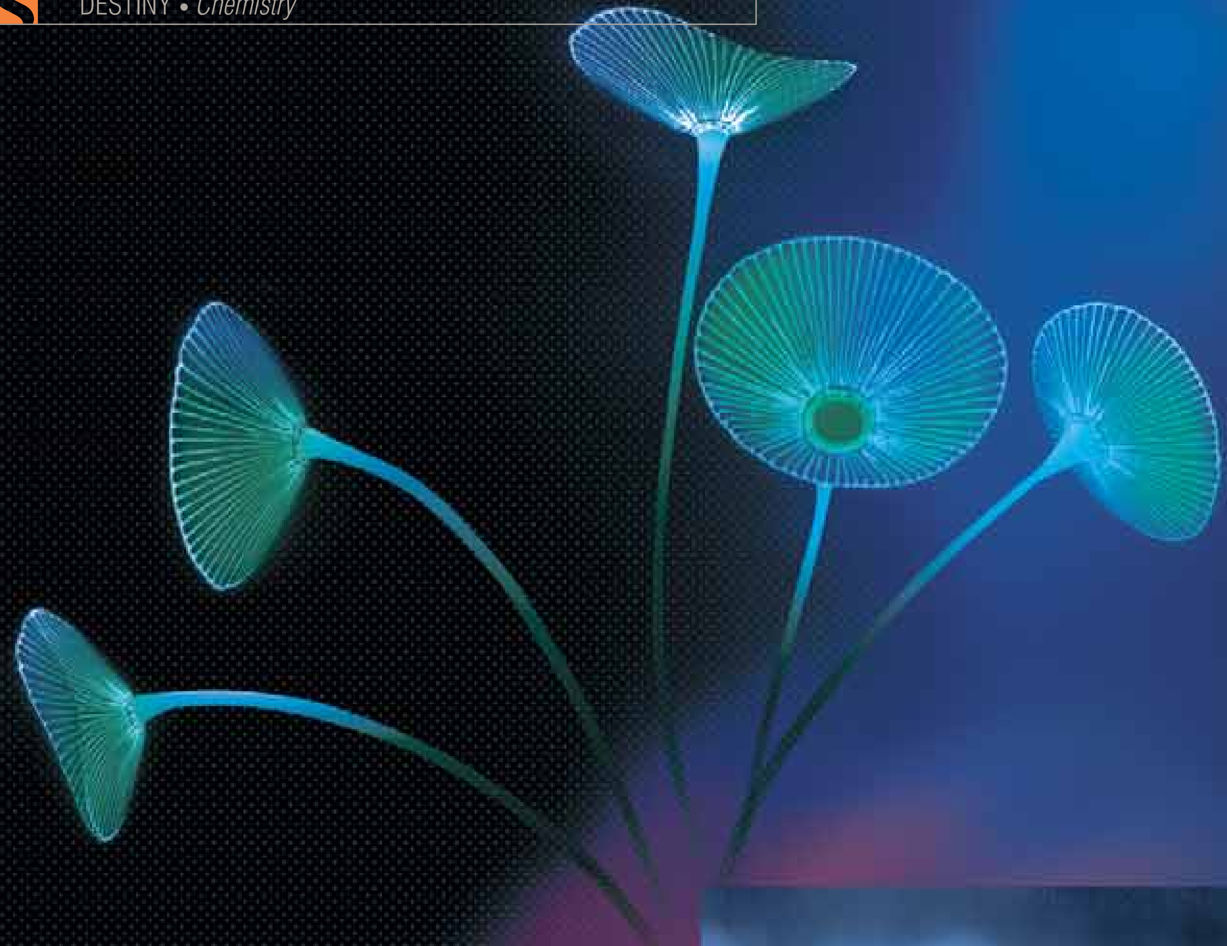
So, how is it possible to change the genetic program of interest? All genes have similar chemical composition and structure: the difference between them consists only in the alternation order of four monomer blocks – the nucleotides A, T, G, and C. To act on a particular gene, a molecule of the substance should recognize this particular nucleotide sequence by some way or other, which is, at first glance, an unsolvable problem.

Nonetheless, a team of Siberian chemists, who came to the Novosibirsk Akademgorodok in the first years of its foundation, had another opinion. N. I. Grineva and D. G. Knorre (Institute of Organic Chemistry, Siberian Branch of the USSR Academy of Sciences) utilized the principle of molecular recognition, used by Mother Nature itself, to formulate the concept of directed impact on the genes with the help of oligonucleotides, fragments of nucleic acids, "armed" with special chemical groups. The first paper on oligonucleotides by the Siberian chemists was published in 1967: this particular date is now regarded as the official "birthday" of this new direction in molecular biology and pharmacology (Vlassov, 2007)

Not only did Knorre have a solid scientific background and had become a great scientist, he also knew how to teach. He managed to organize an outstanding team: everybody was in a bustle, new ideas appeared every day. His outstanding personality attracted people of his own kind. Actually, he was responsible for the training of molecular biologists for the whole of Siberia. M. A. Grachev, who later became Director of the Limnological Institute, Siberian Branch, Russian Academy of Sciences, said that he had decided to accept Knorre's offer to go to Siberia as soon as he saw his tennis shoes which he wore when he came "to conquer" the capital.

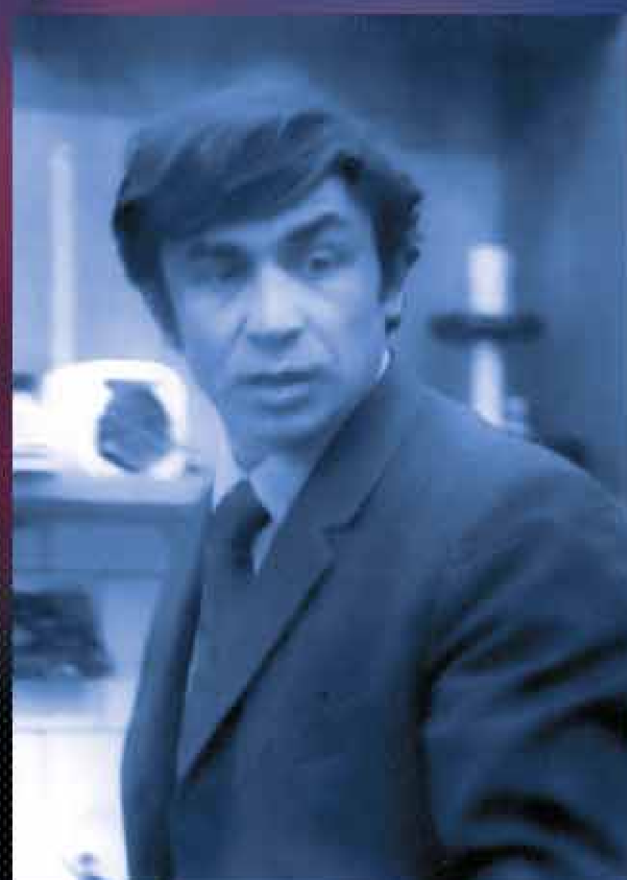
They had no idea of molecular biology or biotechnology at that time. When the construction of Akademgorodok (an academic town) began in Siberia, literally from scratch, physical and chemical science institutes were the first to appear. Knorre, a young metropolitan scientist involved in physical chemistry, came here aiming to study a brand new scientific area, molecular biology. Eventually, he founded the first research institute in this area over the Ural Mountains, the Novosibirsk Institute of Bioorganic Chemistry, unmatched in its potential at that time. Over his 17 years as the Dean of the Department of Natural Sciences with Novosibirsk State University, Knorre completely remodeled the teaching system creating the fundamentals of training high- quality specialists for doing research at the interface of chemistry, biology, and medicine. It makes good sense to regard Knorre as the father of molecular biology in Siberia (Vlassov, 2016).

In 2016, Academician D. G. Knorre celebrated his 90th anniversary



“I do not know what made Lev Sandakhchiev focus on this cell. Perhaps, he had some doubts concerning the central paradigm of the new biology: no doubts left on what controls the cell after the discovery of DNA double helix by Watson and Crick in 1953.
Yet how Acetabularia manages to synthesize its cap after the rhizoid with the nucleus it houses is removed? Thirty seven years ago, in 1969, Sandakhchiev, ahead of his time, started pioneering studies into the fate of DNA at the level of a single cell.
The front of the world science has advanced and ***Acetabularia*** will soon undoubtedly become the center of attraction of molecular cytology.”

Grachev, 2006



L. S. Sandakhchiev

On How Lev Sandakhchiev Founded the Computing Center

I was a postgraduate student of Lev Sandakhchiev and we both worked at the Institute of Organic Chemistry. We studied *Acetabularia*, a unicellular alga. Unfortunately, now this classical object of developmental biology has been forgotten and abandoned. Lev was fascinated with this alga. Naturally, our experiments were not too welcome in a chemical institute. Therefore, when, in 1975, Lev was invited to organize the State Research Center of Virology and Biotechnology Vector, he agreed although not without hesitation.

Lev was loved immeasurably and there were sound reasons for this. He was handsome, high-spirited, very clever, and creative. You can talk about Lev endlessly.

This is one of Lev’s favorite stories and he was extremely proud of it. I heard it from Lev several times, and the story was always accompanied by his thunderous laugh and admiration for his own quick wit.

It happened in1979, at a meeting of the Ministry of Microbiological Industry, when the construction of Koltsovo was just beginning. Lev presented the prospects of Vector development and, in particular, the construction of the main building for the institute. He said, “Comrades, the designers have not done the full amount of work. They did not plan a computing center.” The Minister asked Lev, “What for do you need a computing center?” “Why,” said Lev ingenuously, expressing concern for the new project and grave responsibility, “Here comes Leonid Ilyich Brezhnev and asks,” Where is your computing center?’ And we have nothing!” Of course, he did not say “nothing” but used a much more colorful word. It was impossible to say better.

Then, Lev said, there was dead silence. The Minister went green, then turned red, and tensely uttered with a threat in his voice, “Lev Stepanovich, you are way out of line. Do you remember where you are? This is a meeting of the Ministry!” Lev answered pretending to be embarrassed, “Oh, I beg your pardon, it just slipped out.” In fact, it did not: he had carefully thought over where, when, and what to say. Discussion followed. Some 15 minutes later, the Minister said, “After all, Lev Stepanovich may be right about building a computing center. They will not praise us if we do not have it.” And he ordered to construct a computing center.

Lev was very fond of this story.

The meeting of the Council for Biological Sciences on Lake Baikal: R.I. Salganik, L.S. Sandakhchiev, I.Yu. Koropachinskii, V.I. Evsikov, D.K. Belyaev, and M.V. Vysotskii (*left to right*). *1982*

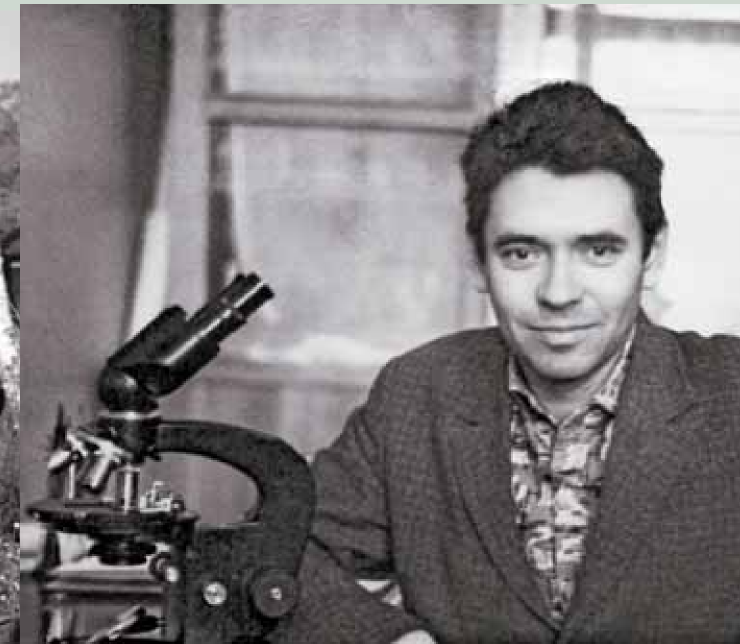
Acetabularia is a green alga abundant in subtropical seas. It consists of a stalk (5 cm long) and a cap attached to it. It is a single giant cell with a single nucleus localized to the rhizoid

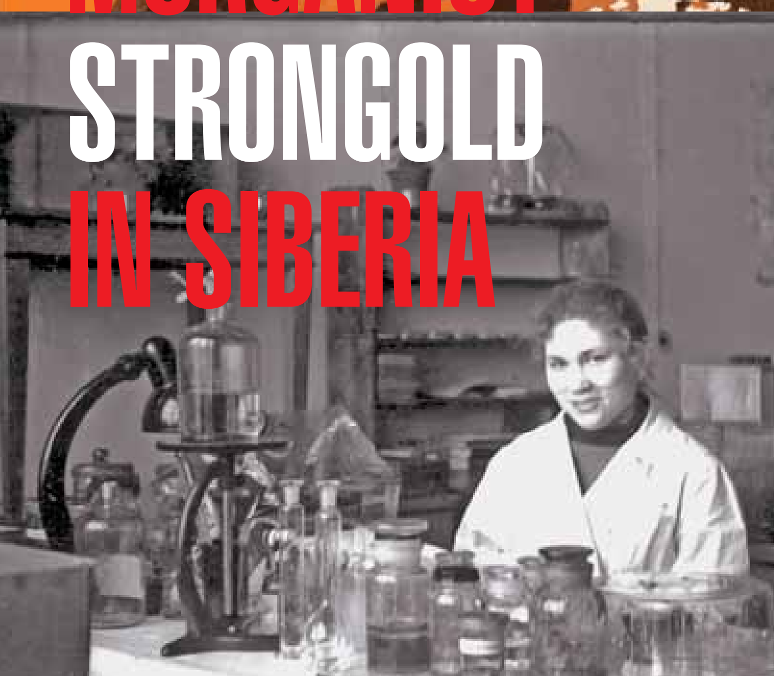
N.D. Belyaev, Institute of Molecular and Cellular Biology, University of Leeds, United Kingdom

V.K. SHUMNY

The Weissmanist–MORGANIST STRONGOLD IN SIBERIA

Key words: laboratory animals, genetic model of pathology, cryoarchiving, transgenic animals, phenotyping, imaging, pharmacology, toxicology, nanobiosafety





Nowadays, genetics is one of the most swiftly developing and demanded sciences in the world. However, in the middle of last century, "genetics" (and its Soviet "synonyms" – a "pseudoscience" or even an "imperialist harlot") was a trendy swearword among the laymen. These dark times in the history of national biology were named "lysenkovschina" after its leader, Trofim Lysenko, a known experimentalist and selectionist. The persecution, which lasted for over a quarter of a century and employed a whole range of tools and tricks of the repression apparatus of the Communist Party, ended only in 1964 with the resignation of Nikita Khrushchev, who actively supported Lysenko. And even though the late fifties saw a rise in genetic research, the founding of the Institute of Cytology and Genetics far beyond the Ural mountains was a daring challenge to the top officials of the Soviet state, party and science bureaucracies

The term *weissmanism-morganism* (or *weissmanism-mendelism-morganism*) used by the followers of T. D. Lysenko to denote classical genetics, "a bourgeois idealistic pseudoscience," was derived from the names of the founders of genetics, the outstanding scientists A. Weissman, a German zoologist, the founder of neodarwinism; Thomas H. Morgan, an American scientist who received the Nobel Prize in physiology and medicine "for his discoveries concerning the role played by the chromosome in heredity"; and G. Mendel, an Austrian botanist and abbot, the founder of the teachings of heredity

Vladimir K. SHUMNY, Doctor of Biology, professor, Academician of the Russian Academy of Sciences, Scientific Adviser for the Russian Academy of Sciences, and Vice President of the Vavilov Society of Geneticists and Breeders of Russia. Professor at the Natural Sciences Department, Novosibirsk State University. Awarded with the Orders of the Red Banner of Labor, Badge of Honor, and Merit for the Motherland. Author of over 500 research papers and 4 monographs

I rightfully consider myself an old-timer of Akademgorodok: I came here in May of 1958 with the first landing party from Moscow State University. About a hundred people from our cohort went straight to Novosibirsk, and not only biologists.

At that time, I had already been assigned to go South, to the Krasnodarskiy Krai, but having learned, well before graduation, about the founding of the Siberian Branch of the Soviet Academy of Sciences we, a crowd of students, went straight to the director of the newly organized Institute of Cytology and Genetics, N. P. Dubinin. We had a long talk; he was trying to figure out our preferences, our notions of genetics, and in the end, selected a few people, whom he assigned to laboratories right away. I found myself in the Heterosis lab headed by Yu. P. Miryuta – a wicked geneticist and plant selectionist and a devoted apprentice of Academician N. I. Vavilov. I even had to defend my thesis during breaks in my work, because my first thesis advisor got me working by sweat of my brow right away.

Delegation of Soviet geneticists at the V International Genetics Congress. Berlin, 1927.
Left to right: S. S. Chetverikov, A. S. Serebrovskiy, G. D. Karpechenko, N. I. Vavilov

"HARMFUL AND IDEOLOGICALLY FOREGN…"

The persecution of genetics in the USSR lasted from 1935 to the end of 1964, inspired by T. D. Lysenko, an experimentalist in agronomy. Based on his observations of the influence of temperature on the development of grains, the future Academician and Hero of Socialist Labor stipulated the theory of stage development of plants; the theory served as the basis of the yarovization technique (using low temperature influences on crops), which he ardently advertised.

Lysenko did not contain himself in promoting his ideas: "Scientific world or not, the class enemy is always an enemy, a scientist or not."

The polemics between scientists dealing with problems of theoretical biology and genetics and the followers of Lysenko's doctrines, known as "the Soviet creative Darwinism" or "Michurin's teachings" (in fact, I. V. Michurin, who died in 1935, had very little to do with it) sparked in the mid-1930s. One of the main theses of Lysenko's teachings was the denial of genes and chromosomes as units and instruments of heredity. On the opposite, he considered heredity to be intrinsic to any particle of the living matter. The second thesis consisted in the inheriting of acquired traits. Yet another cornerstone was vegetative hybridization: Lysenko stated that grafting changed the plant's heredity and the resulting "vegetative hybrids" were no different from regular hybrids. Thus Lysenko's teachings were, in essence, a compilation of ideas which existed in biology in the 19th century.

By the time Lysenko became a member of VASKHNIL (ВАСХНИЛ, a Russian acronym for the V. L. Lenin All-Soviet Agricultural Academy), Lysenko's followers were speaking of genetics ("mendelism-morganism") as a metaphysical, idealistic capitalist science. The attempts of prominent scientists to appeal to facts proved fruitless: "lysenkists" referred to their own achievements in agriculture and drifted toward ideological and political accusations. The final discussion ended with a "disclosure": "We will not speak with morganists; we will continue disclosing them as representatives of a harmful and ideologically foreign school, introduced from the alien abroad, scientifically false in its essence." (VASKHNIL session stenographic report, 1948).

Not only ideas were repressed, but their carriers, too. In 1940, Academician N. I. Vavilov and his closest colleagues were arrested. Vavilov was sentenced to execution; the sentence was later changed to a 20-year imprisonment.

In 1948, relying on Stalin's personal support, Lysenko organized the so-called August Session of VASKHNIL, "On the state of affairs in the biological science," which resulted in the dismissal of the majority of geneticists and other biologists sharing their views. Teaching genetics was canceled, textbooks were seized from libraries and destroyed. By mid-1950s, there were no genetics and geneticists in the USSR to be salvaged; after the August Session, there was nothing to be saved; one could only speak of the revival of genetics in the country.

From: (Zakharov-Gezekhus, 2004)

Main entrance to the building on Sovetskaya street, 20, where several institutes and the Presidium of the Siberian Division of the USSR Academy of Sciences were situated.
Left to right: D. Bileva, S. F. Nikiforova (Ivanova), L. A. Chugaeva.
Novosibirsk, 1958

N. P. Dubinin, director of the ICG SB AS USSR, at his work desk. *1958*

In 1958, the construction of Akademgorodok was just beginning; they were still felling the forest. During the first years, everyone was cooped up in a giant building downtown, on Sovetskaya street, 20, which hosted the whole Siberian Branch. At first, ICG employees occupied a single room; by spring of 1958, the Institute received half of the second floor of the building.

The working conditions were Spartan: the Department of physical, chemical and cytological foundations of heredity occupied three rooms. The biggest room, where the cytologists worked, had three cubicles for the chief's office and for the photobox. The second room was occupied by biochemists (there was no such thing as "molecular biologists" back then), and the third room, by physicists. By that time, we managed to get hold of some equipment: MBI-3 microscopes, microtomes, thermostats, etc.

The study of the material foundations of heredity, from nucleic acids and genes to cytoplasmic organelles, was one of the most important fundamental research fields in the Institute. For many years, this

In 1958, the whole ICG occupied just half of one floor of the building on Sovetskaya street, 20. L. A. Prasolova, a member of the Laboratory of Ecological Genetics, is in the photo sort of research was virtually forbidden in the USSR, while in the rest of the world, the science was progressing in great paces: they figured out the structure of DNA, studied the organization of many genes in a number of living organisms, scrutinized the structure of cell membranes, etc.

The reason of this lag was clear: from the mid-thirties to late fifties, biology in the USSR was a battlefield spiced with tons of ideology. When the first founding documents of the Siberian Branch of the Soviet Academy of Sciences were published in the summer of 1957, including documents on the Institute of Cytology and Genetics, it came as a joyous surprise for Soviet scientists. For the first time since the sadly notorious August session of VASKHNIL in 1948 (Russian acronym for Lenin All-Union Agricultural Academy), when genetics was branded as "capitalist pseudoscience," it was finally recognized as a legitimate branch of natural sciences in the Academy system.

The Noah's Ark of Genetics

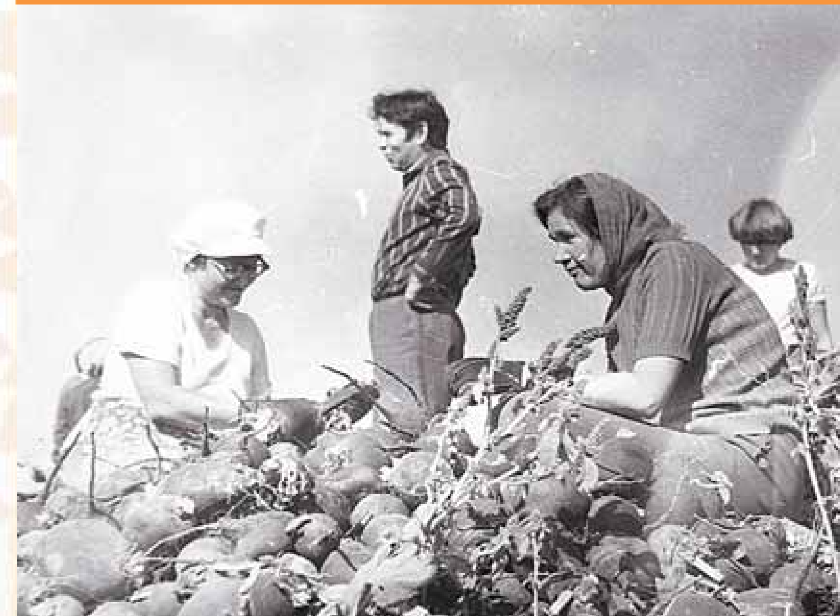
The creation of such an institute in *lysenkovschina* times was supported as early as in 1955 in the infamous "Letter of 300", written by outstanding Soviet scientists, from mathematicians to biologists. Nuclear physicists played a very special role here, and especially I. V. Kurchatov, the father of the Soviet atomic industry and the driving force behind the letter, who persuaded M. A. Lavrentiev to push for the Institute of Cytology and Genetics to be included in the list of the first ten institutes of the Siberian Branch. This interest of nuclear physicists in the development of genetic research stemmed from the fact that back then very little was known about radiation and its possible damaging influence on the heredity of humans and other living organisms. It does not come as a surprise that the Institute had a laboratory of radiation genetics from the very beginning.

The founding director of the ICG, N. P. Dubinin – an outstanding classical geneticist and the informal leader of Soviet geneticists of the time – went through rough times after 1948, when he had to work outside his profession in the Forest Institute. It was shortly before the creation of the Siberian Branch that he came to be the head of the Radiation Genetics Laboratory in the Institute of Biophysics SB AS USSR, however, the creation of the namesake institute kept being postponed. It was then that Dubinin succumbed to Lavrentiev's persuasions, who promised that in Siberia, "the business of developing genetics will have unlimited possibilities," but played a crafty little trick with the name of the new institute, beginning it with a little-known term, cytology (the study of the cell and its structures). However, Lysenko's zealots realized quite well that a new research center was being created beyond the Urals, which could lead to full recognition and further development of genetics in the USSR.

By the moment the ICG was founded, Soviet Russia had just a few remaining islets of classical genetics in several educational and academic organizations. These were the decimated remains of once powerful, internationally recognized Russian schools created in the 1930s by world-renowned scientists: N. K. Koltsov, A. S. Serebrovskiy, S. S. Chetverikov and N. I. Vavilov. After 1948, the vast majority of their colleagues and followers lost their jobs. Those who survived the repressions and the War, worked outside their profession: for instance, Yu. Ya. Kerkis, who was among the first researchers

Deputy Academic Director, head of the Radiation Genetics Laboratory of the ICG, Yu. Ya. Kerkis (*center*) at a *sovkhoz* sheep farm in Tajikistan, where he was the director during the *lysenkovschina* years

N. P. Dubinin (1973) wrote: **"The first task in applied genetics was the implementing of the plans to create triploid hybrids of sugar beets … This happened in the time when the All-Union Sugar Beet Institute, located in Kiev, still condemned the polyploidy method as an "allegedly false, anti-Michurin fancy of "morganists-mendelists."**
The summer of 1958 went well; in no time, we produced tetraploid sugar beets. Bearing in mind the importance of this work, we began to think about producing two to three generations of sugar beets a year. But this was impossible in the climatic conditions of Novosibirsk. We decided to send a brigade to an expedition to Abkhazia to force-grow three generations of plants. I came to Lavrentiev with these plans. He agreed with my arguments right away.
The brigade headed by V. A. Panin traveled to Abkhazia and spent several very difficult years there clinging selflessly to land and plants, which brought us closer to the dawn of new selection … the hardships of field work fell on the shoulders of several very young enthusiasts who worked in the brigade; they consulted with me throughout the work. By 1961, the brigade created the first triploid sugar beet strain, which raised the yield per hectare by 15 % … By 1972, nearly all sugar beet crops in the Kuban region were planted using our heterotic triploid material. This allowed producing 70 million rubles worth of extra sugar



V. K. Shumnyi during beet harvesting in the Iskitim *sovkhoz. Novosibirsk district*

1961 Triploid sugar beet strains

One of the main tasks the ICG faced after its creation was to prove the high applied value of genetics, focusing on the area of plant selection. Novosibirskaya-67, a strain of spring-planted wheat, was one of the convincing examples; it was created using the radioactive mutagenesis method by P. K. Shkvarnikov (a teammate of N. I. Vavilov) and I. V. Chernyi from the ICG and V. P. Maksimenko from SB VASKHNIL. The first mutant wheat plant was produced in 1959 in the progeny of the Novosibirskaya-7 wheat strain as the result of a 5 KR dose of gamma rays. By 1974, the new strain was acclimatized in six regions of Siberia and Urals. In one of his reports, Lavrentiev remarked that the introduction of the new wheat strain alone paid for the first stage of construction of Akademgorodok. Thanks to its high resistance to drought and to many plant pathogens, Novosibirskaya-67 became a milestone strain eventually used to create a large number of modern strains of the main grain in Siberia

1967 Novosibirskaya-67 wheat strain

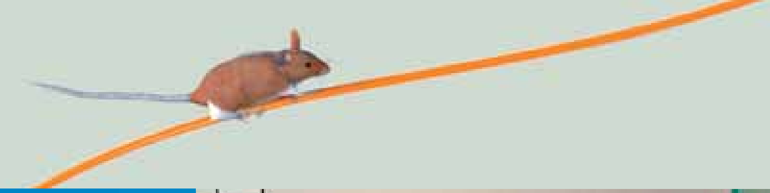
A visible manifestation of discontent from the "above" was the hindrance to the construction of the Institute building. In the initial plans, the Institute of Cytology and Genetics was situated next to the Institute of Organic Chemistry. Locations of the future construction were marked by plaques, but after Khrushchev's first visit, the ICG plaque disappeared, replaced by a different one – "The Institute of Catalysis". The construction of the main building of the Institute began only in 1960, in a completely different place

in the world to formulate the notion of disturbances in intracellular homeostasis as the reason of mutations, worked as a head of a *sovkhoz* farm; Z. S. Nikoro, a cytogeneticist and an apprentice of N. P. Dubinin, became a musician and played the piano; etc. For this reason, many of those who received Dubinin's invitation volunteered to go to Siberia to their new workplace.

What the ICG became was not just the core of revival of the national genetics; it brought together representatives from all Moscow and Leningrad schools, who had been working autonomously and even competitively. This created a unique environment for integration, a merger of the best academic traditions for solving a single global task – the rehabilitation of genetics in the USSR.

on page 104

In the course of the six decades from the beginning of the construction of ICG, the main building was supplemented with an experimental devices module, a vivarium and an SPF-Vivarium, where laboratory animals are kept in strictly controlled environments



Officially put in commission in 2009, the SPF-Vivarium of the ICG SB RAS is an infrastructural object unique for Russia; it continuously receives new complex technological and research equipment

FOR THE NATIONAL HEALTH

Over the last quarter of a century, the requirements to organizing all kinds of work with laboratory animals have become considerably more stringent in all developed countries of the world. An SPF (specific pathogen free) vivarium is a facility for keeping and breeding laboratory animals according to the accepted standards, i. e. without pathogenic microorganisms. This is because any infections are a source of variation in experimental data, interfering with their reliability.

According to current international rules, the main basic and applied studies aimed at elaborating new approaches to treating diseases and to elevating human physical and social welfare should be performed using animals kept in stringently controlled conditions; preclinical trials of new drugs and the biosafety assessment of new materials and products will be part of the work.

However, the keeping of SPF animals is only one side of the coin. Over 20,000 genetic strains of laboratory mice are now available. The creation of genetic models – experimental laboratory animals with specified genetic characteristics – has considerably accelerated in recent years, so that the number of such strains will exceed 300,000 in the next two decades.

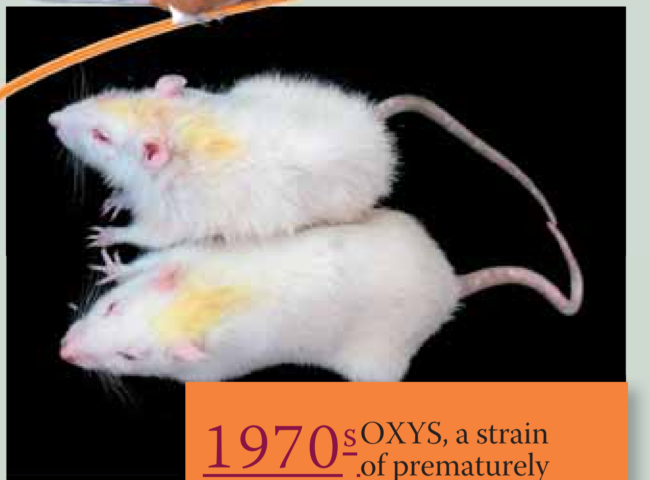
Now over 20 national centers for genetic resources from North America, Europe, Asia, and Australia united by international organizations coordinate the activities in this field. Until recently, Russia had no analogs of such centers. However, limited genetic diversity of these animals considerably hindered basic science; and the conditions of their keeping, which did not meet the current international standards, interfered with putting innovations on the external market.

The new Center is involved in basic research in "postgenomic" systemic biology as well as in the studies of experimental genetic models of human diseases. The Center will become a test site for large-scale preclinical trials of pharmaceuticals and of the products containing genetically modified components.

In the developed countries, such centers are on the list of national priorities and can be regarded as a symbol of statehood along with the hymn, emblem, and flag. There is nothing surprising about it: such genetic centers are an indispensable element of the science and technology complex designed to solve one of the main problems a country faces – to contribute to the health of the nation through improving the health of its citizens.

From (Moshkin, 2010)

2009 SPF-Vivarium is put into commission



1970s OXYS, a strain of prematurely aging albino rats

BREEDING FOR ACCELERATED SENESCENCE

The "elderly" diseases are frequently developing in humans in parallel with and on the background of a set of aging manifestations. Creation of the models simulating such situation is a complex problem. In fact, a single accepted model of accelerated senescence – SAM (senescence accelerated mouse)—exists in the world; it was created by Japanese scientists and is currently represented by 12 substrains. According to our studies, the rat strain OXYS, created at the Institute of Cytology and Genetics SB RAS in the 1970s by the team of Academician R. I. Salganik, can be a full-fledged model for accelerated senescence and related diseases. The development of a set of acceletared senescence signs in these animals resulted from a directed selection of Wistar rats for early spontaneous cataract.

Currently, accelerated aging manifests itself in a 28 % shorter lifespan as compared with the intact Wistar strain and in an early development of phenotypic aging changes and age-dependent diseases on the background of an early involution of the thymus and a decrease in the activity of the T-cell component of the immune system. This model is efficiently used for a rapid assessment of new diagnostic, prevention, and therapeutic tools for various age-related diseases and prevention of accelerated senescence.

The trials using OXYS rats were sufficient to demonstrate the ability of the mitochondrion-targeted antioxidant SkQ ("Skulachev ions"), synthesized by the team of Academician V. P. Skulachev, not only to prevent and hinder the development of cataract and retinal dystrophy, but also to alleviate the already developed pathological changes to their complete disappearance.

(Kolosova, 2008)

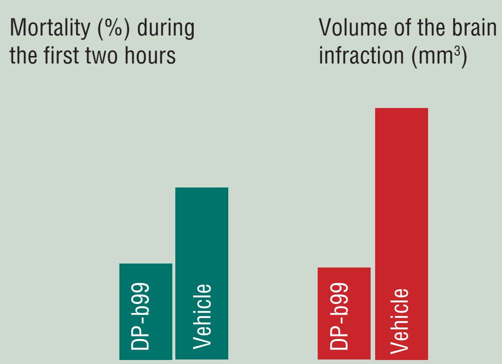
SELECTION OF HYPERTENSIVES

The hypertensive NISAG (ISIAH) strain rats with a stress-sensitive arterial hypertension have been produced through a long-term selection for the level of arterial pressure under conditions of mild emotional stress (Markel, 1985, 1991). Study have demonstrated that the NISAG rats actually display a genetically determined increase in the sensitivity to stress factors, which appears, first and foremost, as a development of stable hypertensive status. With a decreased response threshold to external stimulation, the arterial pressure can increase under routine "normal" conditions.

The mechanisms involved in the development of arterial hypertension in NISAG rats adequately reflect the pathogenesis of human hypertension in urban populations. This fit was observed not only at the level of neuroendocrine and morphophysiological responses, but also in the behavioral patterns (high motivation to compete for "life's comforts," elevated aggressiveness, and increased exploratory activity). This close similarity between our experimental model for hypertension and the corresponding human pathology allows the NISAG rats to be used not only for studying the mechanisms involved in the development of hypertensive states, but also in the search for and testing of new drugs for the prevention and treatment of hypertension and its complications.

It is known that a severe complication of hypertension is brain stroke. It has been found that the NISAG rats are very sensitive to any impairments of the cerebral blood circulation. Even a weak deficiency in blood supply to certain brain regions can lead NISAG rats to an extensive brain stroke and even a lethal outcome. This made NISAG strain an indispensable experimental model in the search for pharmacological preparations to control brain stroke.

(Markel, 2008)



An impairment of blood circulation in the middle cerebral artery in the NISAG rats with arterial hypertension induces the development of a brain stroke. Administration of DP-b99 immediately after the stroke considerably reduces the necrotic lesion and decreases the mortality rate during the first hours after the stroke

M. A. Sukoyan and O. L. Serov, staff members of the ICG SB AS USSR

ANIMAL BIOREACTORS

Production of therapeutically valuable human proteins is a promising direction in modern biotechnology. The strategy for the creation of dairy cattle as bioreactors involves insertion of a combined genetic construct carrying the human DNA sequence encoding a necessary protein into the region controlled by the regulatory elements of animal "milk gene." According to this strategy, thus created transgenic animals are able to synthesize large amounts of the corresponding human protein exclusively in the mammary gland and secrete it into milk.

The projects on creation of transgenic bioreactors usually comprise three stages: production of the genetic construct with a human gene under the control of regulatory regions of a "milk gene" (for example, casein), testing of this construct in transgenic mice, and, eventually, insertion of the selected constructs into the genome of dairy cattle.

Creation of an efficient producer is a stroke of good luck and a guarantee that a herd of its offspring will be produced in relatively short terms to supply the market with valuable pharmaceutical product. A laboratory is organized for such a herd to isolate and purify the recombinant protein; this protein is conveyed to the corresponding pharmaceutical institutions for testing, performance of preclinical and clinical trials, and approval of its use in medical practice.

In July 2006, the joint Russian – Brazilian project conducted by the Institute of Cytology and Genetics succeeded in creating a first transgenic goat carrying the human G-CSF gene which codes a granulocyte colony-stimulating factor, widely used in the treatment of the consequences of radiation therapy and chemotherapy as well as in the regeneration medicine. *(Serov, Serova, 2008)*

Two transgenic kids of opposite sexes carrying the human G-CSF gene—Camilla and Augustine (*right*), born in March 2008. The very moment of microinjection of recombinant DNA into the male pronucleus of goat zygote (*below*)

V. A. Berdnikov in the Institute greenhouse with his research subject – field peas

I have come to realize that this anecdote is in fact, a curious illustration of Lavrentiev's initial idea. He was, without doubt, a managing genius, and was facing two major tasks – strategic and current. Actually, he was creating the Academy of Sciences of the Russian Federation, because all other Soviet republics had their own academies already. His idea was to organize it far away from Moscow, in an industrial Siberian city.

The strategic task, a very deep one, was to build Akademgorodok, where representatives of different sciences would live and work side by side. From the very beginning, this task had a component of integration, which eventually developed dramatically, especially in the times when the Siberian Branch was headed by Academicians V. A. Koptyug and N. L. Dobretsov. The very fact that we, a bunch of green graduates, were mixed and matched regardless of our specialization, probably was not a coincidence.

One acknowledge the ingenuity of Lavrentiev: interdisciplinary projects began budding right from the start. For instance, our famous cyberneticist and mathematician, A. A. Lyapunov, who had a keen interest in biology and was an vocal opponent of *lysenkovschina*, set up a new specialization program within the Department of Natural Sciences of the NSU – Mathematical Biology.

The roots of integration

By the beginning of 1958, 25 people were working in the ICG, including 2 Doctors of Sciences and 5 Candidates of Sciences. The number kept growing, and those were not only "decorated" scientists, but also a lot of young people from universities and institutes in Moscow and other cities.

In the beginning, we lived in a dormitory, which was situated in several 2- to 3-apartment houses in Zaeltsovskiy Bor, a Scots pine forest outside Novosibirsk; overall, about fifty came to live there. I remember the dormitory in a three-room apartment on Derzhavina street, where 4 economists, 3 chemists and 4 geneticists lived together. The economists often quarreled with the chemists, and yet everyone was very interested in genetics. In about a year, I heard them quarreling and calling each other mutants, homozygotes and other purely genetic terms, i. e. in their speech, they used genetics argo as swearwords.

E. K. Mindina demonstrates a new breed of crossbred sheep

«Domestication is akin to a cataclysm. In domestication, the explosion of forms and new directions occurs due to the fall of homeostatic systems created by the preceding evolution, and mobilization reserves yield their deeply hidden forms of genetic material (the dormant genes).
<…> The domestication experiment offers an insight into the species' potential. Science can, if necessary, implement any of such possibilities».

From (Belyaev & Trut, 1982)

D. K. Belyaev at the fur farm of the research farms of the SB AS USSR in Kainskaya Zaimka (*right*).

Domesticated foxes are the result of long-term breeding for tamability of foxes of the wild phenotype from farm populations, which has been conducted at the Institute of Cytology and Genetics for over 45 years. During this period, over 50,000 progenies of the foxes have been obtained and tested for their ability to domesticate

1950s The first stage of D. K. Belyaev's fox domestication experiment

AN EVOLUTIONARY EXPERIMENT

The large-scale experiment reproducing the earliest stage of domestication was commenced by prof. D. K. Belyaev as long ago as in the early 1950s with silver-black foxes. The essence of this experiment was the selection of foxes for the tolerance to humans. As a result, a unique population of domesticated foxes, known worldwide, was created.

The results of an unusual evolutionary experiment have demonstrated that the genetic transformation of behavior (from wild to domesticated) entails the morphological and physiological changes similar to those that took place in the past in dogs and other domestic animals. Of the physiological changes, note first an increase in the activity of the most important vital function, reproduction, and weakening of the functional state of the hormonal system underlying adaptation and stress, the pituitary – adrenal system. In other words, the selection according to behavior pattern disrupts the physiological and morphological systems created and maintained in nature by stabilizing selection.

A similar character of the changes in animals under domestication as well as the fact that they occur quickly is hardly explainable from the standpoint of trivial genetic mechanisms. Belyaev formulated a principally new concept of naturally present destabilizing selection as a specific form of directional selection, which results in destabilization of the regulatory systems of ontogenesis (individual development) and, as a consequence, a drastic increase in the rate of morphogenesis.

As US geneticist G. Lark expressed in 2003: "It becomes ever clear to me that the experiment with foxes is one of the actually grandest experiments over several last decades. As if you in Novosibirsk knew beforehand what would be needed in future for the integrative genetics of quantitative traits. Doubtlessly, Belyaev was a great personality."

From: (Trut, 2008)

For the first visit of Khrushchev to Akademgorodok, the ICG geneticists prepared an exposition of their achievements: new plant strains, antiviral chemicals, furbearing animals with unusual fur colors, and the first corn hybrid. Mikhail Lavrentiev, who inspected the exposition before the visit, took a long time to look at their stand, gave it a thought and decided: to move all objects into a separate room, lock that room – and that he should take the key! Belyaev tried to argue, but Lavrentiev patted his shoulder and said: "I separated the church from the state."

Academician M.A. Lavrentiev and Academician D.K. Belyaev

Later, in 1973, N.P. Dubinin wrote: "The paper from July 2, 1959, printed the speech of Khruschev, where he said the following: "Academician Lavrentiev, who has come to Novosibirsk along with other scientists, is doing a great thing. I have known Academician Lavrentiev for a long time and he is a good scientist. But we must procure the new academic centers with people who are able to move science forward, so that their labor provides the necessary help to the industry. This is not always taken into consideration. It is a known fact, for example, that the Institute of Cytology and Genetics is being built in Novosibirsk. Its appointed director is the biologist Dubinin, who is an opponent of Michurin's theory. The works of this scientist are of very little scientific and applied purpose. If anything makes Dubinin famous, it is his papers and speeches against the theoretical statements and practical recommendations of Academician Lysenko".
My director's fate in Novosibirsk was doomed."

A rough path

In 1960, the Institute saw several extensions: the Experimental Farm of the SB AS USSR for creating new breeds of cattle and furbearers, the Genetics and Selection Center, and new land for experimental fields for plant selection laboratories.

The construction of a new building for the Institute began: by 1961, there were 12 labs and over 280 employees. In autumn, the first students came to the new Medical Biology Division of the Natural Sciences Department of the NSU. Its specially developed study programs were supplemented by guest lectures of major scientists from Moscow and Leningrad.

However, throughout all these years, up until Khrushchev's resignation in 1964, the ICG remained semi-illegal, always on the brink of complete dismissal. One of the first victims was Dubinin, who basically lost his directorial position in 1960 following a direct order of Khrushchev, for "morganism-weismanism." Lavrentiev interfered but only managed to secure his own right to choose a successor candidate. It was Dubinin's deputy, the head of the Genetics Department, Dmitriy Konstantinovich Belyaev.

Geneticists were incessantly bothered by commissions sent the Party Central Committee and personally by Lysenko; those commissions had clear directives – to close the Institute or at least bring it back to the tracks of Michurin's biology by replacing its chief executives and laboratory heads. Lavrentiev always received these people personally and showed them around. One time after one of these checks he came to Belyaev and said, quoting a Russian folk saying (literally): "These men are hedgehogs and they've got shivs hidden in their boots."These inspections often left the Institute one foot in the grave – a complete dismissal or change of research profile – and Lavrentiev, our guarding angel, went out of his way to find extraordinary solutions.

Here is a story that sounds more like a joke. During his second visit to Akademgorodok, the first thing Khrushchev asked Lavrentiev was: "How are your Weissman-Morganists doing?" Lavrentiev dodged: "I am a mere

A FROZEN ZOO

Today, there are over twenty cryobanks all over the world, preserving genetic material not only from laboratory animals, but from wild and endangered animal species as well. With cryogenically preserved gametes and/or embryos, with the use of artificial insemination, reproductive cloning and embryo transplant methods, live individuals can be successfully recreated. Such cryobank, unparalleled within the country, exists in the SPF-Vivarium of the ICG SB RAS.
The creation of a cryobank is not limited to the most sparing method of freezing and cryogenic storage of materials; methods of defreezing and extracting of genetic information are no less important.
Speaking of laboratory mice and rats, the transition of the frozen material into a living being is relativey simple: embryos are defrozen and implanted to females of the same species. But what kind of surrogate mom does it take to transplant gametes or embryos of a rare species – or even a species bordering extinction? At last, we found an interesting approach to solving this problem. According to the initial hypothesis, interspecific hybrids must make perfect recipients for embryos of two "parent" species.
Researchers from Akademgorodok successfully tested this assumption with the European mink, a species facing extinction. In this case, hybrids of ferret and mink (another mustelid), which can be easily created on farms where both of these species are bred, became the surrogate mothers. However, in the work with ferrets and minks, fresh embryos were transplanted, i.e. they were not subjected to cryoconservation. For further research, two closely related species of dwarf hamsters were chosen – the Djungarian hamster (*Phodopus sungorus*) and the Cambell hamster (*Phodopus campbelli*). Novosibirsk scientists were the first in the world to successfully freeze and cultivate embryos of these laboratory animals. Experiments have shown that these embryos develop successfully in surrogate hybrid mothers.

From: (Amstislavskiy, 2014)

A litter of same-uterus siblings, representing different species (the ferret and the European mink) resulting from embryo implantation to a hybrid surrogate mother

A file of the ICG staff during the May Day parade in Akademgorodok. *1970s*

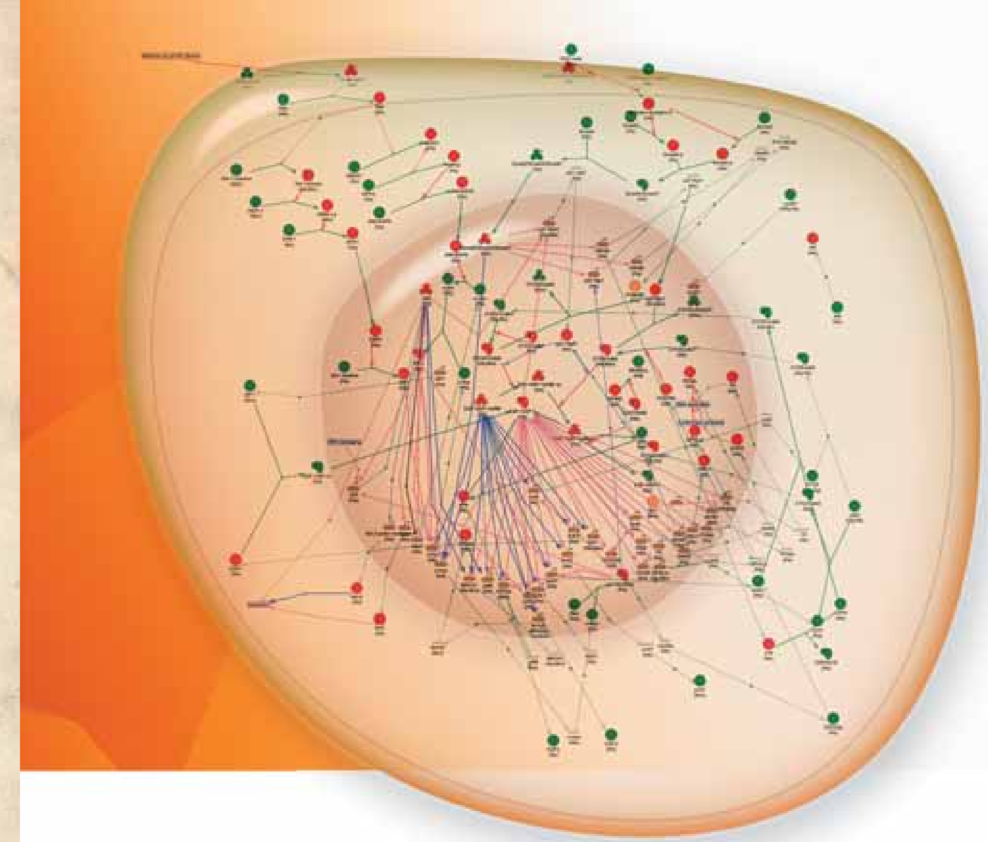
mathematician. I do not know a thing about genetics, and I have no idea which of them are Weissmanists – they do not wear badges, you know." Khrushchev replied with a joke about two belligerent men – an Abkhazian and a Georgian, – who argued about what was in the sky – the Moon or the Crescent. When the clash got out of hand, a Ukrainian approached. The arguing men asked him to be the judge. The Ukrainian looked at the sky, glanced at the men's knives and said: "You know, guys... I'm not from here!" "You are like this Ukrainian, – Khrushchev said, – I'm asking you about these people and you are asking me who they are." Surprisingly enough, that particular visit went more or less smooth.

One time, a commission came to the Institute, headed by an aggressive follower of Lysenko, adamant in their intent to shut down the Institute. After a tour around the ICG premises, they came to Mikhail Alekseevich. But as soon as they began to talk about the Institute and how it failed to conform to the Party policy, the phone rang. Lavrentieve answered: "Hello! ... The Central Committee? ... What Party policies? ... And I have got comrades here who are saying just the opposite... Mistaken, you say? ... Okay ... Thank you!". The commission left "empty-handed." We asked Lavrentiev about the identity of the caller many times, but it was much later that he admitted that it was S. A. Khristianovich, who was sitting in the next room."

By the way, it was Khrushchev to who we owe the current layout and appearance of Akademgorodok. During his first visit, the Chief Secretary was very unhappy about the "chic" and "wrong" apartment houses and ended up "halving" the academic hotel and ordered that *khrushchevka*-type panel houses be built in the future, and not the so-called "full-scale" houses with larger, more convenient apartments. The first apartment I got was in one of these *khrushchevkas*.

The construction of the main building began only in 1962. The construction supervisor asked the researchers to give lectures to the workers so that they knew what they were building. We made a chart and once every week one of us would tell the builders about genetics and laws of heredity. They were an attentive audience and asked a lot of questions. It is hard to imagine a relationship like that nowadays...

The Institute's first computer. V. A. Kulichkov (left) and S. N. Rodin



Nowadays the ICG SB RAS is Russia's leading institution in the area of bioinformatics, actively developing machine visualization tools for biological data as well as data storage, processing and reconstruction of models of key biological processes (Afonnikov, Ivanisenko, 2013). Among other things, the Laboratory of Evolutionary Bioinformatics and Theoretical Genetics performed an analysis of evolution of genes involved in the functioning of the cell cycle – on of the key processes which enable living cell growth and division.
Left – the gene network of the cell cycle represented as a graph in the *GeneNet* system (Ananko *et al.*, 2005)

For almost a decade from its establishment, up until the creation of the Institute of Basic Genetics of the USSR AS in Moscow in 1966, the Institute of Cytology and Genetics in Novosibirsk remained a single major complex genetics research institution in the country, where representatives of all major genetics schools worked, and where all major branches of theoretical and applied genetics of all levels of the structure of the living things were given a boost.

In the autumn of 1964, N. S. Khrushchev resigned; this coincided with the debunking of Lysenko's "achievements." In November, an article authored by D. K. Belyaev appeared in the *Pravda*; it provided a program of genetics revival in the USSR. Among other things, Belyaev wrote about changing the teaching courses in higher education institutions, creating a society of geneticists and selectionists with a corresponding academic journal, and employment of specialists qualified in genetics in all institutions dealing with selection. This was the beginning of a new age in the history of national genetics.

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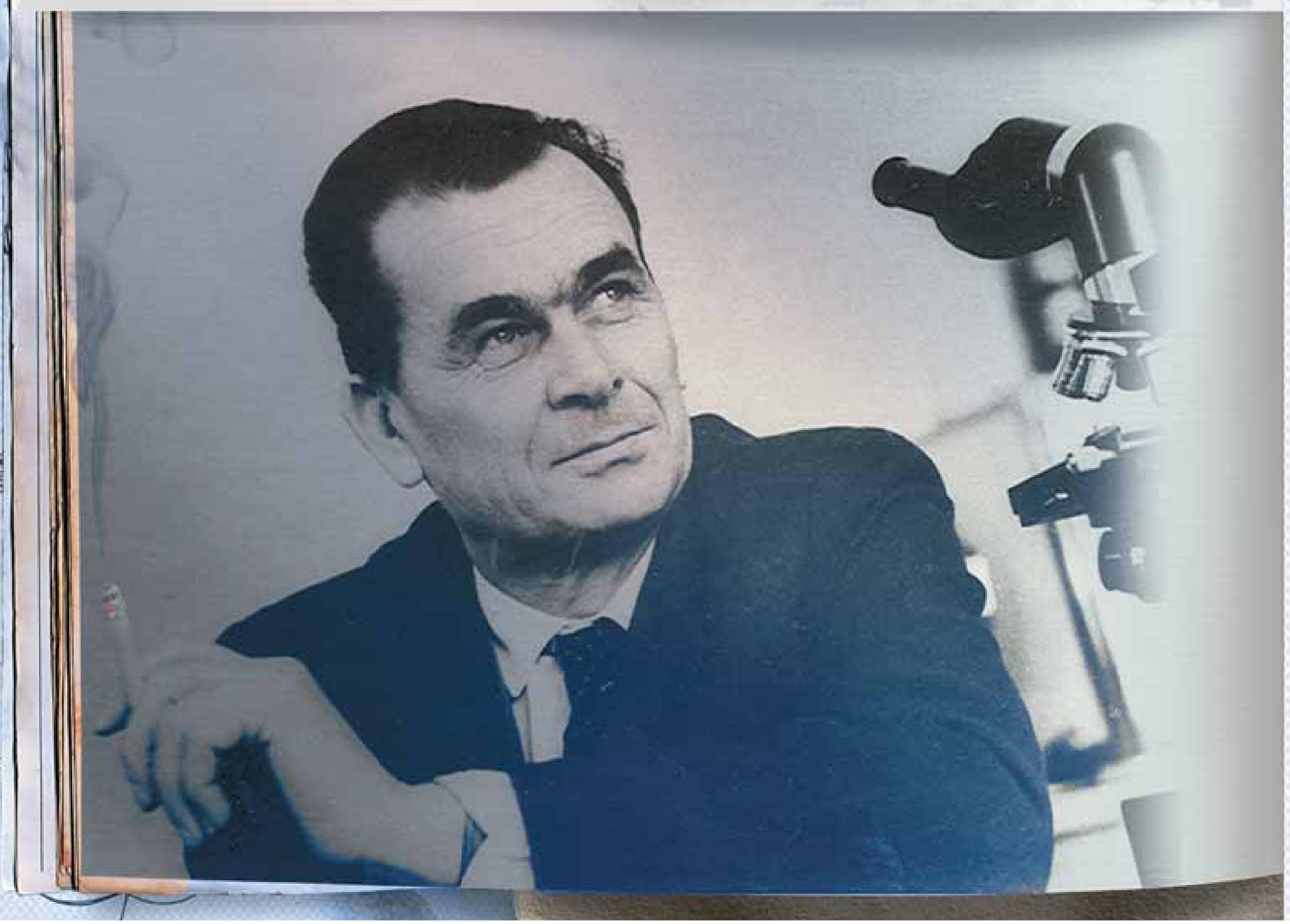
A unique memorial to the most famous laboratory animal: a bronze mouse, like the goddess of destiny, is weaving the double spirals of DNA – the essence of life. Installed in 2013 near the SPF-Vivarium of the ICG SB RAS.
Concept by A. Kharkevich, sculpted by A. Agrikolyanskiy

The publication uses photographs from the archive of the ICG SB RAS

N. D. BELYAEV

Dmitriy Konstantinovich BELYAEV

Brush strokes in the portrait



I have wanted to write about my father, an outstanding geneticist and evolutionist, Dmitriy Konstantinovich Belyaev, for a long time. There are a number of reasons. Apart from my natural desire to collect memories and a promise given to my mother, Svetlana Vladimirovna, I came to realize that his life could be of interest to many people, and not just my children and, perhaps, my grandchildren…
In the wonderful book by B. Hare and W. Woods, "The Genius of Dogs," published in 2013, there is a line: "There is hardly any information on Dmitri Konstantinovich Belyaev. There are no biographies on his life, other than a few eulogies. After Belyaev`s death, his wife published a book of memories from those who knew him, but this was distributed only among friends and colleagues, and it is impossible to obtain a copy."
This statement is not entirely accurate, although the book was indeed a small print, and it was never printed again.
A lot has been said about my father – in articles, books and the Internet. Yet people tend to focus on the results of his famous evolutionary experiment and say very little about his personality. Unfortunately, the little they do say is full of errors. I would like to correct that. After all, many people, especially young people, ask me about details of my father's life, which I thought were well-known. But this is not so, and I must answer these questions here

ABOUT MYSELF

I graduated from the Department of Natural Sciences of Novosibirsk State University with a specialization in Biology in 1972. In 1972—1991, I worked in the Institute of Bioorganic Chemistry of the SB AS USSR: started out as a senior lab assistant and eventually became a senior researcher. L. S. Sandakhchiev and V. G. Budker, both outstanding biologists, were my teachers, and I am deeply grateful to them. But most of all I am grateful to my father, Dmitriy Konstantinovich Belyaev, for his advice and constant support.
From 1991 through 2000, I worked in the University of Birmingham in Great Britain; from 2000, I have been working in the Institute of Cellular and Molecular Biology in the University of Leeds in England. My professional interests focus on epigenetic regulation of gene expression in neurodegenerative diseases. I have the degree of a Candidate of Biology and authored over 80 research works

Dmitriy Konstantinovich Belyaev: a Book of Memories (2002) is a collection of memories of Belyaev's friends and colleagues, journalists, and war veterans. It was published by the effort of several people, especially my mother, Svetlana Vladimirovna Argutinskaya, Vladimir Konstantinovich Shumnyi, father's comrade and friend, and Professor Pavel Mikhailovich Borodin, who had worked with my farther for many years.

My dear mother wrote a chapter about the father, titled "Dima"; it is the first chapter of the book. It is written with endless love and respect to my father. It turned out to be a wonderful tale of love written by a nearly octogenarian woman. Pasha (P. M. Borodin) and I were invited to edit the chapter. We were unanimous in that the writing was too pompous – something the father never liked and would not approve. But my mother, so old and frail, just listened patiently, looking at us with her kind blue eyes, and did not object much. In the end, she did it her way. And she did the right thing, because the chapter

Key words: D. K. Belyaev, Institute of Cytology and Genetics, domestication of foxes, homemade foxes

D. K. Belyaev's parents – Konstantin Pavlovich and Eustolia Aleksandrovna Belyaevs

D. K. Belyaev during the war

My father, Dmitriy Konstantinovich Belyaev, was born on July 17, 1917, in the village of Protasovo in the Nerekht district of the Kostroma county into a family of a priest. In 1927, he went to Moscow to live with his brother, Nikolai Konstantinovich Belyaev, a well-known geneticist, who was repressed and executed in 1938. My father went to school in Moscow; since he was banned from applying to universities because of his clerical descent, he went to Ivanovo Agricultural Institute. D. K. Belyaev became interested in biology very early in his life, much due to the influence of his brother N. K. Belyaev. He had excellent genetics teachers in the Institute, including D. P. Lastochkin, B. N. Vasin and A. I. Panin. Belyaev was raised on the ideas of classical genetics and stayed loyal to them to the end. In August 1941, he volunteered to go to war and returned a major. He received a number of medals and decorations for his service in the Great Patriotic War.

He left military service in 1946 and became a laboratory head in the Research Institute of Fur Industry in Moscow. From 1957 – head of evolutionary genetics laboratory in the new Institute of Cytology and Genetics of the SB AS USSR in Novosibirsk. From 1959 through 1985 – director of the ICG SB AS USSR. From 1964 – Corresponding Member of the Soviet Academy of Sciences, from 1972 – acting member of the Academy. 1975 through 1985 – deputy chair of the Siberian Branch of the Soviet Academy of Sciences. From 1978 through 1983 – President of the International Federation of Genetics

"They often ask if my father was a Candidate of Agriculture. He is mentioned as a Candidate of Agriculture in a number of publications, including a book by Academician N. P. Dubinin, notes of V. N. Soifer, and an interview with Academician D. G. Knorre. This is not accurate. He was a Candidate of Biology. But that does not mean that he considered agricultural disciplines to be inferior or second-grade. On the opposite, he contributed a lot to the creation of the Siberian Branch of VASKhNIL and was friends with its first president, Academician I. I. Sinyagin. Father graduated from the Ivanovo Agricultural Institute and considered it his true alma mater. He was very grateful to and stayed close friends with his teachers, B. N. Vasin and A. I. Panin, whom he considered to be outstanding researchers. By the way, this institute (currently the Ivanovo State Agricultural Academy) is named after D. K. Belyaev."

was great. By the way, it was my mother who began to call my father "Dima." The family called him "Mitya" [another diminutive of the Russian name Dmitriy]. It is interesting that my relatives and my mother decided to name my brother Misha, while my father wanted to name him Ivan. The relatives were insistent, and my father gave way, but he called my brother Ivan all his life.

I have received a number of proposals asking me to write for this book, and I even started writing a few times. But each and every time I eventually realized I was writing about myself – and I did not want that. I am more than reserved in my opinion about my writing skills and I gave up after several attempts because I thought it was better not to write anything at all than write badly.

But time flies. I have reached my father's age. And I decided to write about him as well as I can. Will I be subjective in my narrative? No doubt. Otherwise I would not be my father's son. I stress that I am writing for my children and for anyone who may find it interesting. I believe I am free to write what I consider necessary and possible.

Family and environment

It is a commonly accepted opinion that my father was exiled to Siberia for disagreeing with the regime and for being an advocate of classical genetics. But this is not true. He was offered a position by the founding director of the Institute of Cytology and Genetics of the Siberian Branch of the Russian Academy of Sciences, N. P. Dubinin, and he did not hesitate a moment.

An amusing fact: in his story about my father, G. Paderin, a writer from Novosibirsk, wrote: "Dmitriy Konstantinovich told his wife that he was invited to Novosibirsk to run a laboratory in Dubinin's institute, and she suggested that he should see a psychiatrist." These words made my mother deeply indignant, a feeling that lasted for years. Naturally, she never said anything like that. On the opposite, she realized right away that this transfer would be an excellent opportunity for my father to practice science and would provide a very decent apartment for the family. Back at the time we were living in Raisino, on the outskirts of Moscow, in a tiny two-room Finnish house with a wood stove, an outhouse and chickens in the backyard.

The very expression – "see a psychiatrist" – was absolutely impossible and unacceptable in our family. The atmosphere in our family was dignified and calm, if not idyllic. We all understood how busy the father was and tried to help him to the best of our ability. Our parents did argue at times, but never lost dignity. My mother adored my father, and I dare say that he owes much of his lifetime success to her. He understood that, cared for her and loved her very much.

Father never openly disagreed with the regime. He went through the war and directly experienced *lysenkovschina* [state research policy based on the teachings of the influential Soviet agriculturist and geneticist, Trofim Lysenko, who rejected conventional Mendelian theories in favor of selection based on acquired traits, which was ideologically attractive for the government]; after the infamous VASKhNIL session [VASKhNIL, ВАСХНИЛ, a Russian acronym for the Lenin All-Union Agricultural Academy] he lost his position, but was reappointed right away. He was never afraid of anything or anyone but realized clearly that open dissidence would ruin his laboratory in Moscow and eventually lead to the termination of the Institute in Novosibirsk. He remembered all too well what had happened to his brother Nikolai. I take the liberty of reminding the reader the story of Nikolay Belyaev. He was one of the brightest students of N. K. Koltsov, a brilliant geneticist. Together with Koltsov and N. V. Timofeev-Ressovskiy he was invited to Germany, but ended up in Tashkent, because he was already under suspicion of being of clerical descent, probably due to activity of informants. Nikolai left for Tbilisi, only to be slapped by more informant reports, this time from Georgian geneticists. In 1938 he was sentenced to death and executed.

My parents

R. I. Salganik and D. K. Belyaev with workers at the ICG SB USSR AS construction site
1960

Father never expressed any agreement with the regime, either. He stayed out of the Communist Party his whole life, and did not sign even one of the public letters against A. D. Sakharov. He never made a show out of it but always managed to find a way not to sign those petitions. He knew the rules of the game, though, and did not want to harm the institute, so he stayed on good terms with the Party officials. Luckily, the local officials in Novosibirsk and in Akademgorodok in particular were quite reasonable and adequate people.

Another episode is described by R. Pimenov, a famous dissident mathematician, in his memoirs. His father, I. G. Scherbakov, who was one of our neighbors back in Raisino – a man who had spent quite a lot of time in prison camps after the war and was an ardent dissident even back in Stalin's lifetime – asked my father for a favor: to bring a Knuth Gamsun's book, which was considered anti-Soviet at the time, from abroad. Father went to Scandinavia for three months with a delegation to study fur farming and to negotiate the possibility of exporting fur. Father bought the book and brought it back. Actually, he did a lot of things he was not supposed to do. P. M. Borodin recalls an episode when father brought a cage with long-tailed roosters from Japan. It was risky; something not anyone would dare try. Father's spirit always had a rebellious element to it...

His attitude to religion was that of a decent, educated person. He was a son of a priest and could not but treat religion with respect. He knew the history of religion well, and quoted the Bible sometimes. However, he did not observe any church rituals: he did not go to church and did not pray. There were no icons in the house. But I believe he did have an understanding of God in his soul. He used to say he could not comprehend the origin of butterfly colors without the Creator's intervention.

Regarding his attitude towards Stalin, I assert that for as long as I remember myself (and I remember myself from the time of Stalin's funeral, i. e. from when I was four) my father always said Stalin was a bastard. That is precisely what he said. I grew up with it and never questioned it. He could not think any different, having lost his brother who he loved deeply. His father, a priest, was dekulakized; his house was torched, including a wonderful library.

Father took all attempts to exculpate Stalin very painfully. When I. D. Bodul, the First Secretary of the Moldavian Central Committee of the Communist Party, gave a speech at one of the Party conventions, filled with curtseys for Stalin, father became very worried and showed this speech to everyone. People tried to calm him down: "Who is this Bodul, anyway?" "Bodul may be a nobody, – father replied, – but he does not speak for himself; he has been allowed to say these things today! Tomorrow, Brezhnev will repeat these words." In essence, this is what happened.

Belyaev's main achievement was the concept and implementation of the experiment on fox domestication, which demonstrates the role of behavior-based selection in animal domestication. The experiment is considered to be one of the most famous biological experiments of the twentieth century

A few words on arts

Father is usually pictured as a sort of an academic general, and it seems that we all, including the family, are partly to blame. After his death, mother asked for a favor – that a copy of Tvardovskiy's poem, "Vasiliy Terkin," be put on his table in the memorial room in the Institute. Indeed, he loved that book and knew parts of it by heart. This is what probably produced the opinion that he liked exclusively war stories, poems and songs. However, I must say he was a brilliantly educated and eclectic man, and arts were not an exception. Father excelled in his knowledge of literature, music and fine arts. Our home library, in my opinion, was larger and better than any other home library I have ever seen. And the books were not there for decoration. In a way, father was a self-made man. He used to quote both prose and poetry all the time: in his speeches, in his papers, and in daily life. The choice of authors was eclectic: Russian poems and Burns, Zabolotsky and Lugovskoy, Bulgakov, Chekhov and Mayakovskiy.

And how he taught me to love poetry! It is a story of its own. I was in the sixth or seventh grade, and father made me learn poems by heart and recite them in front of the whole family. Initially, I was not very enthusiastic about this idea. Father told me to learn the first chapter of "Mazepa" and recite it in two days. I learned it, and began reciting: ("Kochubei is rich and glorious..."). "Are you reading a psalm? Do you know who Kochubei is? He was a legendary person!" – father stood up and began to explain, and then went on to recite "Mazepa." It was wonderful and would make a great TV scene nowadays. I continued reciting. When I finished, father praised me

Director D. K. Belyaev (*center*) and his deputies for science V. K. Shumnyi (*left*) and R. I. Salganik (*right*)

and told me to learn and recite "Mtsiri" in three days. I was outraged deep inside, because all my friends were out playing ball, but I had no choice. "Mtsiri" was followed by "Eugene Onegin," Nekrasov, Blok, and many more. Little by little, I began to enjoy it, and came to love poetry; I still remember much of what I learned then. And I am grateful to my father for that.

Lifestyle

In my father's lifetime, I was unhappy with him for two reasons – and it was not only I: so were my mother, our family and our friends. First, he never wrote down anything – or barely anything – from his thoughts on evolution. His work gained worldwide recognition only because of the efforts of Lyudmila Trut, his student and follower. Still, his lectures were stunningly captivating and it was a sheer pleasure to listen to him. He was always happy to teach as long as people listened, but he never wrote anything down. He may have thought he had time and expected to live a long life. His mother lived to 92 and some relatives passed the centennial mark. But he did not.

The second reason is that father never took care of his health. He was essentially a healthy man, and neither his heart or his blood pressure gave him any trouble until he was around 65. But he was a chain smoker, although he did make a few half-heated attempts to quit. He never got any exercise and virtually never walked and did not acknowledge any sports. Our pleas to take his health more seriously never caused anything but irritation: "Where am I supposed to find the time for this nonsense!?"

We had a beautiful garden around the house where we lived. Father would sometimes sit there, but he never worked in the garden – he said he had toiled enough in his childhood. Indeed, he grew up in a rural area and had quite a few skills. He knew how to cut grass with a scythe, but he never did any gardening. There was no use trying to make him do anything, no matter what it was. Everyone remembers that.

All this is exceptionally frustrating. Father had so many plans and wishes. One of them was the Cherga project, which he cherished. He was obsessed with the idea of creating a nature reserve for endangered animals and found a place in the Altai Mountains near the village of Cherga. The task was a complex one and required time, effort and good people, all of which was hard to find. Even though the idea of creating the reserve was supported by the head of the Siberian Branch of the Academy of the time, Academician V. A. Koptyug, the concept itself encountered criticism and lack of enthusiasm: who needs this sort of thing?

On many occasions the father demonstrated a lot more visionary insight than others around him did, and this was the case with Cherga. Cherga was his dream, the purpose of his life in his later years. He breathed the dream. But he did not have the time. And he is partly to blame.

He worked a lot and was always busy with the Institute management and research issues. Unfortunately, not all of these things were necessary and useful. He had to deal with conflicts, both local and those coming from Moscow: he rushed to help people who then wrote atrocious things about him. He had to attend the sittings of Gorisporkom (the municipal executive committee) because he was an elected member of the city council. He used to tell funny stories about those sittings. Usually, a good half of the members tried to play hookey during the first break, and for this reason, the coat-check was closed and they would not hand out the coats. But father used to leave his coat in the car, where his driver waited for him. In the morning, all members checked in, and during the break, father pretended to go for a smoke and left. He said that listening to the jibberish in those sessions was unbearable, and he was very proud of his shifty trick. Actually, father had quite a lot of such stories.

Institute management, 1970: L. K. Antipova (academic secretary), R. I. Salganik, D. K. Belyaev, V. K. Shumnyi, V. I. Molin

If they asked me how he spent his free time, I would answer – working and chores. He had no free time, no hobbies, such as stamp collecting, to speak of. He did not collect edible mushrooms and did not hike in the woods.

His old friend and one of his first economic deputies, Mikhail Nikitich Zhukov, sparked his interest in fishing.

Father got into it, and bought a motorboat. Together with the Kerkises and the Rauschenbachs, father's colleagues, we went sailing on the Ob reservoir and the river Berd' with all its inlets. We went with our families, fished, swam and had basket dinners. Here, father excelled as well. He was a skilled sailor. Once we got into a storm, and a serious storm it was – I was certain we would capsize! – and he steered clear of danger. In the early 1960s, he bought an actual small cutter, with a steering wheel and cuddy. But I never even saw it – father got too busy at work and did not have time for it anymore.

He usually returned home around eight, and often brought along friends or colleagues. We had dinner, talked, usually about the Institute business. Sometimes these talks were meant to stay confidential, and we all understood it.

Unfortunately, I know very little about my father's student years. I am sure, however, that he spent them with more purpose that we did in our time. Some people waste too much time on cards or soccer. I doubt that father spent his time like that. He had a collection of Darwin's works in his library, printed in 1937. There is father's signature in one of the books, dated the same year. Page margins are full of notes in father's handwriting, and there are burnt matchsticks here and there used as bookmarks

When grandchildren were born, he always tried to spend more time with them and rushed to see them before dinner when they were still up. He was very close to my daughter Ekaterina and treated her as an equal. I must say, my father never liked routine chat. It was not forbidden, yet we all strove to talk about things that were truly important and serious. That was normal in our family.

Sometimes he would watch a soccer game with me – or at least tried. I loved soccer and tried not to miss it when it was on TV. Unfortunately, my father's behavior is impossible to describe. His face and his words bore a mixture of some interest and an ironic attitude. However, the interest faded quickly. Father would conclude the players were worthless or could find better and more useful things to do in life. He left for his study and worked until two past midnight, or read books. He loved Russian literature, including some relatively obscure writers, such as Leskov and Melnikov-Pecherskiy... The latter he read shortly before death, knowing it was inevitable, and faced it calmly, still immersed in his Institute business. He knew and loved Anatole France, a writer gone into oblivion in our days. He made me and my wife, Tamara, read all eight volumes of his works. I cannot say we regretted it. On the opposite, Tamara often says that it was my father who acquainted her with Anatole France.

War

Memories of the War were sacred for my father – please forgive the pathos. Starting around April 30, he would begin recalling: "Zhukov moved the forces there, and Konev went there... on May 3, they took Berlin... so many people were killed..." He knew the history of the War until the last day.

On May 9, he would put on all his medals and go to the veterans parade in Akademgorodok, where he always was one of the prominent figures. Yet he did not like to talk about the war. Sometimes he would tell war stories and anecdotes. For example, in 1945 they ended up in a place controlled by Germans and they had to cut and run. In another story, General Beloborodov, who would later become the commander of the Moscow military district, wanted to execute him. It would be a funny story, were not it so scary.

It happened in Belorussia in 1944. Father was driving on a frozen crust across bogs when another car caught up with him and signaled, demanding that he make way. There was nowhere to turn, because they were in the middle of a bog. They reached solid ground and got out of their cars. Beloborodov, who happened to be in the following car, yelled:

– I will execute you!

– As you wish, Sir General!

– I will shoot you right here, right now!

– As you wish.

– Okay. Go, major (father was already a major then), and tell your unit commander to put you in detention for ten days!

Father did not tell anything to anyone, quite naturally. Later, he met with Beloborodov. They both remembered this episode and had a laugh, although for my father, it was no laughing matter back then.

When he spoke about the War, he said it was all blood and dirt. There was nothing even remotely romantic about it. He would remember a shed in Belorussia, and what they saw there after the Germans had fled, and go silent. He said: "I cannot talk about it." And he never did.

Father blessed me and sent me to the army when I was recruited. We did not have a military department in our University, and by law I was obliged to serve in the army for a year after graduation. Father helped quite a few people to avoid enrollment, but he told me: "I will not help you. Army will do you good and it will build your character." I honestly replied that I was not planning to dodge. Together with my mother they went to see me off at the train station. I served in the Air Force in the Krasnoyarskiy Kray. And what a place it was: at times, the temperature plunged to minus 50 degrees Celsius [–58 Fahrenheit]. We had to dig ditches and fill them with earth again, or shovel huge mounds of snow only to put it back where it had been in the first place – the usual army routine. But I made real friends there who I still love a lot. In the army, I came to realize how I loved my father and mother and how much I missed them. I went to see them when I got a three-day leave warrant, and father was utterly happy to see me.

My current thoughts about my father

I had an intention to write about the people who wrote reports and complaints about my father – such things happened, too. But on second thought I decided not to do it. I do not want to mix the good and the bad in one pot and remember my father along with these people. I do not want to translate my writing into criticism and negativism. In essence, history has put everything in its place, and I have got nothing to add to it.

Our family:
Standing: my brother Mikhail, my wife Tamara and I.
Sitting: D.K. Belyaev with grandchildren Katya and Kolya

With grandchildren Katya and Kolya

If I was asked to describe my father in two words, I would say that he was an extremely serious man. This means a serious attitude to the things he served: to genetics, to his own work and to the work of other people, to the Institute, which was always in his heart and mind; to his responsibilities, which were numerous, and quite absurd at times; to his family, which always needed his help; to his friends, whom he loved endlessly, protected and supported to the best of his abilities. He did it all selflessly and unsparingly. I can feel the pathos here, but it is the truth and there is no other way to put it into words.

This does not mean my father was a gloomy and morose man, although it did happen, especially near the end of his life. He had a fantastic sense of humor: when he laughed, you could not imagine a man more amiable. He used to say that people completely devoid of the sense of humor bothered him. When he was in a good mood, the Institute meetings, seminars and research councils sessions turned into a perfect drama theater.

I remember one of those sessions. I have never worked in my father's Institute, even though I was and I still am a biologist, but I had many contacts in the Institute. I happened to be there because our work with O. L. Serov and his team had made us popular. It was late afternoon but there were still a lot of people present. I think it was a research council session of the Siberian VOGIS (ВОГИС – a Russian acronym for the Vavilov Society of Geneticists and Selectioners), where father, as its chairman, was handing out various awards. There were several awards and father was in a great mood.

– Okay, – he said, holding on to his cigarette, – here is a VDNH certificate (ВДНХ – Russian acronym for the Exhibition of Achievements of National Economy) awarded to R. I. Salganic (a famous biochemist and deputy director of the Institute of Cytology and Genetics for many years) for his series of work on nucleases. Rudolf Iosifovich, you owe us a drink!

– Will do, Dmitriy Konstantinovich.

– A bottle of Cognac!

– Sure, sure, sure.

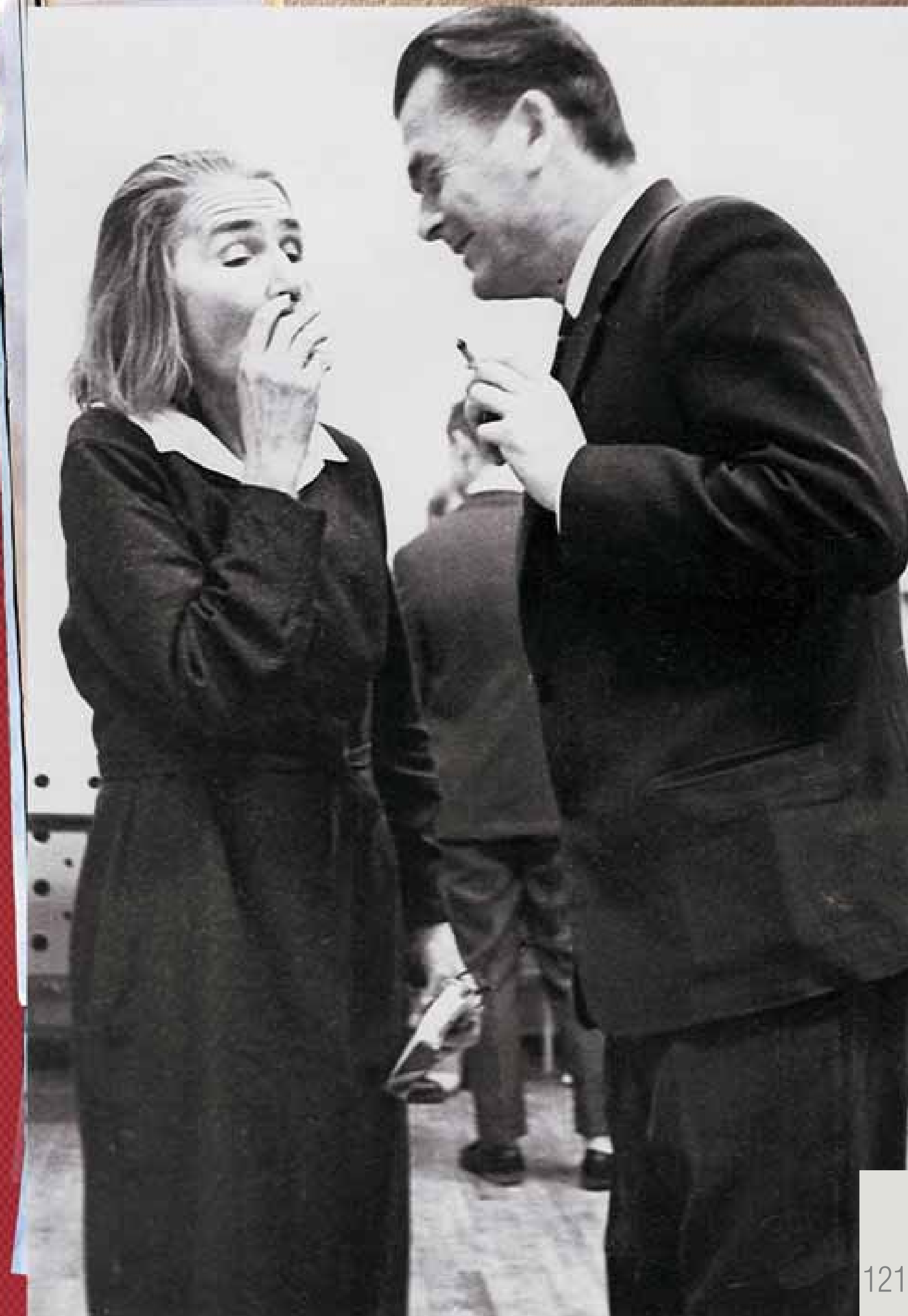
– Don't procrastinate.

– Of course not!

– Here, take your certificate, maybe you can hang it where it belongs...

Next.

SB AS USSR top executives at work. G. I. Marchuk, A. A. Trofimuk, and D. K. Belyaev



Z. S. Nikoro and D. K. Belyaev. Zoya Sofronyevna Nikoro was the head of the laboratory of basic genetics of animal selection from 1963 to 1971; in 1971—1978 – head of the population genetics laboratory of the ICG SB RAS

– A VDNH medal and a monetary award goes to O. L. Serov for his work on chromosome transfer. Oleg, are you here? Where is Serov?

– I'm here, Dmitriy Konstantinovich.

– Here you go. A medal, and the money up to you. Wait, what's that work? Is this what you were doing with Nikolai?

– Exactly, – Serov says slowly and soberly.

– Okay, pin it to your suit, here, come and take it, and it's up to you with the award. Call me, I'll help.

– Okay, Dmitriy Konstantinovich...

Actually, father took these sessions very seriously and took a lot of effort to prepare for them. He never read from paper but always drafted his speeches. And his speeches were amazingly good. On many occasions he scolded me for my inarticulacy, and that was fair criticism.

Father had a striking voice, a beautiful baritone. He used it masterfully, could change its tone or hold a pause when necessary and always kept his audience hooked, like a good actor. No surprise he was a relative of Kastorskiy, a famous bass singer in the Mariinskiy Theatre in St Petersburg early in the 20th century. Kastorskiy was viewed as an equal of Shalyapin, and my wife plays his records to our guests, claiming its Dmitry Konstantinovich voice. And it is, indeed, similar.

Father loved his friends and treated them with tenderness. He constantly said that there is no bond holier than friendship and followed this principle to the fullest. At this point, I should recall his closest friends: B. L. Astaurov, B. N. Sidorov, N. N. Sokolov, V. V. Sakharov, V. V. Khvostova, V. K. Shumnyi, L. V. Krushinskiy, V. I. Evsikov, L. S. Sandakhchiev, P. M. Borodin, A. O. Ruvinskiy, N. B. Khristolyubova. I ask for apology if I have failed to mention somebody.

He loved just to spend time in a company of close friends or discuss serious Institute business, and sometimes his friends would face the music – which was not always deserved and fair. But they loved him and did not hold grudges for long. Father believed that one should always tell the whole truth to a friend, otherwise you are not such a good friend yourself. Sometimes the friends would talk back, and father, in turn, would not be very upset.

Another episode. Once father came home in a rotten mood. My friend Pasha Borodin had dropped in to see me. Father attacked him: "Aha, there you are, my dear. What's with all the mess on the farm? The cages are all torn, the sheds are broken, and you are tight as a clam!" "How would I know? I never even go there." Father got even more upset. "And why don't you know what's happening on the farm?" "[X] is supposed to be taking care of it." "Outrageous! – father says, – these are your comrades, your lab, and you are hiding behind their backs? This won't do!" I interfered: "This is unfair, why are you scolding Pasha? Find the people responsible for all this." This is when I caught it bad for aiding. Father went on: "This man, [X], is he your friend? I will fire him if it all goes on like this, for heaven's sake! He is a loafer and an empty man." Pasha and I defended the man, of course. Father continued: "You are not his comrades if you cannot tell him the truth. You must be the first to tell him he is lazy and that I am going to kick him out. Tell him."

We did not tell him anything, of course, and everything turned out well in the end. Including the sheds.

Sometimes father is pictured as a coarse man. This is hardly true. He was a strict and consistent person and always stood his ground. He was not soft, but he was kind and fair. Sometimes job cuts were declared in the institutes, and that always made father sick. The very idea hurt him. But ultimately, all people kept their jobs, and I still have no idea how he managed that. Yet he was constantly worried about these layoffs, and rushed to help selflessly. If an employee's child got sick, he would drop everything to find the best doctors.

Once – I think it was in 1972 – Pasha's son, Grant, got sick. I think he was a year old back then. The illness was serious, and Pasha was away – in the Moshkovo *sovkhoz* near Novosibirsk. He had gone there with A. O. Ruvinskiy to castrate foxes. Father called me up and said: "Pasha must return. The situation is grave, and he should be staying here. Can you cover for him?" I said: "Of course, and I have time." I packed up and took a boat to the sovkhoz. Pasha had been notified, met me and left on the same boat. Luckily, everything turned out well for Grant. And I had a good time at the *sovkhoz* farm – not without use, too.

Such episodes were numerous.

The main things in life

I think that one of the most important things my father accomplished in his life was saving the Institute from closing down. Not everyone remembers that the ICG SB RAS was next door from dismissal from the very beginning for its adamant adherence to the principles of classical genetics, which was completely orthogonal to the ideas of high-ranked biological (and not only biological) executives of the time, headed by Lysenko. Khrushchev was friends with Lysenko and supported him in all ways. The Institute was an annoying eyesore for these people. Complaints, reports, audits and squelchers happened all the time.

R. I. Salganik, a well-known biochemist, was the first deputy director of the Institute of Cytology and Genetics for many years. They were not close friends with my father, yet they shared a common past: both went through the war and began to celebrate the Victory Day together in the fifties, back when we were living in downtown Novosibirsk and our apartments were in the same house. Both worked in the Institute from the start, and bore the burden of all quarrels, complaints and reports together.

Rudolf Iosifovich once told me: "You know, DK and I (he called father DK in that story) were different. We saw eye to eye in some things, and disagreed in other. What you should know, – he said, – is that without DK, there would be no Institute. In dealing with this crowd, he showed his outstanding intellect, his wit, his agility. Of course, many people helped the Institute, but it would be in ruins if not for DK."

Rudolf Iosifovich told me this in 1997, during the Readings on the occasion of my father's 80th anniversary. He had already been living in the USA but came to the Readings and gave a speech in Russian, translating it into English simultaneously. Rudolf Iosifovich passed away a few days ago. May he rest in peace...

This is a good occasion to recall here how the current building of the Institute was populated in the very beginning. This story must remain in the records as the perfect example of personal responsibility. The building was erected in 1962, and before that, its various laboratories were quartered in buildings belonging to a number of other institutes: the Institute of Organic Chemistry, Institute of Catalysis, and Institute of Chemical Kinetics and Combustion. Some people stayed in downtown Novosibirsk in the building on Sovetskaya Street, 20, where it all began. Shortly before the transfer, a gossip spread that the Institute was going to be closed, and the building would be given away to another institute. Father commanded: "We are moving in tomorrow, no ifs and buts!" And they did. This is what I call taking responsibility without fear.

After the relocation, M. A. Lavrentiev summoned father and asked:

– Did you move in illegally?

– Yes I did, Mikhail Alekseevich.

– Good job! Go work now.

No matter how much I speak about Lavrentiev, it will not be enough. Father held him in immense respect and considered him a man of incredible scale. As head of the Siberian Branch of the Academy, Lavrentiev often helped

Left to right: V. V. Khvostova, D. K. Belyaev, N. A. Plokhinskiy, T. A. Toropanova. *May of 1958*

my father; he fought for the Institute and defended it in the face of attacks from Khrushchev's administration. It was Lavrentiev who pushed my father to become an Academician, although father did not see any point in that. A toast for Lavrentiev was raised on all special occasions and feasts in our home.

In 1985, father was elected the academic secretary of the Department of General Biology of the Soviet Academy of Sciences. This turn of events caught him off-guard. He said that when he went to the election he had no idea he was among the candidates. He never intended to get that position and he never worked for it. And suddenly, despite objections from his superiors and promotion of another candidate, father was nominated and elected, and it was a clear-cut victory.

The offer would be a serious career boost and would grant him direct access to many powerful officials. And I must admit that father was extremely flattered, especially because it was unexpected. But he thanked the Academy members, his colleague biologists, and declined. He explained that this position demanded long stays in Moscow, and he could not abandon his Institute for long periods. Moreover, he had plans in Siberia. The plans included the Cherga nature reserve, where he was planning to move after leaving his position as the Institute director. In one word, he turned down the position. Another person was elected.

I did not touch upon the subject of my father's scientific research here. A lot has been written about it, but again, I stress that his work became world-famous by the effort and works of Lyudmila N. Trut. I tried, to the best of my memory and recollection, to tell about his character, his interests, and what kind of person he was. It makes me sad that father never knew, at least in some measure, the degree of recognition his scientific results would receive.

He brought glory to Russian science; there is no doubt about that. Alas, there are so few people like him left out there...

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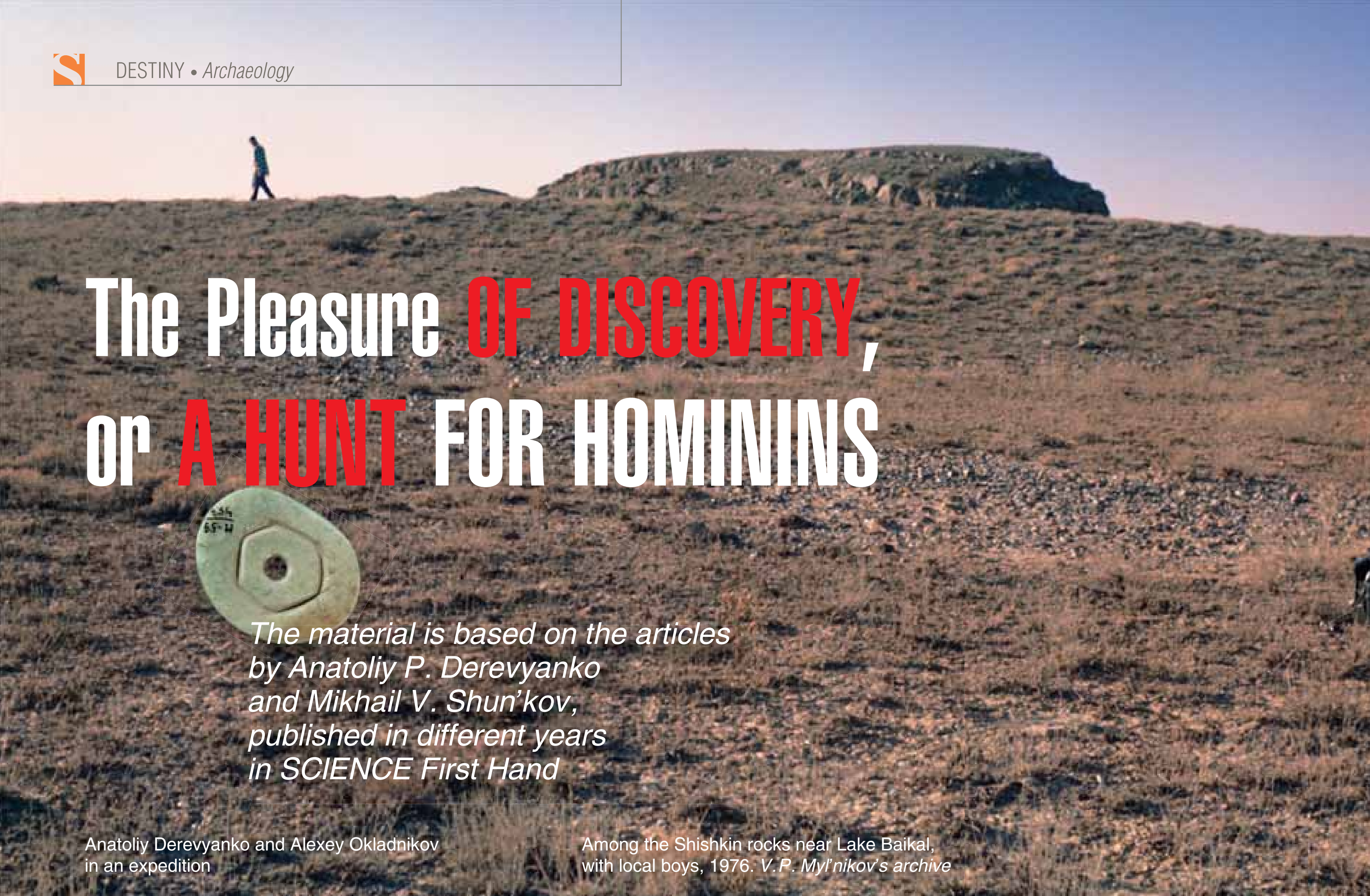
Photographs courtesy of family archive and ICG SB RAS archive



The Pleasure OF DISCOVERY, or A HUNT FOR HOMININS

The material is based on the articles by Anatoliy P. Derevyanko and Mikhail V. Shun'kov, published in different years in SCIENCE First Hand

Anatoliy Derevyanko and Alexey Okladnikov in an expedition

Among the Shishkin rocks near Lake Baikal, with local boys, 1976. *V.P. Myl'nikov's archive*

When Alexey Pavlovich Okladnikov was asked what he valued most in life, he replied it was the pleasure of a new discovery. Recently I was asked a similar question, and I understood that no archaeologist can formulate the gist of our profession better. Certainly, big ideas do not spring out of nowhere, researchers come to them step by step. Any discovery requires numerous validations, which is the usual practice. When we go on expeditions, we do not seek for something absolutely unknown; normally, expeditions are preceded by thorough preparations, especially if the region is new for digging. We study geology, geomorphology, and natural conditions that existed there twenty thousand, two hundred thousand, or a million years ago… Today, discoveries rarely come as a surprise. What you don't expect is the quality of the discovery and a chain of related discoveries stemming from it.

Academician Anatoliy P. Derevyanko

In the late 1930, an outstanding archaeologist, historian, and explorer Alexey Okladnikov made one of his sensational discoveries when he found the remains of a Neanderthal child in Teshik-Tash Cave (Uzbekistan). In spring 2017, a group of scientists from the Max Planck Institute for Evolutionary Anthropology, headed by Prof. Svante Pääbo, announced that they developed a method to retrieve hominin DNA from sediment samples collected in once-inhabited caves. What do these two events, separated by decades and thousands of miles, have in common?

The history of science knows no more alluring and controversial question, a question that would attract universal attention, than the origin of life and the evolution of man. The non-Biblical version of human origin is rooted in the hazy 1600s, when the works of the Italian philosopher Lucilio Vanini and the English lord, barrister and theologian Mathew Hale, with the speaking titles *On the Primitive Origin of Man* (1615) and *The Primitive Origin of Mankind, Considered and Examined According to the Light of Nature* (1671), were published. In summary, by the late 19th century, the idea of man as a product of a long evolution of more primitive anthropoid beings had germinated and ripened. Just one small thing was lacking – to discover this pithecantropos (from Greek pithekos "ape" and anthropos "man") "in flesh," which was done in the early 1890s by the Dutch anthropologist Eugene Dubois, who found the remains of a primitive hominin on the island of Java.

Since that time, another issue, as topical and controversial as man's descent from apelike ancestors, was placed on the agenda: geographical centers and development of anthropogenesis. Thanks to the amazing discoveries made in the recent decades by the cooperative efforts of archaeologists, anthropologists, and specialists in paleogenetics.

1990 Establishment of the archaeological site Denisova Cave

Key words: paleogenetics, mitochondrial DNA, nuclear DNA, hominid, Neanderthal, Denisovan

Until recently, it was only possible to determine DNA sequences and whole genome sequences from present-day individuals from which DNA can be isolated in good condition from fresh tissues such as blood. To evolutionary scientists this is somewhat frustrating because it represents an indirect way to study the past: one studies DNA sequences that exist today, uses the best models we have for how mutations accumulate and estimates what common ancestors may have looked like. This is frustrating because what we have are estimates subject to many uncertainties for example as a result of the mutational models used. However, by the end of the last century the breakneck development of molecular biology had given us methods for retrieving DNA sequences from archaeological and paleontological remains first of Late Pleistocene animals and then humans (Pääbo, 2014).

The first representative of archaic people that became known to science is the Neanderthal, *Homo neanderthalensis*. The Neanderthals mostly lived in Europe but traces of their presence have also been discovered in Near East, West and Central Asia and in the south of Siberia. These short stumpy people, physically strong and well adapted to the severe conditions of the northern latitudes, in terms of the brain volume were on a par with modern humans. In a century and a half that has passed since the first Neanderthals' remains were discovered, hundreds of their sites, settlements and burial grounds have been studied. It has turned out that these archaic people not only made quite advanced tools. According to Okladnikov, the excavations in Teshik-Tash Cave (Uzbekistan) "revealed an unpredicted, truly amazing picture, a picture no researcher had ever seen: the skull of a Mousterian man was circled, once in a strict order, clearly in accordance with a premeditated plan, with ibex horns. That arrangement provided compelling evidence of a rational mind, a logical plan of action, an entire world of ideas that stood behind that action."

No wonder that prior to the beginning of the 21st century, many anthropologists classified the Neanderthals as an ancestral form of modern humans; however, after mitochondrial DNA from their remains was examined, they were treated as a dead end. In 2007, Pääbo's laboratory investigated the mtDNA from the left femur of the Teshik-Tash Neanderthal child and from the bones found in Okladnikov Cave. Their comparison with earlier decoded genomes showed similarity between the Siberian and European Neanderthals.

The Neanderthals were considered to have been forced out and replaced by modern humans of African descent. Further studies have shown, however, that the relations between the Neanderthals and *Homo sapiens* were not as simple as that. Currently, there is no doubt that on the border of the areas populated by these humans not only cultural diffusion but also hybridization and assimilation took place. Today, the Neanderthals are classified as a sister group of modern humans, and their status of "man's ancestors" has been restored.

In the rest of Eurasia, the development of the Upper Paleolithic followed a different path. Let us trace this development through the example of the Altai region, which has produced some astonishing results obtained with the help of the paleogenetic examination of the anthropological findings from Denisova and Okladnikov caves. Paleogenetic studies confirmed that the remains discovered in Okladnikov Cave were Neanderthal whereas the results of the sequencing of mitochondrial and then

on page 133

"One day, we may then be able to understand what set the replacement crowd (the 'new humans,' who replaced the archaic hominins – Translator's note) apart from their archaic contemporaries, and why, of all the primates, modern humans spread to all corners of the world and reshaped, both intentionally and unintentionally, the environment on a global scale. I am convinced that parts of the answers to this question, perhaps the greatest one in human history, lie hidden in the ancient genomes we have sequenced" (Pääbo, 2014)

Academician Anatoliy Derevyanko: "I wanted to be a journalist, but in 1961, I went in an expedition with Alexey Pavlovich Okladnikov and that was it: I became a fan of archaeology forever…"

"Alexey Pavlovich Okladnikov never once vacationed at a health resort in his entire life, not because he was never sick. His whole life was his tireless labor – in the field, in the laboratory, at his desk. <…> When you read his works, you realize that the roots of his success lie in his deep respect and heartfelt care for the culture and history of the epochs and peoples, which seem to have vanished entirely off the face of the Earth. <…> Behind the so-called remnants of material culture, he saw, above all, a man endowed with a soul, thoughts, and feelings, a man who had been collecting, bit by bit, what we now call today."

From the book "Looking for a Golden-Horned Dear" by A.P. Derevyanko (1980)

Academician Alexey Okladnikov, the founder of research school for the history, archaeology, and ethnography of Siberia, the Far East, and Middle and Central Asia

A GIRL FROM THE STONE AGE

…All around us is the opulence the south. Even here, in this somber gorge, this land strikes with its lavishness. Opulence blooms everywhere: in colors, in aromas, in contrasts. Grapes ripen at the foot of the mountains; the never-melting snow blinds us with its dazzling glare from mountain tops.

The cave is dusky though it isn't deep. It descends 20 meters inside the mountain, and its ceiling is 7 to 8 meters high. It seems that enough light should be reaching its interiors. But the mountains… They obstruct the sun. Its rays seldom touch the cave floor. At first glance, it seems strange: Why would the primitive man avoid the sun? But in a moment, the sun rises in the east and ascends higher and higher up the sky. Finally, sunrays reach inside the cave, bringing life into it. Yes, the whole place revives from a huge mass of wasps and bees. Oh! The primitive man had thought about that when choosing a place to live.

<…> The cranium was lying with the crown down. It must have been crushed by a falling clot of earth. The skull was small! A boy's or a girl's.

With a spade and a brush, Okladnikov began widening the dig. The spade hit against something hard. A bone. Another one, and one more…It was a small skeleton, the skeleton of a child. An animal must have found its way into the cave and picked the bones. They were scattered, some of them gnawed and bitten. But when did this child live? In what years, centuries, millennia? If he was a young master of the cave when people who worked stone lived here … The thought was terrifying. If it was so, the child was Neanderthal. A man who lived tens of thousands or even a hundred thousand years ago. He must have a very pronounced brow ridge and no chin.

Teshik-Tash Cave.
Archive of the Institute of Material Culture History (St. Petersburg)

1939 Discovery of a Neanderthal burial in Teshik-Tash Cave

The easiest thing to do was to turn the cranium to have a better look but this would have disrupted the excavation plan. They had to complete the excavations around it leaving the child's bones untouched. The dig around them will deepen, and the bones will remain as though lying on a pedestal.

The archaeologist couldn't sleep that night. He thought about what may come out of that find and sneaked amazed glances at the workers who didn't sleep either. They sat around a fire, arguing… In the morning, Ikram said:

"They are leaving. Don't want to work here. They say: Muslims must not dig out the dead."

What will he do without the workers? If they go back to the *kishlak* [village], no one will ever come here.

<…> The *kolkhozniks* sat down in a circle, their deep, angry eyes piercing at Okladnikov.

He thought: What should he begin with? Should he tell them about the years of searching, about his struggle and determination, stunning to everyone in a man of his age? Tell them about his faith, fanatical faith, which, however, required proof? How he searched for this proof in taiga along the Lena River, near the desolate shores of the Angara, be it rain or heat? How they camped in tents, from the breaking of ice in spring to snowflakes in autumn, sleeping on frozen earth, about ice-cold rivers out of which you come stiff frozen, about clouds of mosquitoes, whose bites made your face burn, and you could barely speak, your eyes and lips swollen, but you couldn't hide from them. Against all odds – they marched further into the taiga, in search for answers, because they believed in the truth of history. In the truth without which people cannot live in this world yet which remains hidden in the millennia.

He looked at the workers around him. Grim faces, mistrustful eyes… They don't speak Russian. No, he must be brief. He must talk only about things that are familiar to them, things they'll understand.

Okladnikov shook his head, as he usually did when he took up on a hard business, and his stubborn curly hair pressed against his forehead.

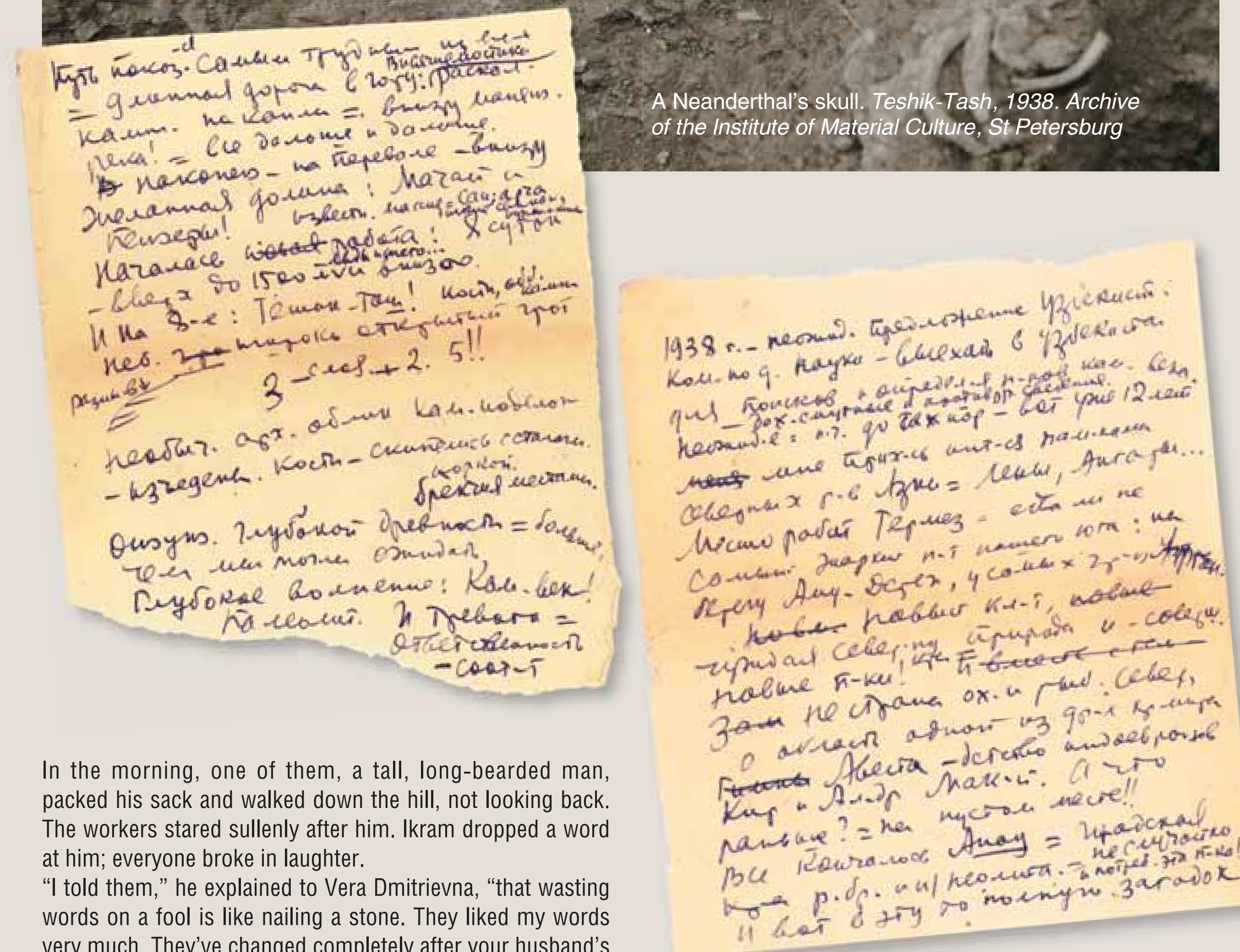
"Long, very long ago lived a man. He was called a Neanderthal. We all come from this man. All people, no matter if their skin is white, or red, or black – all of us are equal, like brothers."

Okladnikov spoke slowly, so that Ikram could translate him. He saw the eyes of the Uzbeks grow warmer; they whispered to one another, shaking their heads approvingly. They were his friends, and he regretted he hadn't told them from the very beginning about himself, about Siberian peoples, about the amazing life of archaic humans, whose traces he had found in taiga. Those men became even closer to him: their fate had so much in common with that of Northern peoples.

"Now ask them: Do they agree to continue the excavations?"

<…> The *kolkhozniks* didn't sleep all night. They sat around the fire, drank green tea, sipping loudly, and argued.

A Neanderthal's skull. *Teshik-Tash, 1938. Archive of the Institute of Material Culture, St Petersburg*



In the morning, one of them, a tall, long-bearded man, packed his sack and walked down the hill, not looking back. The workers stared sullenly after him. Ikram dropped a word at him; everyone broke in laughter.

"I told them," he explained to Vera Dmitrievna, "that wasting words on a fool is like nailing a stone. They liked my words very much. They've changed completely after your husband's lecture."

Then he drawled pensively, looking at Okladnikov.

"In the hands of a true blacksmith, iron flows like water."

An excerpt from A.P. Okladnikov's journal.
Uzbekistan, 1938. St Petersburg Branch, Archive of the Russian Academy of Sciences

The child's bones were left untouched. They were even covered. The archaeologists dug around them, and the bones were on a ground pedestal, which became higher every day. It appeared to be growing from the underground.

The night before that memorable day Okladnikov had trouble falling asleep. He was lying on his back, hands behind his head, looking up at the black southern sky. Far above, the stars were swarming. They were so many that it seemed there was not enough room for all of them. That faraway world inspired awe and at the same time instilled serenity. You felt like thinking of life, eternity, the faraway past and the faraway future.

What could the ancient man be thinking about when he was looking up at the sky? It was the same as it is now. Maybe, sometimes he also had trouble falling asleep, was lying in the cave and looking up at the sky. Did he only have memories or did he have dreams as well? What was that man? The stones told a story but there were many things about which they remained quiet.

Life buries its traces deep underground. Overlaying them are new traces, which with time also go down. And so it happens century after century, millennium after millennium. Life puts layers of its past in the ground. Paging through them, an archaeologist can learn about the doings of the people who used to live here and to determine, virtually without mistake, the times when they lived.

Drawing the curtain above the past, they removed land layer by layer, as time had put them."

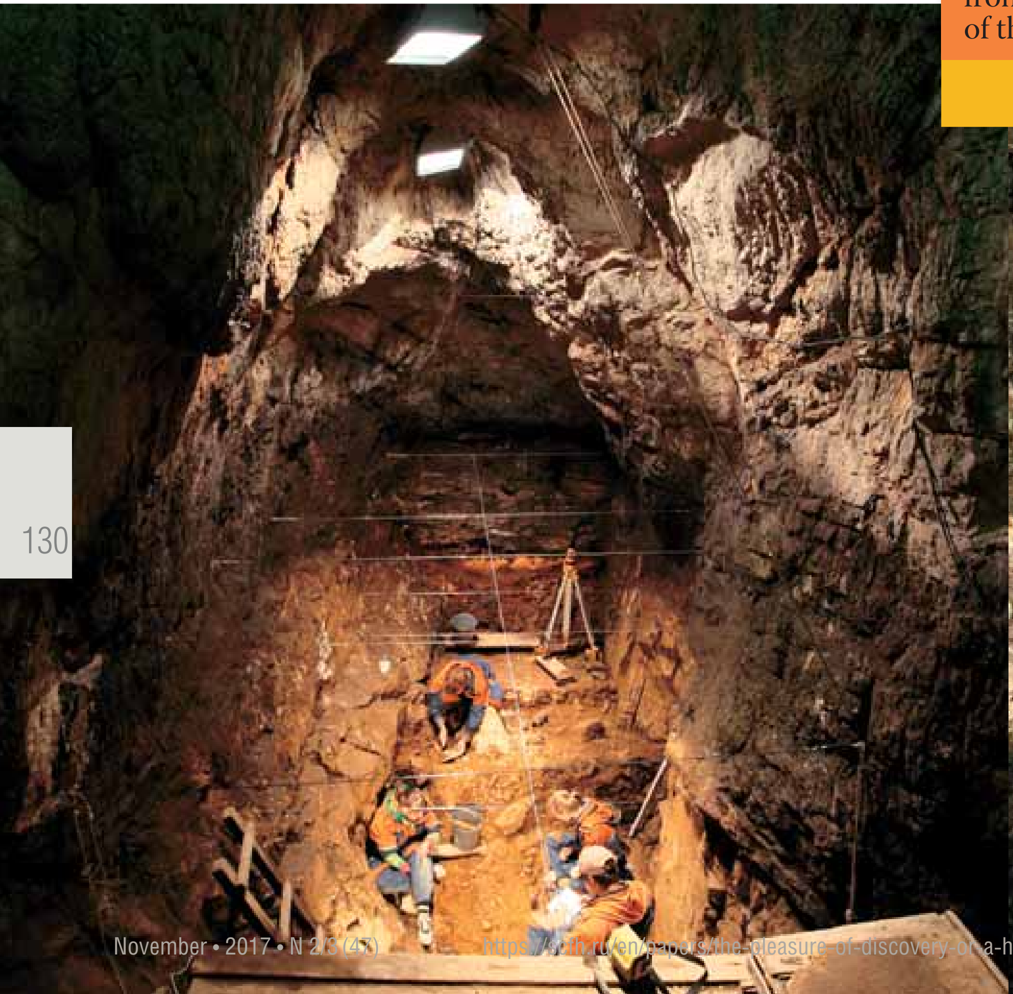
Before starting the excavations, Okladnikov, as usual, dug out a test pit.

The pit revealed five cultural layers, i.e., five layers of earth retaining traces of man who lived there. The layers alternated with sterile ones, which deposited during the periods when man did not inhabit the cave.

Man came to this cave five times and left it five times. What made them leave? Giant catastrophes? The sterile layers contain silt and sand. There are boulders in the cave. Is this evidence of floods? Or, perhaps, man left the cave in search for better hunting grounds? Or a formidable enemy attacked people and forced them out of the cave? And then, again and again, man returned to these amazingly scenic places.

From the book "Along the path of faraway millennia" by Ye. I. Derevyanko and A. B. Zakstelsky

2007 Study of the mtDNA from the left thigh bone of the Teshik-Tash Neanderthal

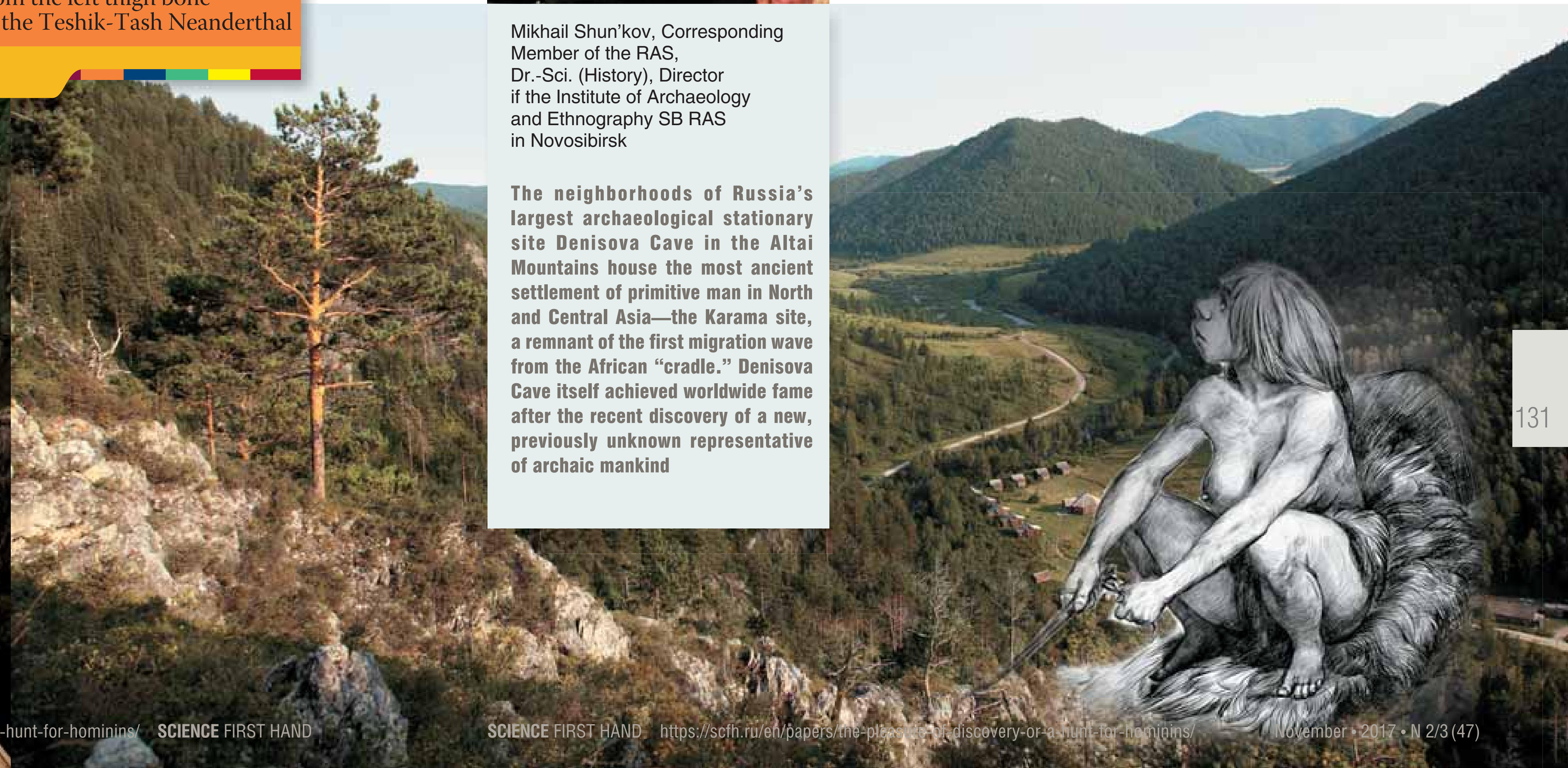


Mikhail Shun'kov, Corresponding Member of the RAS, Dr.-Sci. (History), Director if the Institute of Archaeology and Ethnography SB RAS in Novosibirsk

The history of the Institute of Archaeology and Ethnography in Novosibirsk began from a standing commission to the Presidium of the Siberian Branch of the USSR Academy of Sciences at the end of 1958; its immediate predecessor was the Institute of History, Philology, and Philosophy SB USSR AS, established in 1966. The main organizer of the institute was Academician Alexey Okladnikov, a researcher with an enormous chronological, thematic, and geographical range. Serge Elisseeff, a professor at Sorbonne, once exclaimed in delight: "Okladnikov is a colossus of science!" Led forward by Okladnikov, researchers at the Novosibirsk institute set off to explore virtually all the epochs in the development of human society: from the early Stone Age to the late Middle Ages and the Modern Era. They rummaged large areas in North, Central, and East Asia to discover unique cave sites, primitive settlements, and rock images. Many of these finds and discoveries have become part of the treasure of Russian and world archaeology.

Okladnikov was succeeded at the director's post in 1983 by his student, a renowned expert in ancient history Anatoliy Derevyanko, who initiated a reorganization of humanities at Novosibirsk Science Center. Interdisciplinary studies of Asian antiquities in close cooperation with leading science centers of Russia, Europe, Asia, America, and Australia brought fundamental results, rated among the most outstanding achievements of modern archaeology.

Shun'kov, 2015



The neighborhoods of Russia's largest archaeological stationary site Denisova Cave in the Altai Mountains house the most ancient settlement of primitive man in North and Central Asia—the Karama site, a remnant of the first migration wave from the African "cradle." Denisova Cave itself achieved worldwide fame after the recent discovery of a new, previously unknown representative of archaic mankind

2008 Discovery of a finger phalanx of a Denisovan child

Many-meter-thick deposits in Denisova Cave retain traces of man's life from the Middle Paleolithic to Middle Ages

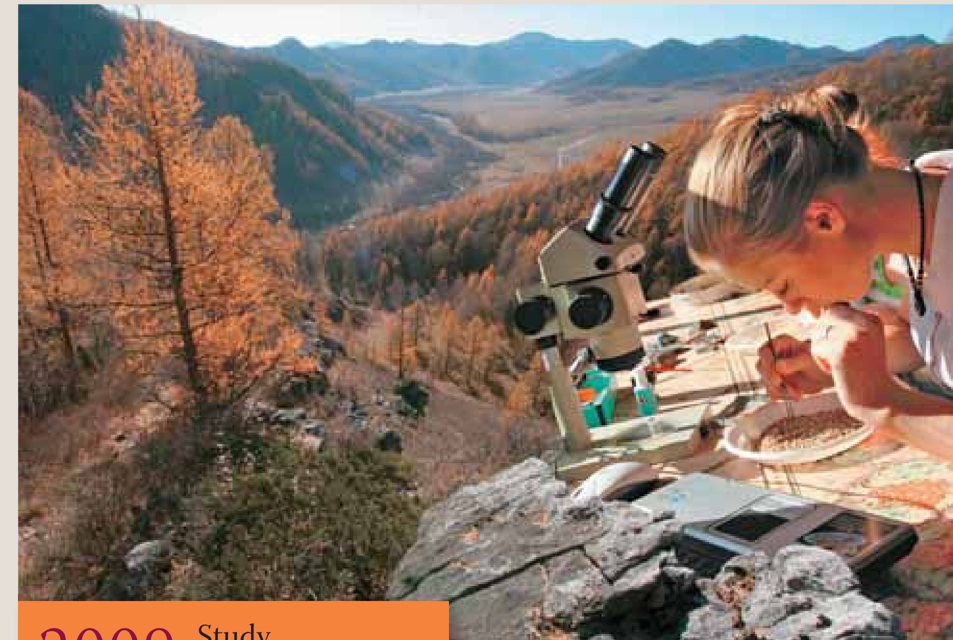
nuclear DNA from the bone samples discovered in the occupation layer of the Upper Paleolithic early stage in Denisova Cave sprang a surprise on the researchers. The bone fragments proved to belong to a new fossil hominin, unknown to science, who was given the name of *Homo sapiens altaiensis*, or Denisovan, after the locality where he was discovered.

The genome of the Denisovans differs from the reference genome of a modern African by 11.7 %, and that of the Neanderthal from Vindija Cave, Croatia, by 12.2 %. This similarity testifies that the Neanderthals and Denisovans are sister groups with the same ancestor, who branched off the man's mainstream evolutionary trunk. These two groups separated approximately 640,000 years ago, taking the path of independent development.

Judging by the archaeological data, 50,000—40,000 years ago, in the northwestern region of Altai two different groups of primitive people lived next to each other: the Denisovans and the easternmost population of the Neanderthals, who came there at about the same time, probably from the territory of modern Uzbekistan. The roots of the culture whose carriers were the Denisovans can be traced back to the earliest sequences of Denisova Cave, as it was mentioned earlier. Interestingly, according to the panoply of archaeological findings reflecting the development of the Upper Paleolithic culture, the Denisovans were not only on a par with the anatomically modern humans inhabiting at that time other territories but in some respects were superior to them.

The discovery of the Denisovan, a new member of the hominin family, is of critical importance for modern science. For a long time, Siberian archaeologists believed that the population that inhabited South Siberia and created the earliest blade industry in Europe had been humans of a modern physical type. However, when the evidence for an unknown subspecies became compelling, scientists realized that the development of modern man followed a much more labyrinthine path than they previously thought. The hypothesis of a linear evolution of mankind, which prevailed in science until the late 1980s, clashed against the new data obtained by sequencing first the mitochondrial and then nuclear DNA and, finally, collapsed.

Based on the currently available archaeological, anthropological, and genetic materials from the most ancient sites in Africa and Eurasia, scientists now trace the origins of humans of a modern anatomical and genetic type, *Homo sapiens*, to at least four types of hominins: *Homo sapiens africaniensis* (East and South Africa), *Homo sapiens neanderthalensis* (Europe), *Homo sapiens orientalensis* (Southeast and East Asia) and *Homo sapiens altaiensis* (North and Central Asia). Evidently, not all of these subspecies have contributed equally to the formation of anatomically modern humans: *Homo sapiens africaniensis* featured the greatest genetic diversity, and it was he who laid the foundation for the modern human. However, the most recent data of paleogenetc research dealing with the presence of Neanderthal and Denisovan genes in the gene pool of modern mankind have shown that the other groups of ancient people did not stand back either.



2009 Study of the mtDNA from the phalanx of the Denisovan

Studying the cave soil. *The archaeological site Denisova Cave*

Huge prospects for further development of the theory of anthropogenesis come from a new paleogenetic method for retrieving traces of ancient people from sediments, which was developed by the international team led by Prof. Pääbo. As of today, researchers have found both Neanderthal and Denisovan DNA in soil samples from Denisova Cave; importantly, they have discovered it in the layers containing no fossil remains. This evidence suggests that archaic people had lived here tens of thousands of years earlier than we previously thought.

Skeletal fragments of archaic people are very rare archaeological finds, so the new way of working with fossil DNA will tell us much more about the time when they lived and about their place of living and migrations. Perhaps, we will even hunt down where exactly the Denisovans lived: an analysis of the genome of modern people indicates that they lived somewhere in Asia, but we yet have no clue as to where and when, and their remains have so far been found only in one place – in Denisova Cave.

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IN SEARCH OF THE LOST GENOMES

The human genome is contained in chromosomes that are present in almost every cell in our bodies. It is composed of approximately 3,2 billion nucleotides. When cells replicate for form germ cell that will contribute to the next generation mutations occur. As a result of these mutations 50 to 200 new substitutions exist in every new individual that is born. These substitutions accumulate in the genome over time to the extent that roughly one nucleotide in a thousand differs between two human genomes today, whereas roughly one nucleotide in a hundred differ between a human and a chimpanzee genome. In addition, duplicated DNA sequences differ both between individuals and between species.

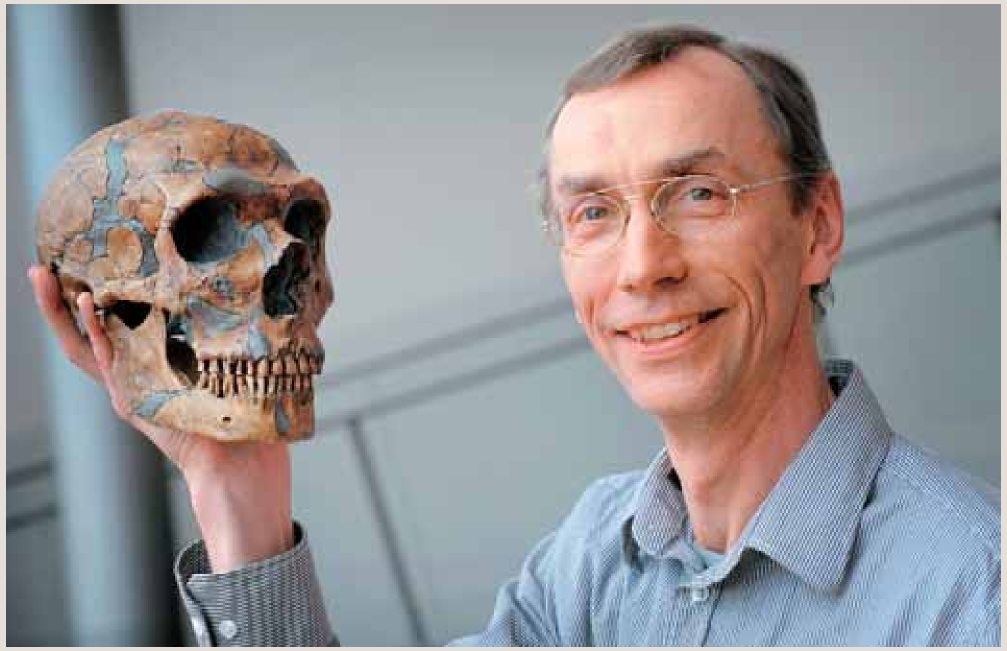
Each particular nucleotide site in the genome has its own history that could in principle be traced back through past generations. Such a history can be depicted in the form of a tree showing common ancestors shared with the same site seen in other individuals today. However, in reality, it is impossible to trace the history of a single nucleotide site. Therefore, one generally traces the average history of a segment of the genome, or the entire genome, and depicts that in the form of a tree that thus represents an average picture of how most sites in the DNA segments or genomes whose nucleotide sequences have been determined are related.

Until recently, it was only possible to determine DNA sequences and whole genome sequences from present-day individuals from which DNA can be isolated in good condition from fresh tissues such as blood. To evolutionary scientists this is somewhat frustrating because it represents an indirect way to study the past: one studies DNA sequences that exist today, uses the best models we have for how mutations accumulate and estimates what common ancestors in the past may have looked like. This is frustrating because what we have are estimates subjects to many uncertainties for example as a result of the mutational models used. Since over 30 years, our laboratory works on methods to overcome this "time trap" by going back in time and retrieving DNA sequences from archaeological and paleontological remains. This is possible only on rare occasions when well-preserved tissues can be found. Direct ancestors of present-day organisms are also almost never available. However, this approach nevertheless opens up new possibilities in that it allows DNA sequences from past populations and extinct species to be determined.

Of particular interest to us is the closest extinct relative of all present-day humans: the Neandertals. This robust form of hominins emerged in Europe and western Asia approximately 300,000 to 400,000 years ago and disappeared between 30,000 and 40,000 ago. The debate concerning the relationships between Neandertals and modern humans and about what happened when they met lasted for decades. One idea was that modern humans replaced Neandertals without interbreeding, in which case the Neandertal contribution to present-day human genetic variation would be zero. Another idea was that Neandertal were the direct ancestors of Europeans. In this case, the Neandertal genetic contribution to present-day people in Europe would approach 100 %. Obviously, all levels of contribution between 0 % and 100 % are also possible, and different levels of Neandertal contribution to present-day Europeans have been argued for on the basis of archaeological and paleontological data.

We got a first chance to directly test these hypotheses in the mid-90s when we were allowed to analyze the Neandertal bones that were discovered in the Neandertal Valley in Germany in 1856 and gave its name to this hominin group. At the time, we were able to draw on over ten years of experience with the development of techniques to extract and amplify small amounts of DNA from ancient remains of cave bears, mammoths and other late Pleistocene mammals (Pääbo, 2014). We focused on the mitochondrial DNA (mtDNA), because every cell contains hundreds or even thousands of mtDNA copies, making it easier to retrieve mtDNA than any particular part of the nuclear genome. We reconstructed the most variable part of the mtDNA and estimated phylogenetic trees to reconstruct the history of the mtDNAs of Neandertals and present-day people. In contrast to the nuclear genome, the mtDNA is inherited as one single unit from mothers to offspring without recombination so a phylogenetic tree for mtDNA reflects not the average history but the exact maternal lineages that relate the mtDNA analyzed. On the one hand these trees showed what was already known, that the mtDNAs of all people inhabiting the Earth today trace their ancestry back to a common ancestor about 100,000—200,000 years ago. But they also showed that the mtDNA lineage of the Neandertal type specimen went much further back in time and shared a common ancestor with present-day mtDNAs in the order of half a million years ago (Krings *et al.*, 1997). Subsequently, we and others have determined several other Neandertal mtDNA sequences. They all fall together outside the variation of the mtDNAs of present-day people. Thus, in 1997, it was clear that for the mtDNA, the complete replacement model held: no person today carries an mtDNA derived from a Neandertal.

However, the mtDNA represents only a tiny part of our total genome. The full picture of our genetic history can only be obtained by studying the nuclear genome. In the early years of this millennium it became feasible to consider sequencing genomes from ancient organisms thanks to new techniques that made it possible to sequence millions of DNA molecules rapidly and inexpensively. We were lucky to receive funding from the Max Planck Society for a five-year effort to improve the technique of the extraction of DNA from ancient bones and making DNA libraries that could be used for high-throughput DNA sequencing. We also analyzed a large number of bones from many sites in Europe to find those bones that contained



Professor Svante Pääbo, Director of the Department of Evolutionary Genetics at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany

the largest relative proportion of Neandertal DNA. We settled on a site in Croatia, from which we used tree bones from different Neandertal individual and sequenced more than one billion short DNA fragments extracted from the bones. We developed computer algorithms to match these short DNA sequences to the human genome while accounting for errors induced by chemical process that have affected them over tens of thousands of years. Only a few percent of all sequences derived from the Neandertal individuals. Nevertheless, in 2010 we were able to present about 3 billion nucleotides of Neandertal DNA that had been mapped to the human genome. Together these DNA fragments covered about 55 % of the parts of the Neandertal genome to which short fragments can be mapped (Green *et al.*, 2010). This was enough to ask if any genetic interaction had occurred when modern humans encountered Neandertals.

If Neandertals made no genetic contribution to modern humans, the Neandertal genome would be equally far from Africans, Europeans and any other present-day populations. In contrast, if present-day Europeans carried the DNA that they had inherited from Neandertals, European genomes would carry fewer differences to Neandertals than African genomes, since Neandertals were never in Africa so would not be expected to have contributed to genomes there. To test this, we sequenced the genomes of five present-day people and identified positions where two of these differed from each other. We then asked how often at these positions the Neandertal genome carried the variant seen in one present-day person and how often it carried the variant seen in the other present-day person. This approach of counting matches to pairs of present-day genomes was necessary since the quality of the Neandertal genome was so low that we could not trust sequence variants that were seen only in the Neandertal genome and not also in one of the present-day genomes. When we compared two African genomes in this way, the Neandertal genome matched variants in the two genomes equally often. This is to be expected since there was no reason to expect that Neandertals would have contributed DNA to the ancestors of any of the Africans. Intriguingly, when we compared a European and an African to the Neandertal genome, we detected statistically significantly more matching to the European genome, suggesting that Neandertals had contributed DNA to the ancestor of the Europeans. Even more surprising was that when we compared a person from China to an African, and a person from Papua New Guinea to an African, we always found that the non-African matched the Neandertal genome more often than the African genome. This was surprising to us since Neandertals have probably never been in China and surely never in New Guinea. How could this be?

The explanation that we suggested and that has since been borne out by work in our own and other groups was that Neandertals met modern humans and mixed with them probably in the Middle East. If these modern humans later became the ancestors of everybody that today live outside Africa, these early modern humans can so to speak have carried with them the Neandertal genetic contribution also to geographical areas where Neandertals never existed. As a result, between 1 and 2 % of the genomes of every person whose roots are non-African is of Neandertal origin. That the Neandertal component in the genomes of present-day people has since been dated by studies of the extent to which Neandertal-like DNA segments have been broken down to smaller pieces by recombination that happens in each generation (Sankararaman *et al.*, 2012). It has also been confirmed by subsequent studies of a modern human that is about 40,000 years old who carries much larger segments of Neandertal DNA than present-day people since they lived much closer to the time of mixture (Fu *et al.*, 2014).

Of course, it is unlikely that mixing between Neandertals and modern humans happened only in one population and exclusively in the Middle East, but given the data at hand in 2010 this was the simplest explanation of our findings. Further insights were to a large extent limited by the comparatively low quality of the Neandertal genome. This was to be changed thanks to our collaboration with Anatoly Panteleevich Derevianko.

The excavations at Denisova Cave, led by Academician A. P. Derevianko and Professor M. V. Shunkov of the Institute of Archaeology and Ethnography of the Siberian Branch of the Russian Academy of Sciences have generated many fundamental and novel insights into human evolution. One of their crucial finds is a hominin toe bone discovered in 2010. When we applied new, ultra-sensitive methods that my laboratory have developed to extract DNA and produce DNA libraries to this bone, we were able to sequence almost 50-fold more endogenous DNA from this single small bone than from the three bones from Croatia that had been used to produce the first Neandertal genome a few year earlier. This individual turned out to be a Neandertal and its genome was sequenced to a quality higher than most genomes determined from present-day, living people (Prüfer *et al.*, 2014).

Using such high-quality genomic information, it is possible to observe differences between the two genomes that the individual inherited from her father and from her mother. One can thus gauge the extent of variation in the population where the parents of the individual lived. One can also estimate how closely related the mother and the father of the individual were to each other. In the case of the Neandertal from Denisova Cave this yielded an unexpected result. The paternal and maternal genomes had long segments of DNA that were identical. This means that the parents of this individual were closely related. One can estimate that they must have been related at the level of half siblings. When in the future further Neandertal genomes are sequenced to the same high quality as the one from Denisova Cave, it will be interesting to see if this was an unusual situation among Neandertals or if it reflects the social pattern typical of Neandertals.

The high quality of the Neandertal genome from Denisova Cave can also be used to estimate what parts of the genomes of present-day people were inherited from Neandertals. This confirms that everybody outside Sub-Saharan Africa carries between 1 to 2 % of Neandertal DNA. This proportion is slightly larger in East Asia than in Europe, suggesting that additional admixture between Neandertals and modern humans may have happened during the colonization of Asia (Vernot and Akey, 2015). To get a perspective on this, you may recall that we all have one half of our DNA from each of our parent, about 25 % from each grand-parent, about 12 % from our great grandparents, and so on. From an ancestor six generations back we have on average inherited about 1.5 % of our DNA. Thus, from the point of view, of the total amount of DNA people today have inherited from Neandertals it is as if they had a Neandertal ancestor six generations back. However, due to recombination that occurs when new germ cells are formed in each generation, the Neandertal DNA is distributed in much smaller fragments than the DNA you have inherited from your ancestors six generations back. You may also ask how much of the total Neandertal genome exists distributed among people living today. This estimate is still very approximate but it would seem that at least about 40 % of the Neandertal genome can be found in people today.

Amazingly, the high-quality Neandertal genome is not the only great gift that Denisova Cave has given the world. In 2008 a tiny piece of the phalanx of a fifth finger of a child was discovered in the East gallery of the cave. We were privileged to work on this find and were happy to be able to generate first a low quality genome (Reich *et al.*, 2010) and then, as our techniques improved, a high-quality genome from it. In this genome, each position in the part of the genome amenable to mapping short pieces of DNA was covered over 30 times (Meyer *et al.*, 2012). When we compared this genome to other genomes, we were surprised to find that it was neither a modern human nor a Neandertal. It shared a common ancestor with Neandertals but this ancestral population lived about four times further back in time than the oldest ancestral population shared among present-day human populations. After discussions with Academician A. P. Derevianko and his team in Novosibirsk, it was decided to name this new hominin group "Denisovans." It is the first hominin group described on the basis of a genome sequence rather than a morphological description. Although remains of Denisovans have yet to be found outside the Denisova Cave, we can learn about their history and the history of other hominins by studies of their genome.

Interestingly, in the order of 5 % of the genomes of people that today live in the Pacific, for example, Aboriginal Australians and Papuans, come from Denisovans (Reich *et al.*, 2011), suggesting the ancestors of these populations met Denisovans and sired offspring with them. In addition, about 0.2 % of the genomes of people in Mainland Asia come from Denisovans (Skoglund and Jakobsson, 2011; Prüfer *et al.*, 2014). By comparing the two high-quality genomes of a Neandertal and a Denisovan that have been determined from Denisova Cave, we can also discern gene flow events that have occurred between these two groups and other gene flow events that have affected these two groups differently. A minimum of two additional instances of gene flow can be detected by these comparisons: one from eastern Neandertals into Denisovans, and one from an unknown hominin that diverged a million or more years ago from the human lineage into Denisovans (Prüfer *et al.*, 2014). In addition, recent work shows that early modern humans in Europe mixed with Neandertals when they first arrived there (Fu *et al.*, in press).

The emerging picture is thus a complicated one, where many different hominin groups exchanged genes with each other on what must have been many occasions. Often this exchange was of limited magnitude but it shows that the gene pools of most or even all hominin groups in the Late Pleistocene were open systems that allowed genetic variants to spread from one group to another. One interesting question then becomes of this may have been of functional importance. As yet, we do not know much about this, but I want to bring up a few examples of what has emerged from studies by several groups in the last two years.

One way to ask what functional role Neandertal genetic variants may play in present-day genomes is to ask what the genes are that carry Neandertal variants that have risen to high frequency. The fact that these variants have become frequent today may suggest that they were positively selected in the past. The group of genes that is statistically overrepresented in such genomic segments are keratins, i. e. structural protein in present in skin and hair (Vernot and Akey, 2014; Sankararaman *et al.*, 2014). Thus, it is likely that in the future we will find that some aspect of the morphology or function of skin and hair that is present in some people in Europe and Asia derive from Neandertals.

There are also aspects of metabolism that are affected by Neandertal variants. For example, Europeans but not Asians carry more Neandertal variants than statistically expected of genes involved in the catabolism (Khrameeva *et al.*, 2014). It is not yet known what these variants do but it will hopefully be discovered in the next few years. Interestingly, a variant of the gene encoding a protein that transports lipids across cell membranes and is derived from Neandertals has risen to a frequency of up to 35 % in East Asia and Native Americans. This variant is associated with increased risk to develop type 2 diabetes (SIGMA Consortium, 2014). It may seem surprising that a Neandertal gene variant that confers the risk of disease has become frequent in the population. One may speculate that a variant that causes diabetes today in people who enjoy ample nutrition throughout life may have represented an advantage in a situation of food shortage. Thus, this gene variant may represent a Neandertal adaptation to starvation that in the past was advantageous also in modern humans.

Have Denisovans like the Neandertals contributed functionally to present-day people? Recent work suggests that this is the case. The population in Tibet carries genetic adaptations to life where the partial pressure of oxygen is low, as is the case at high altitudes on the Tibetan High Plateau. The major gene variant responsible for this adaptation affects the number of red cells in blood and occurs at a frequency of about 80 % in Tibet but is very rare elsewhere in Asia. Last year it was shown that gene variant is likely to be inherited from Denisovans (Huerta-Sánchez *et al.*, 2014). Thus, it seems that the gene flow from Denisovans has contributed to making life at the high plateau in Tibet possible. Similarly, there are indications that gene variants important for how the immune system deals with infectious diseases may have been acquired both from Denisovans and from Neandertals (Abi-Rached *et al.*, 2011).

There is thus a picture emerging where Denisovans, Neandertals and possibly other archaic groups who had lived in Eurasia for hundreds of thousands of years and had adapted to local environments met and mixed with modern humans on many occasions. This gave modern humans the opportunity to acquire locally advantageous gene variants from these groups. This is a phenomenon often referred to as "adaptive introgression" in other species (Hedrick, 2013) which may have been of some importance for modern humans as they colonized new environments throughout Eurasia (Racimo *et al.*, in press).

In summary, the fact that a gene flow has been detected not only from Denisovans and Neandertals into modern humans but also between various other hominin groups shows that these were not closed genetic systems. They may best be regarded as a "metapopulation" – a web of populations that included Neandertals, Denisovans, modern humans and other groups, which were linked by but an intermittent or sometimes perhaps even persistent gene flow (Pääbo, in press). In this metapopulation gene variants spread directly, but also potentially indirectly between groups who were in contact with each other over other groups.

These results support the idea expressed by Academician Derevianko already in 2005 when he said "Dear colleagues, please do not offend Neanderthals.

They are among our ancestors!" (Derevianko, 2005). The analyses of the genomes from Denisova Cave have shown that this generous attitude was correct and should be extended to Denisovans and perhaps also other hominin forms.

From: (Pääbo, 2015)

Drawing by N. Kovalev

The Ukok diary

N. V. POLOSMAK

1993 The frozen grave of the "Altai Princess" is discovered on the Ukok Plateau

In 2004, the State Prize for Science and Technology was awarded to Doctor of History Natalia V. Polosmak and Academician Viacheslav I. Molodin, both affiliated with the Institute of Archaeology and Ethnography, SB RAS, for their discovery and investigation of the unique Pazyryk monuments dated 4th-3rd cc. BC on the Ukok Plateau in the Altai Mountains. Found at the intact "frozen" burial site was a woman's tomb with a remarkably well- preserved woman mummy and rich mortuary inventory

With each successive thawed layer of the ice tomb, the time was going backwards taking us further and further away from the modern age. Ukok contributed to this feeling through its solitude, aloofness from everything that was important on the mainland and strange, Indian-like names of mountains, rivers and settlements: Ak-Alakha, Chindagatuy, Bertek, Moinak...The silence around us was pristine, disturbed only by the remote drone of the engine at the frontier post. At night everything froze: the lake had an ice skin, small flowers and grass blades were covered with ice... With sunrise, however, everything went back to life. This daily return of life after the night's cold was a stunning feature of Ukok!

The taste of rhubarb jam

I understood just recently why it is so difficult for me to recall that time: it appears that I can hardly remember any events. Evidently, something did happen in the camp: people would come and go, every day we ate something, slept some time and talked to somebody. Nevertheless, it did not go deep or left any trace in the memory; rather, it seemed a vexing distraction from the main thing that commanded full attention. When they tell me something about the events of those years, I can recollect that, indeed, there was a helicopter that brought us a fridge and gas masks and then took them back. Also, a doctor with a ludicrous (given the situation) specialization flew in, and some other amusing

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Key words: "frozen" graves, Gorny Altai, Pazyryk culture, Ukok plateau, woman mummy

Ukok, photo by K. Bannikov

Photo by V. Novikov

things happened, which now touch me deeply because I understand that it was because people cared about us, worried about us and wanted to save us God knows from what.

And who could know what should have been done in that situation? We were the first. Of course, there had been S. I. Rudenko, who had dug the "frozen" Pazyryk graves in the early 1960s, but ours was a different time with different resources...And the main resource was the helicopter. I wish to sing praise to it and its pilots who would come to us over the high snowy mountains, with or without loads, in the bad and very bad weather, and we would always wait for them because they were our connection with the mainland that appeared to be so far away. It seemed as if we were on an island lost in the ocean, and sometimes the waves would wash ashore bread, tins and letters, and one day they even cast ashore gas masks and a fridge.

The events occurring around us and related to the routine camp life (if the word "routine" may apply here) had no impact at all on what was happening in the interior of the burial pit – every minute of our existence belonged to it, and it was the pulse of my life. Looking back now, I realize that this immersion into my own feelings and experiences was within an inch of a trance, when the world shrunk to the ice lens at the bottom of the grave. In the meanwhile, the camp lived its own life: entertained guests and celebrated birthdays, went on outings to pick up rhubarb and make rhubarb jam, Ukok's longed-for delicacy.

The composition of our party formed in an inexplicable fashion and seemed phantasmagoric, too. Again, this was the spirit of the times; it reflected the surrealistic situation of that summer in Ukok and was a projection of the strange turns of fate that occurred in the lives of many participants of these events.

What brought Genny from Harvard University there and why did she take root in our camp? It escapes me. This lady astounded us when she picked up in her arms our biggest fellow, Pchela (nickname for his surname "Pchelintsev"), spun round with him and carefully put him down on the ground. Funnily, after this incident he sank in our eyes and no longer seemed as macho. She could catch logs with unfaltering hand and was up to reining up a horse if she felt like it.

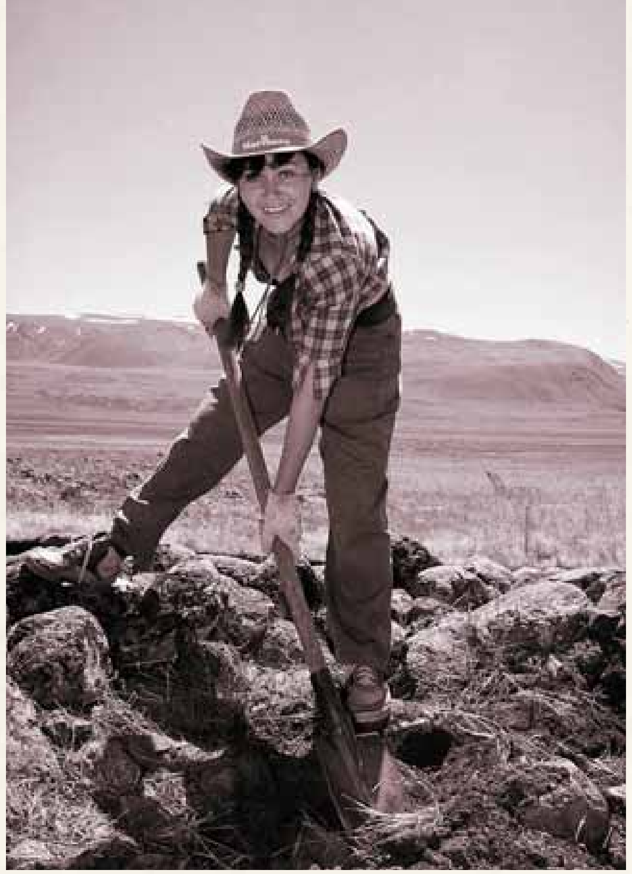
There was wonderful Frau Gerda, a very nice German woman with an amazing vibe of an eighteen-year-old girl. She had come to Altai as a tourist and was bogged in our camp. She got stuck in all our routines. No other frau would have stayed: she fitted in thanks to her outstanding personality. She always tried to be useful in that way or another, either by cooking something very German or by cleaning the bones of the Pazyryk horses extracted from the tomb. At night, she would stay by the fire "until the last customer," and at the farewell party volunteered to act the part of the mummy – or the Lady, as she called her – rolled in a sleeping bag, she gave us a truly creepy show as she popped out darkness. I wonder where she is now, after so many years. In Germany, people live long and I do hope she is still fine.

We did have a great team, very friendly and tight-knit. One day, a Japanese girl, Tei Hatakeyama, appeared in our camp, brought either by helicopter or by the wind – so tiny and zephyrian she was. Just came out of thin air, and that was it. "A mirror image of a netsuke," commented Kostya Bannikov with his love for everything Japanese (he was learning Japanese at the time). In Japan, Tei was a postgraduate studying animal style, if I remember it rightly. It did not matter though. In the camp, she never left the "frozen" grave. Whenever we lifted our eyes up from the bottom of the pit, we would always see not the sun but Tei's little face and the just as interested snout of my spaniel Pete. Sometimes, they could not take it any longer and fell down into the pit. Pete would just jump down, having had enough of being just an observer, and Tei would very politely plead to please go down to maybe help in some way and touch that ancient ice. Having received the go-ahead, she would climb down and stand reverently by in her sopping wet canvas shoes.

Then, there was Karla. If you ask me how this German undergraduate came to us and why she stayed, I cannot answer. People used to materialize and walk through our life like shadows but some of them stayed in flesh and blood. They were accepted for some reasons unclear either to them or to us and thus became part of the Ukok family. This was the case with that German girl – she stayed, and we still keep her detailed drawings of the horse harness found in the mound.

Matthias Seifert was an invited dendrochronologist. God knows what he had been expecting when he was flying in, but it looked like the reality disagreed with his expectations. For a Swiss guy, mountains and glaciers were old hat but Ukok had something that stirred the blood and made the months spent there the best ever lived. When Matthias, who had taken on the look of a regular village guy, was flying out, he was crying. Though everybody promised that we would definitely see him again, we all understood that it would be very different. We did meet, but that was a different life and different meetings.

Matthias did a great research into the dendrochronology of the Ukok kurgans. Thanks to him, our research institute has its own dendrochronologist, Igor Sliusarenko. Having seen Matthias at work, Igor could not resist it. He realized



Elena Kuznetsova, historian with the Research and Development Center for Preserving the Historical and Cultural Legacy of the Novosibirsk Oblast, participant of Ukok expeditions:

"I was lucky: I happened to be in Ukok when I was an undergraduate, during our field-period on archaeology. As I recall it, everything about this expedition was a surprising adventure and luck: our start from the Open-Air Museum in Akademgorodok, the first helicopter trip in my life, the amazing scenery of highlands... A true archaeological party and its head – a young good-looking woman, rigorous academic research and camp life, Scythian kurgans and a camera crew of NHK, a Japanese television broadcasting company. In my school day, after the lessons of the history of Ancient Egypt and Ancient Greece, I decided that I would be an archaeologist and was even going to join an archaeology study group. Shortly, however, I switched to something else and forgot all about my dream until I happened to come to Ukok.

After the Ukok excavations, it was impossible to leave behind archaeological expeditions. Several years in a row, having taken the exams beforehand, our united expedition party would board a helicopter and go deep in the mountains to take part in unique archaeological excavations. The end of the field season was an unpleasant surprise; all we could do was wait for the spring to come suddenly to Natalia Viktorovna with the habitual question: "When are we off?"

Anton Luchansky, a TV journalist of GTRK (Russian abbreviation for the "State Television and Radio Company"), participant of Ukok expeditions:

"For me, as well as for many of my fellow historians, Ukok became an unforgettable emotional experience that can never be repeated. Not only because we became older but for lots of other reasons, too.

When in the very beginning of the 1990s we came to the Kosh-Agach district, we plunged into the atmosphere of a true scientific inquiry. Adding to the bunch of vivid impressions were the pristine nature of the uplands, Spartan conditions and a glimpse into the local traditional culture.

The summer of 1993 was one of the strongest impressions of my youth. That year, my good friend Kirill Lugov and I were getting to Ukok on our own. It was an adventure full of intriguing twists, meetings and happenchance. When we finally got to the camp in the frontier guards' car, everybody was agog as they anticipated a big discovery, even a sensation: the archaeologists had hit an ice lens in a regular burial mound. And a sensation it was – for a couple of months, the plateau lost at the crossroads of four borders became a site that attracted experts of different fields and journalists from all over the world. As for us, we were happy to feel part of an important investigation.

This is how the Scythian mummy became a fact of my biography and archaeology turned into a life-long passion. Even after I went to television, I continued going on expeditions, though in a new quality. Now my task is to tell viewers about archaeology, a challenging but fascinating occupation."

Drawing by Anastasia Abdulmanova

Elena Shumakova, an artist, Institute of Archaeology and Ethnography (Novosibirsk), participant of Ukok expeditions:

"During our first season Ukok seemed to be another planet, huge and unexplored. We had a haunting feeling of an alien presence, of being watched. I think it was partly because there were so few of us on that immense "serving plate" – the mountainous plateau with nothing but stars above it. The border guards, with their sudden apparition and just as surreal vanishing in the local scenery and the beam of the searchlight going along the barbwire contributed to the mysteriousness and made us think of the Zone from *Stalker* by Andrei Tarkovsky.

I was deeply impressed when, having placed the clothes and fragments of clothes lifted up from the tomb into photo cuvettes, we (Natalia Polosmak and the author –Ed.) rinsed them in the water of the nearby lake to get rid of the marks of decay. In fact, we just did some washing for a person who had lived a couple of millennia before us. Could that person (or we) imagine such a thing happening? The time reduced to nothing, and millennia became an instant.

For a long time, this story remained my "inner experience": anticipating the restorers' displeasure, we kept it to ourselves. One day, however, having mentioned this episode in Abegg-Stiftung, a well-known restoration center in Switzerland, I received surprising support. It turned out that it was the water of the glacier lakes of the plateau that had preserved and "brought" to our days the unique content of Ukok's frozen burials."

Photo by V. Novikov

that his calling was not ceramics he had been involved with but that fresh wood. Today, he has been working with it for almost quarter of a century.

At that time, many things changed, both in our lives and in our ideas about the job, archaeology. The archaeology was different, both technically and emotionally. We were saturated with the "grave smell," the tenacious smell of the organics that had been decaying for over two millennia and had been purified by ages. It was the smell of the wet clothes on the interred woman, the odor of the wood of the tomb chamber and log coffin; it was the aroma of the bygone world. We lived in two dimensions: in the Pazyryk world that shrank to the five by three meter pit and in the modern world, our camp. The ancient world seemed much closer and more real than the modern one, an unwanted break before the everyday return to the enchanting and unpredictable past.

The saddest day was the day when we lifted the woman mummy from the log coffin and carried her on the custom-built stretcher to a small house in the camp, where she had to "wait" for the helicopter that would take her to Novosibirsk. That was the end of the first part of this story – and the second part has spanned more than twenty years and seems to have no end in sight.

A friend of mine, an ethnographer from Altai, said, "If She had not wanted it, you would have never found Her." I agree. But if She had wanted it, what for? I have been thinking about it all these years and I am sure it was not for that hysterical campaign that we have been witnessing in Altai. No, that would be too trivial. She has come to tell us something important for us, and our task is to understand how we can hear this story about herself, her culture and her time.

In fact, this is what we have been doing for almost 25 years: we have been "listening" to her story. If we accept that life does not end with physical death, we can say that her destiny is fortunate. After more than two thousand years of oblivion, she has become the life-breath of writers

and artists; films are made about her, fashion designers create collections based on her costume; dozens of people throughout the world copy her tattoos; a new mythology has developed around her...In fact, we gave her a second life. This may be the meaning of her apparition in a frozen grave on the Ukok Plateau...History needs personalities. When we talk about those unspeakably remote times with no names, for lack of something specific we have to resort to such concepts as "archaeological culture," historical "community," and so on. Then, the apparition of a concrete person from there becomes a miracle that breaks our abstract notions expressed in terms, making those times part of the continuous life, in which we so far are the last, they used to be the last, and soon somebody else will be the last.

Photo by V. Mylnikov

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K.L. BANNIKOV

The Arbiters of Eon

"If you're not interested in archaeology, it doesn't mean that archaeology won't someday be interested in you," once wrote on my bathroom's wall a man whose school nickname Archaeologist would become his profession.

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Between ethics and aesthetics. Above the sea level, so to speak

Raimbek is a hospitable man, but he doesn't talk much. Why should he? To feel a person, you don't need to jabber. If you happen to be Raimbek's guest, you shouldn't think your host is so taciturn because you've done something wrong. If someone doesn't talk to you, it doesn't mean they don't feel you or aren't happy to see you. And the other way round. We, the denizens of large cities, have become so used to the never-ending *how-are-you* and *what's up* as well as to the fact that everyone couldn't care less about how we truly are. But here it's all clear *how*. If you're alive – you're doing great, so why babble? Idle chatter is nothing but a snag for true feelings.

Once we called on Raimbek and drank tea in silence. It was only when the long-awaited drone of a helicopter roared in the distance that Raimbek decided: this occasion was worth a word of mouth. He paused for a second and uttered, laconic as an Indian, "Now!"

The helicopter brought the main squad of archaeologists, for whom we, the leading party landed on the Ukok Plateau in the Altai Mountains a month ago, had grown impatient of waiting.

What – you've heard nothing about the Ukok Plateau? About the tattooed Scythian horsemen, remarkably well preserved in permafrost? About their beloved beasts – the numinous griffons – an ornament that they put on everything worth decorating? About the real griffons that sometimes fly over to Ukok from the neighboring Mongolia? About the Ak-Alakha River, whose water is like milk? About the sunsets projecting gods' dreams on snow-capped peaks? Then I do envy you: the "hard drive" of your subconscious mind has still a lot of space.

In truth, archaeologists had long known about Ukok, but they began to dig there systematically only in 1990, when an expedition from Novosibirsk excavated the first mound to discover a double grave of Scythian warriors. Their bodies did not survive, only the skeletons. But the garments, the felts, the quiver – all these finds were in excellent condition.

This culture, called the *Pazyryks* – after its first place of discovery – stands out for its remarkably well-preserved organics. All thanks to the Scythians, tough guys, who dug three-meter-deep graves in permafrost and banked over them colossal mounds of rocks and boulders. Since they did all this high up in the mountains, ground- and rainwater that filled the burial chamber did not melt during summer: everything that froze there froze forever.

Apart from permafrost, other factors contributed to the outstanding preservation of the mound: the acid–base balance of the soil; the time of the burial; intrusions

Key words: "frozen" graves, Gorny Altai, Pazyryk culture, Ukok plateau, woman mummy

Drawing by Anastasia Abdulmanova

of robbers, not only the so-called tomb-raiders of modern days but also ancient grave robbers, driven by mystical, rather than mercenary, motives.

Finding a mound with an optimal combination of all these factors is a big try. More truly – no matter how hard you try, you won't find one because this kind of luck can only be granted by spirits willing to unearth a long-hidden secret. This is the metaphysics of archaeology according to a well-known Siberian shaman Bair Richinov.

Ethical issues, relating to metaphysics, are our constant source of worry. Is grave-digging ethical in relation to those gone to the next world, or they don't care? Do excavations bring harmony between that world and this one? Or strike a discord? Is scientific search a legitimate cause for curiosity? Won't our thirst for knowledge about this world bounce back at us in the next one?

Material things exist in space; their mental images exist in time. Forgotten things do not exist. Creators and owners of things disappear together with their creations and belongings. Archaeologists do not simply grub the ground – they breach through time, unearthing ancient things, those material clots of world-culture history, and patch holes in the walls of our world. Archaeologists – the arbiters of Chronos and Topos, the priests of Clio and Urania – recover the ideas about the world that are materialized in things, pulling them out of oblivion.

Therefore, the metaphysics of archaeology is the sole purpose of its geek participants – such rare yet 'do-it-all' workers as a senior laboratory assistant. So, to dig or not to dig? That is the question. But not to us or to the skull of another "poor Yorick," whose yellow bone has emerged from under the shovel.

Here comes the world fame

When our boss Natalia Polosmak, back then a PhD at the Institute of Archaeology and Ethnography in Novosibirsk, decided to excavate the mound, that would soon make history, a well-known archaeologist, professor Vyacheslav Molodin, who also happened to be her husband, said, word for word, "Normal mounds aren't enough for you?" A scientist demonstrated scientific skepticism. However, archaeology, the most materialistic of all sciences, hinges on one nonmaterial circumstance – Fate. From Fate's point of view, Natasha, who had learned to trust her intuition, saw it better. And the ordinary, totally unremarkable mound was excavated.

We opened the burial chamber – a larch vault. Inside we saw pure ice, white, in sign of our pure thoughts, totally opaque. So we thought: No celebration yet. Anything could be inside. As well as absolutely nothing. Robbers might have rummaged the grave before the ice formed, filling an empty vault.

A week went by with us sitting on ice in a pit, then another week... We tried to melt the ice, we poured hot water on it, but the frozen monolith didn't seem to end. The spirit of scientific skepticism electrified the atmosphere so one could charge batteries in this air.

"O-o-oh, it's all so bad! We'll find nothing but ice!" moaned Lena Shumakova, the world's best archaeological artist.

"A-a-ah, what will I write in my report?" our boss repeated worriedly.

"U-u-uh, we're all gonna die!" screamed Ira Oktyabr'skaya, the great ethnologist of Asian peoples, when she saw me cut bread with a knife I used to poke ice in the grave.

"All systems have an end," I snapped back, wiping the knife on my insect-protection suit, which I, by the way, didn't change after work since I only had one.

Ira rushed out to vomit, while we continued our lunch, exercising in grave humor.

Episodes and characters

We didn't have any communications. Neither did we want to. It was a mythological era, when satellite phones weighed and cost like satellites, and mobile phones weren't something regular folks would normally have. So we, like many of those who found themselves in similar circumstances, lived in the reality of most primitive communications and sent word to the world by means of couriers, messenger pigeons, and visiting academics. But somehow this was enough for rumors about our find to spread even before it finally thawed.

Those in the big world knew what we found here and were highly sympathetic, helping us in every way they could. They sent us parcels with items they thought were indispensable. We were doing just fine when, all of a sudden, a helicopter unloaded a big box full of gas masks with a cheer-up note that could make the spirits weep.

"What the hell?!" was the group's response.

"Could this be about the ancient bacteria?"

"U-u-uh, we're all gonna die!" Ira blubbered and whisked away.

Hardly had we sent the gas masks back, with our thanks, another helicopter brought us a fridge, a big new Stinol.

"And what the heck is this for?"

"To freeze the bacteria?"

"Maybe to keep the mummy?"

"But there are shelves inside!"

"We can break the shelves."

"Why break a good thing?"

"Okay, but where are we supposed to switch it in?..."

So the fridge flew back too. In return, we received a live medical man.

Ooh-la-la!—a radiant, fashionably dressed dandy fluttered out of the helicopter. He introduced himself as an urologist and made a dirty joke.

"Another intrasocial monster," Dimka aka Archaeologist muttered disapprovingly about the urologist. He was generally disapproving of urologists.

However, the doctor soon flew away, once he realized that we didn't need him. As a farewell gesture, he made an appearance at the excavation site and declared that the "patient," i.e., the mummy of a young woman, had suffered from lepra, when still alive.

Don't know about the others, but I was head over heels with joy. Hurrah! We were all gonna go to a leprosarium! For such an occasion, I put on a raincoat of vibrant green color, made a bell from a tin can and fastened it to my leg. Adorned like that, I came up to Ira:

"Ira! Our 'client' had lepra. We're all gonna die. So let's now kiss!"

Then arrived another fancy Dan. He emerged from the helicopter, exquisitely dressed in a safari suit, looking like a beau from a men's magazine. "Hi," he said. Okay, hi yourself. And who the heck are you?

The fancy Dan turned out to be a Matthias from Zürich, a dendrochronologist. He got wind of the ancient logs, sharpened his saw and rushed up here.

To be fair, a week later all that remained glossy about this guy was his Hasselblad, his other glamor gone with the wind, like pollen. All because Matthias was a right guy, open to assimilation.

We are standing on the lake shore, like three *Alyonushkas* from the Russian fairy-tale, pondering over the unfair distribution of substance in nature. So much water, and nothing to dissolve it with. Near stands Matthias, with a week's growth on his jaw and sacks under his eyes. Dressed in a most indigenous undershirt and *kirza* boots. His eyes are full of sorrow. So much water not dissolved with alcohol...

"Matthias," drones pensively Shura Pavlov, a scourge for computer monsters and an ex-deputy-dean of the Department of Law at Novosibirsk State University,"... you... are... You're looks like Russian... Russian alcoholic."

"*Cha-a-arma-a-ant*, <...>" drawls Matthias, just as pensively.

We all keep gazing at the water...

One more episode.

"Hey you, string the tent!"

"Let's drink! *Razlivai*!"

"*Arigato gozaimasu*," responded a Japanese girl Tei Hatakeyama-san from the Tokyo Museum of Literature to a half-cup of almost pure alcohol, only slightly dissolved with water, and began to sip it like sake, gripping the cup with both her little hands.

Hatakeyama-san was, essentially, 32 kilos of biomass, together with her glasses and mountain boots. But a drop of alcohol didn't kill a mouse. Even Anton Luchansky, a famous musician and TV reporter, had exorcised the demons from the tent and threw out the oil stoves, but Tei kept sitting, like a *netsuke*, smiled and chanted, "*Arigato gozaimasu*."

"O-oh, she is a true daughter of a samurai!" uttered Archaeologist, magnificent in his brutal machismo, and patted the little lady on the back.

More truly, he was about to pat her... The girl dropped on all four and crawled out of the tent, pattering "*Hazukashii*," which could be translated from Japanese in this context as "Sick! I'm sick!"

By morning, all of us were *hazukashii*. But the Japanese Thumbelina, having recalled whose daughter she was, gathered all her willpower and made it first to the excavation site.

Grave for National Geographic

One day, the smell of the thawed organics, promising a sensation, dragged the team of *National Geographic Television*. We could smell that someone extraordinary was flying from the way the helicopter was cruising the air, making aerobatic stunts. We saw an open access door and a cameraman in white pants and jackboots, taking a shot.

"Kill you all," muttered the officer Vovka from the frontier post, who had raced up on a pregnant mare.

"Welcome, dear colleagues," the translator rendered Vovka's words in a politically correct way.

Together with the television team, the helicopter brought people from the *National Geographic* magazine – a photographer and a writer. The entire herd set up a camp at the excavation site, not to miss a thing. Even before the start of a working day, one of producers would roam near the mound, soon followed by the rest of the team. All of them longed for "action" because, from a filmmaker's point of view, the monotonous archaeological process

Drawing by Anastasia Abdulmanova

always lacked something, be it dramatism, optimism, pessimism, mysticism, sado-maso-eroticism, or other sorts of dynamism.

One pastoral morning, they had it all. That morning began in a most ordinary way, with the drowsy scooping of water that drenched into the pit from the thawing permafrost. Exactly when we dipped out the last drop of water, the southern wall of the grave crashed. Those who know something about the structure of Scythian mounds should now freeze in anticipation of a dramatic denouement because this crash meant that the wall could have well crushed on the mummy. And it would have if our squad hadn't been prepared for any mishap. The wooden block with the mummy had been shielded with large wooden sheets, which caved in under a tonne of pebbles.

An ethereal projection of the NG producer was fading at the edge of the pit, he himself rushing at full speed towards the camp to summon his team. Soon the whole world would know that the pit wall had crashed on our watch.

"*Hazukashii*, idiots! Get out the ground!" shouted someone in our group.

At the horizon, shrouded in a cloud of dust, the entire television team was rushing towards us. Rich, the cameraman, was hastily chewing his sandwich and adjusting the white balance in his camera. Ralph, the sound engineer, was putting on his earphones with one hand, attaching a fluffy mouthpiece to a stick with his other hand and tying his shoelaces with a third one. The light directors and assistants were unfolding reflector screens. The producers helped and spurred them in every way.

"Hurry up, guys!"

They were approaching, and our shovels whirled like fan blades. If an independent expert from an anomalies committee had happened to be there, they would have discovered that the teleportation of a cubic meter of ground to a distance of a dozen meters was possible. It's pity that it was the filmmakers from *National Geographic* that witnessed the teleportation phenomenon. When they finally hovered over the pit, they could only shoot a brush gently sweeping the logs in a most pastoral way.

Last adventure of the biological structures

The withdrawn bodies and objects, which had spent in ice 2,500 years, were to be preserved for future generations in the same form as they were discovered, or even better. We, senior laboratory assistants with the archaeological squad in summer and men of various professions in winter, descended from the mountains and returned to our urban life; however, our friends-archaeologists had no time to waste. All the items awaited top-notch restoration. For a year, the restorers saturated the vault logs and wooden blocks with polyethyleneglycol-based substances to make them imperishable. And the heroes of the day – the mummies – went to Moscow for final conservation at the Institute of Biological Structures, whose main "client" has been and still is some guy named Vladimir Lenin.

The restoration is as costly as it is unique, but it's worth the cost. Only the scientists of this institute, not the priests of Ancient Egypt, can embalm a body precisely as it is,

without turning into a resin cocoon and even without deforming the intravital volume of tissue. Consider Lenin, for instance, whose freshness and flourishing complexion is a constant source of vituperation: he has been on display in open air for 90 years and still as good as new – a triumph of matter over mind.

One day, the author of these lines had an honor to collect the body of a Scythian warrior in Moscow and escort it to Siberia, i.e., return to the lesser motherland. There were five of us because the man was portly and two meters tall; however, one would suffice to carry him: all his tissues were dehydrated and each cell was saturated with a preserving agent. After a year in secret tinctures, the embalmed skin felt like polyethylene.

However, I still remember the soft cold palm of the anatomic pathologist when we shook hands at parting at the platform of the Yaroslavsky railway station. Although his hand didn't smell of the Styx sludge or the Cerberus hound, it still felt like a hand of Charon, accustomed to greetings and departures.

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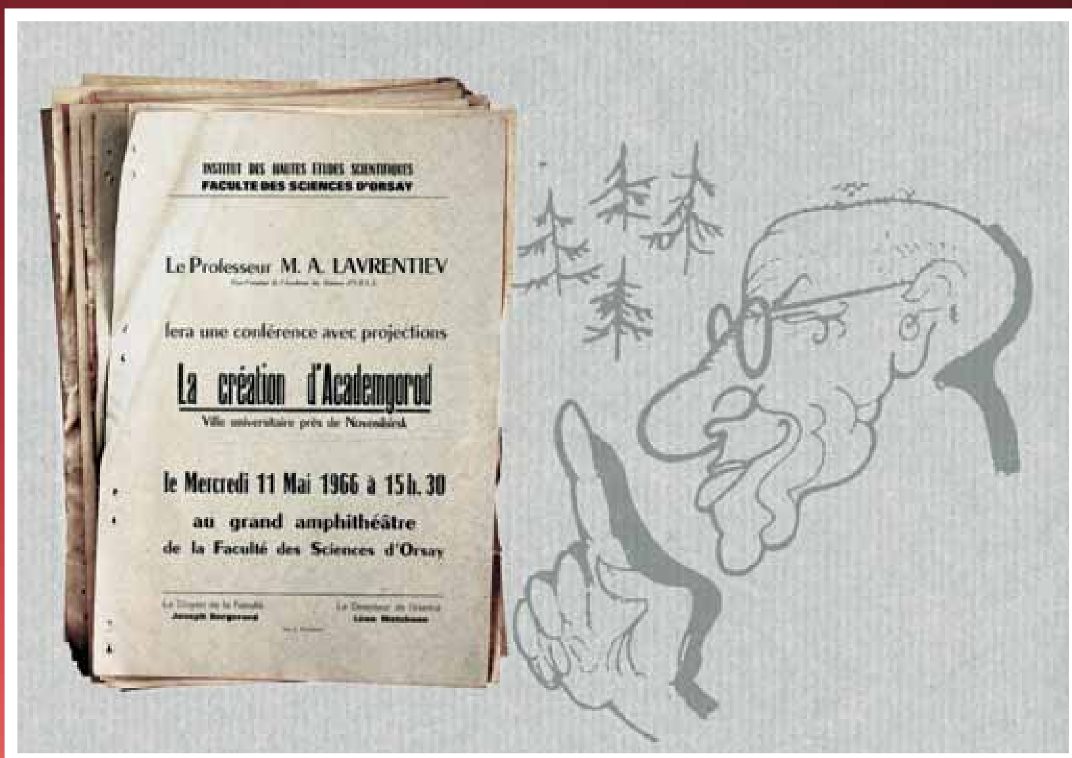
Photo by V. Mylnikov

Ukok, photo by K. Bannikov
Drawing by E. Shumakova



Announcement about M.A. Lavrentiev's talk
"The birth of Akademgorodok" (1966),
kept and kindly given by French friends to the team
of the Club of the Cheerful and Sharp-Witted
that visited France in October 1989.
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