N.L. DOBRETSOV

The Harmony of Trinity

Dedicated to the 50th anniversary of the Siberian Branch of Academy of Sciences

Organization, in May 1957, of the Siberian Branch of the USSR Academy of Sciences was a revolutionary event and not just for the national science. In only ten years research work conducted within the Siberian Branch was acknowledged to be world level. To compare, it took Tomsk research school, which is the oldest in Siberia, almost a hundred years to reach the same mark!

Development of the young Siberian research has attracted the attention of the world academic community from its first steps, primarily because Academgorodok, 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: high concentration of outstanding researchers with a variety of interests and schools and a large number of young investigators took off like a rocket.

People would come here to gain experience — similar research centers sprang up in Russia and all over the world. Academgorodok was visited by some outstanding political and public figures such as Charles de Gaulle, Olof Palme and Rajiv Gandhi, 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 chemistry.

Some years later, the activities lulled and disappointment set in. For instance, an issue of *Nature* published in the late 1980s — the period of crisis and recession in the USSR — and dedicated to Soviet research in general and Academgorodok in particular stated that our research, including the people and equipment involved, had "become older" and lacked new ideas... Though these statements must have distorted the facts on purpose, there was some truth in them. "Herculean" efforts were made to reverse the situation, and yet a lot remains to be done.

Having survived the hard times together with its country, Siberian research has approached a new stage of development. A lot has been achieved in the last ten years: research equipment has been renovated, unique new systems have been developed, and cooperation with foreign partners has become more active. Research in Siberia has again become a focus of attention — the USA and European Community, China, Korea, and Japan have shown interest in cooperation with us. We can offer to our potential partners unique theoretical and applied developments in physics, mechanics, molecular biology, and medicine, catalysis, nanotechnologies, and mineral resource extraction, to name just a few.

Fifty years is the age of maturity, and the anniversary is the right time to assess the past, realize the present, and have a glimpse into the future.

"Nobel" quality

All over the world, the situation with research is often judged based on works honored with the Nobel Prize or considered to be at its level. So far, the Siberian Branch has only one Nobel laureate — in 1975 Academician L.V. Kantorovich was awarded the Nobel Prize in economics for his contribution to the theory of optimal resource distribution: he conducted a comprehensive investigation into linear programming and the theory of optimal planning of economics. And today, the core of the research activities of the Institute of Economics and Industrial Engineering is economic calculations using advanced mathematical models.

As for studies worthy of the Nobel Prize in the eye of the world research community, they are plentiful. These are primarily investigations carried out by researchers belonging to Academician G.I. Budker's school involving colliders and the development of the method of electronic cooling of heavy particle beams applied to proton, antiproton, and heavy ion accumulators all over the world. These pioneer works were performed at the Institute of Nuclear Physics, which is a world leader in the field of accelerator physics, high energy physics, and plasma physics. The Institute has recently developed a high-power free electron laser, which opens up excellent opportunities for interdisciplinary theoretical investigations, for instance, in chemistry and biology, and for the development of new technologies.

Another leader in the domain of physical sciences is the Institute of High Current Electronics, Tomsk, where scientists of the school headed by Academician G.A. Mesiats discovered explosive electronic emission, the phenomenon that became the basis of a variety of high precision accelerators of dense electronic and ion beams as well as of the impulse sources of x-ray radiation.

Spin chemistry — a new direction based on the theory of weak interactions — owes its origin to the research school founded by Academician V.V. Voevodsky, the Institute of Chemical Kinetics and Combustion: he brought up a galaxy of prominent scientists, who subsequently set up

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1966 President of France Charles de Gaulle: "Thanks to the importance of works carried out here and also thanks to the noble idea underlying the creation of Academgorodok, its name has long become world famous. Here we can find a combination of up-to-date intelligence and tradition..."

1957 The USSR Council of Ministers issued the decree on the organization of the Siberian Branch of the USSR Academy of Sciences

their own research directions. Achievements in this area have been nominated for the Nobel Prize several times, and have now been proposed for the State Prize of the Russian Federation in the field of R&D.

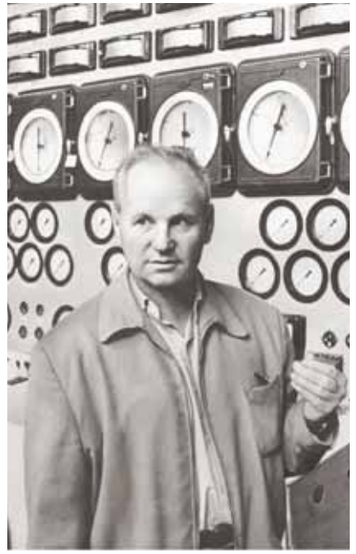
As far as organic chemistry is concerned, special mention should be made of the studies headed by Academician V. A. Koptyug which focused on cation transition states arising from isomerization of aroma compounds and their models — long-living carbocations. However, in 1994 the Nobel Prize was awarded to G. Olah, the head of the American scientific school — the second in the world — concerned with carbocation chemistry achievements.

Internationally acknowledged are investigations into the synthesis of gene-targeted biologically active compounds on the basis of oligonucleotides (DNA fragments). Launched under the guidance of Academician D. G. Knorre, these studies provided foundation for the promising biochemical field connected with new generation drugs. Today, these investigations are carried out at the Institute of Chemical Biology and Fundamental Medicine — it is not without reason that its researchers are highly regarded all over the world.

It is well known that Nobel Prizes are not awarded in mathematics and geology. Nevertheless, achievements of our mathematicians should be given the highest appreciation possible — and these include not only the results

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

Novosibirsk Academgorodok was the first successful pilot project on establishing a center of theoretical research and education



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

obtained by the founding fathers of the Siberian Branch, Academicians M. A. Lavrentiev and S. L. Sobolev, but also the work by their younger colleagues such as Academician Yu. L. Ershov, who developed special algebraic applications recently honored with the State Prize of the Russian Federation.

True discoveries of the century were the three largest oil- and gas-bearing basins: West Siberian, East Siberian and Lena-Yenisey. Credit for this should largely be given to the scientific school headed by Academician A. A. Trofimuk. Siberian deposits are the future of the Russian oil and gas industries; their development in the next 20 years will be the largest power project not only for Russia but, probably, for the entire world.

We cannot fail to mention the discovery of gas hydrates, i. e. gases in the solid state, in permafrost. Gas hydrates have been found to be very widely spread on our planet: their deposits located in ocean shelves and shallow shore seas are greater than the deposits of all fuels discovered on land. This discovery has provided mankind with virtually inexhaustible resources of hydrocarbons: the first to create the technology for extracting and using this fuel will control the world.

In 2005, the State Prize of the Russian Federation marked the discovery and investigation of the ancient Pazyryk monuments located in the Altai Mountains. These explorations were headed by Academician V. I. Molodin and Dr. of history N. V. Polosmak, Institute of Archaeology and Ethnography. The new finds are just a part of the unique results obtained by the Siberian archaeological school created by Academician A. P. Okladnikov.

The results mentioned above do not constitute a complete list of achievements made in the last 50 years by research teams of the RAS Siberian Branch, but it is impossible to reflect everything within the scope of one article. And now we must dwell on another topic: how this unprecedented "expansion" of research to Siberia became possible.

Nothing can be more important than people

To begin, I would like to refer to the so-called "Lavrentiev triangle" which reflects the three-component objective of the Siberian Branch: personnel training, interdisciplinary research, and adoption of research achievements in industry. The first component of this triangle is personnel, namely, research schools created by prominent researchers who came to Siberia together with their disciples. They were more than outstanding researchers — their creative ideas concerning research and organization of research investigations could not be developed in Moscow, St Petersburg or Kiev. It was research schools set up on a completely new basis with maximum research freedom that became a starting block and foundation of further investigations.

Today, research schools — these originating from the 1960s and the ones that have appeared recently — are our basis and our hope. At first, we used to do our best to keep everybody we had trained here, at the Siberian

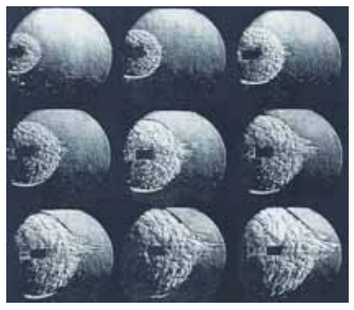
The King of Sweden Carl XVI Gustav is presenting the Nobel Prize to Academician L. V. Kantorovich, who performed comprehensive studies in linear programming and theory of optimal planning of economics

1975 Academician L. V. Kantorovich was awarded the Nobel Prize in economics

Branch; but at the early stages of the reorganization we came to the understanding that this was not essential. So, our new approach was to welcome students wishing to study for Master's degree, do postgraduate researchand defend candidates' theses. Even though not all of those trained here will work at our research institutes or even continue to do research, thanks to this approach we are able to attract a lot of young investigators and exert our influence on other national and some overseas research organizations.

This is why brain drain has not been so harmful: younger generations of students trained at Novosibirsk State University — an integral part of the Siberian Branch — replace those who have left. Without this unique educational institution, we would have no fresh blood and, hence, no future — many Russian research schools are fading away for this reason.

Apart from Novosibirsk State University, continuous selection and replenishment of the Siberian Branch's research staff became possible thanks to the Academgorodok-based School of Physics and Mathematics and famous all-Siberia contests for schoolchildren in mathematics, physics, chemistry, biology and other subjects. Krasnoyarsk State University and Buryat State University developed from the branches of Novosibirsk University; also, it influenced profoundly many other higher educational establishments of Siberia, Russian Far East, and Urals. For instance, the Siberian school of mathematics contributed a lot to raising the level of teaching this science: nearly all heads of Mathematics Departments at universities have either graduated from Novosibirsk University or defended their theses at research institutes of the Siberian Branch. Our textbooks on mathematics and other subjects such as physics and biology written for the School of Physics and Mathematics are considered to be among the world's best and were translated into foreign languages.

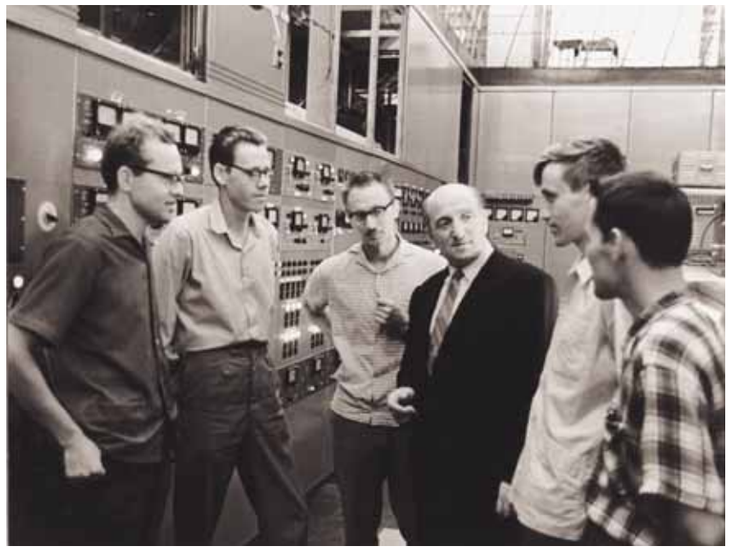


Siberians have made some outstanding achievements in the development of theoretical foundations and means of modeling high-speed processes. The cinegramme shows initiation of a detonation wave by a high-speed body (bullet) traveling through a solid substance

The first collider developed at the Institute of Nuclear Physics was the father of a series of pilot and industrial collider setups

This system of research staff training has provided a continuous flow of young talented researchers into academic institutions and research schools, thus contributing to their further development.

The next important component of our Branch is research organization, namely, integral interdisciplinary studies and search for discoveries in the areas where branches of learning overlap. The founding fathers of the Siberian Branch have ingeniously put into life the ideas expressed by Mikhail Lomonosov in his Note on the Necessity to Transform the Academy



V. Sidorov, I. Protopopov, S. Popov, G. I. Budker, A. Skrinsky, and V. Petrov in VEPP-4 control room

of Sciences as long ago as the 18th century: "An astronomer often needs mechanic's or physicist's advice, a botanist and anatomist needs advice from a chemist, and an algebraist cannot always write bare formulas but has to take a physical substance, and so on. To do this, they always have to be on friendly terms. Freedom and unity of sciences often require communication and permission to practice in what the other person knows..." At the early stages of the Branch's development, such interaction of disciplines manifested in the adoption of mathematical methods by various areas of knowledge; subsequently, it became much broader. Our current integrated projects unite experts of various branches of learning: physicists and chemists, physicists and biologists, chemists and biologists, economists and mathematicians...

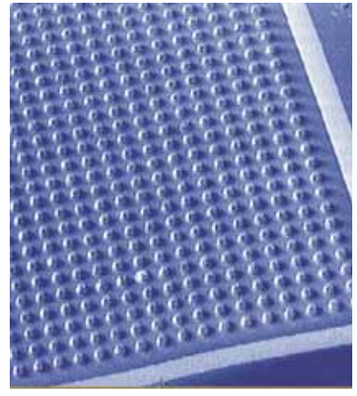
And, finally, the last "side" of the "Lavrentiev triangle" was practical application of research achievements. Alongside theoretical studies, research workers and top managers of the Siberian Branch focused on using the research potential accumulated to the advantage of regional and national industries. It was for this reason that most institutes were designed to have pilot production facilities, and a number of design and technology units and a pilot plant were created.

Like other principles underlying the Siberian Branch, the principle of putting into practice research achievements has evolved considerably in the fifty years of our existence. In the early years, we had to carry out the tasks set by the government: to protect the city of Alma-Ata from mud flows, to develop techniques against ice blocks on the rivers Yenisei and Lena, to create Siberian winter wheat, etc.; and all these tasks were successfully fulfilled.

As a result of expanding cooperation with Siberian and European factories, a number of unparalleled research ideas were developed and put into practice, such as the vanadium catalyst that replaced the expensive platinum catalyst and made a revolution in sulphuric acid production. This is only one achievement made by the internationally acknowledged research school founded by Academician Boreskov, Institute of Catalysis.

Nowadays, having come out of a recession, the Siberian Branch is entering a new stage connected with the development of technoparks (special economic zones), cooperation with large companies, and establishing small and medium-size businesses springing up from research groups separating from our research institutes and departments of Novosibirsk University.

The great research potential of Siberia has played an important role in the creation of West Siberian oil and gas complex and KATEK (Kansk-Achinsk Fuel and Energy Complex),



A semiconductor structure — the photodetector array with indium columns 5 μm high developed on the basis of high technologies

in the construction of the Baikal-Amur railway, the mining of Yakut diamonds, starting the development of gigantic oil and gas deposits of a new type in East Siberia, etc.

A recent example is the machine developed at the Institute of Theoretical and Applied Mechanics — this automated system based on a high-power CO_2 laser is designed to cut steel, titanic and other alloys of virtually any thickness. Though similar systems have been developed, our system has a number of advantages due, in the first place, to the power of the laser and high ability of governing the process. Another challenging task is laser welding. Since we are among the leaders in this field, we believe we could cope with it if we get an order from the state and are provided with the necessary means.

The Siberian Branch of the Academy of Sciences has a unique system of theoretical education. The photo shows students of the summer physical-mathematical school, Novosibirsk, defending their "fantastic" projects

1959 Novosibirsk State University was founded

Cutting out own path through the forest

How do we see our future? I believe we should try to be ahead without catching up, i.e., focus on doing investigations in niches that have not been occupied yet, as well as to explore new, so far untouched fields. Here, there are a few paths to follow. First, to continue working within allied research areas using unique innovative equipment, such as the free electron laser, pilot stations of the Siberian Center of Synchrotron Radiation, the research system of the Institute of the Solar-Terrestrial Physics, the wind tunnel of the Institute of Theoretical and Applied Mechanics, and others.

We have applied this approach to one of the most advanced research areas — nanotechnologies. Evidently, if we try to cover everything, we will lack people and finance, which is why it is so important to find niches where a breakthrough can be achieved. A lot has been done in this respect, for instance, the revolutionary three-dimensional nanostructures based on the so-called Prints technologies: they open up great prospects for various engineering solutions, from an invisible mirror to hyper-sensitive materials. Judging by the family name of the scientist, you may think that this technology was developed abroad. In actual fact, Doctor of Physics and Mathematics V. Ya. Prints is a research worker of our Institute of Semiconductor Physics.

The second strategic direction is research into unique objects and phenomena, such as Lake Baikal, boreal forests, permafrost, etc. Investigations in these fields carried out in cooperation with foreign colleagues have made a valuable contribution to science, and new discoveries are in store for us.

The third and least predictable strategy is the creation of new research schools, "embryos" of revolutionary research directions, which we cannot assess today but should cherish in every possible way. Generation of new unconventional ideas must be the best way of quick development and achieving breakthrough in any branches of knowledge.

As for the tactics, we believe that the so-called centers of shared resources have proved to be a very satisfactory solution. This idea was conceived at the Siberian Branch and has been wholeheartedly supported by the Academy of Sciences and by the Ministry for Education and Research. A few years ago, we estimated that 80—90 % of the equipment of our research institutes needs to be replaced, which would cost approximately $250 million. Shared resource centers have allowed us to purchase less equipment. This year we are completing replacement of large research equipment, which has cost us only $120 million.

Today, we are facing a much more grandiose task: creation of innovative setups belonging to the so-called megascience and costing hundreds of millions and billions of

The research school of Academician V.A. Koptiug — SB RAS Chairman from 1980 to 1997 — made a notable contribution into the theory of regroupings occurring in the molecules of organic compounds through the formation of carbocations. Such regroupings are of great practical interest because they allow us to obtain complex compounds and compounds difficult to produce

dollars. It goes without saying that the Siberian Branch cannot cope with this task on its own. The only possible way is state support and/or international cooperation. One such setup is the CERN collider — a lot of European countries have participated in its construction, including Russia represented by the Academgorodok-based Budker Institute of Nuclear Physics. If we want to create something completely new, we should spare no effort. Life will show whether we will be able to implement such projects in the near future.

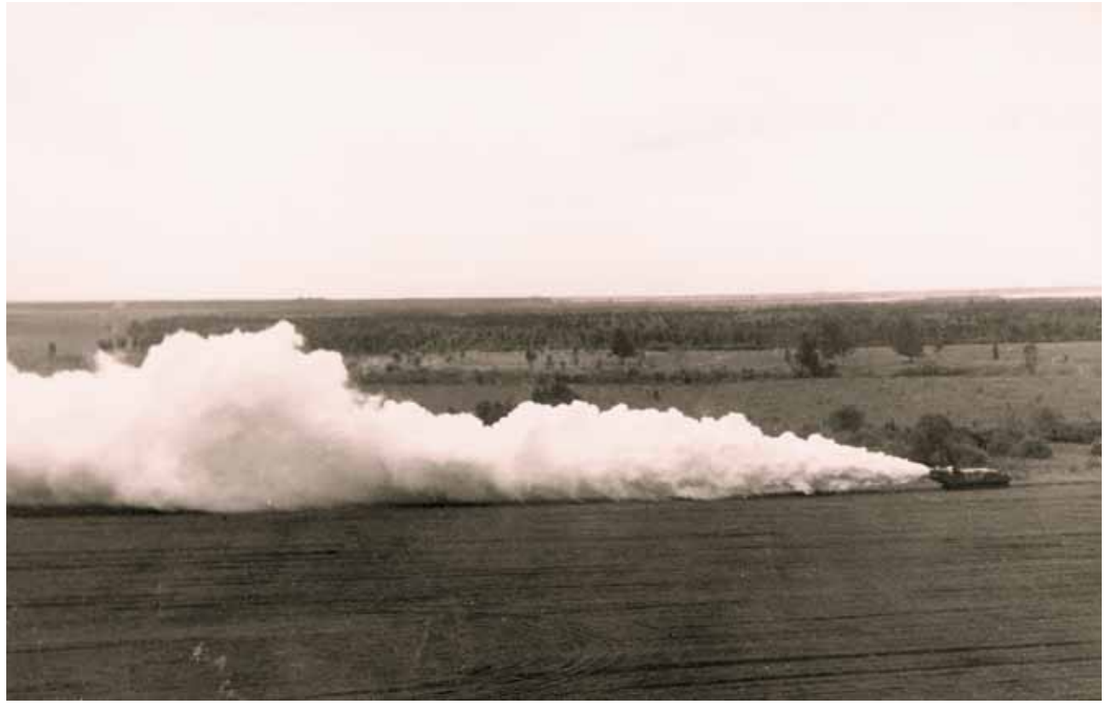
In the same way as "Moscow" is not the equivalent of "Russia", "Novosibirsk Academgorodok" is not the equivalent of the "Siberian Branch", which includes nine research centers, each having a character of its own. Typical of our research system is feedback — any problems arising at a certain institute or in a certain region become our common concern and can be resolved through joint investigations with other units of the system.

Also, the Siberian Branch includes a network of research stations: they are seismic (half Academy of Sciences' seismic stations belongs to the Siberian Branch), permafrost, heliogeophysical (some of them have setups of the world and national level), geospheric, and biospheric. This network ensures continuous observation over an area of 11 million sq km and makes part of the world monitoring system; should it not exist, entire Siberia would be a "white spot" for the rest of the world, which would make it impossible to develop any planetary model or world database.

We have always "cut our own path through a forest" and were, at times, reproached by the Academy of Sciences for showing too much initiative. This refers, for example, to the competition of basic projects we organized and to the concentration of our human and financial resources in the most important research directions. The program of theoretical research of all state-run academies being prepared today can profit from our experience — in fact, there is no other experience to rely upon. Programs of the Presidium of the Russian Academy of Sciences and its divisions saw the light after two cycles of our integrated projects had been completed. Even though our initiative has not always been given credit, we (like other regional branches of RAS) are happy to be a test site for important projects, some of which are of great consequence for research development.

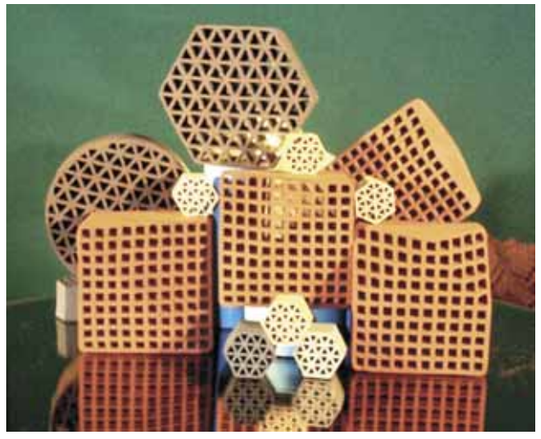
As for the prospects of the Siberian Branch, its future is inseparable from the development of the Russian Academy of Sciences. In the early days of perestroika, the leaders of our state believed that we had "too much" research — so it had to be cut to the minimum and reconstructed. Only in the first years of the 21st century the country's top authori-

Works aimed at generating a directed chemical effect of oligonucleotides (short fragments of nucleic acids) on the genetic material have gained international recognition. The photo shows the future doctor of chemistry G. Karpova



Field tests of the powerful aerosol generator designed to fight pests

The block oxide catalyst designed to oxidize ammonia contains no platinum and is applied in the production of nitric acid



On the Ukok plateau of the Altai Mountains, Siberian archaeologists found unique “frozen” burials of the Pazyryk culture. The bodies, fabrics, woodenware, leather, and felt objects were well preserved

The rotating dome hides the world’s largest coronagraph of the solar observatory based in the Sayan Mountains

Academician M. A. Lavrentiev was Chairman of the Siberian Branch of the USSR Academy of Sciences from 1957 to 1975

ties began to realize that Russia had no future without high technologies and, hence, without research.

To conclude, I would like to appeal to younger generations of Siberian researchers and quote the remarkable words by the first Chairman of SB RAS Academician M. A. Lavrentiev that have become legendary: “When I am asked what the future of the Siberian Branch depends on, I say that it depends on keeping in harmony the trinity of research, personnel, and industrial production. If any of these three components dominates, this will lead to stagnation and regress. This harmony is not a recipe where the exact amount of each ingredient is known and, if you follow the instructions correctly, you will cook a tasty dish. The harmony between the three ingredients should result from collective efforts of researchers, top managers of production industries, and state authorities. Time will make the necessary revisions but the principles that have proved fruitful should work after we are gone”.

The Atlas of Tibetan Medicine written on the basis of the 17th c. treatise on medicine is the result of many years of scrupulous work done by the scholars of the Buryat Research Center

2006 A station designed to observe greenhouse gases