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The Anniversary of the Foundation of the Russian Academy of Sciences

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THE ANNIVERSARY OF THE FOUNDATION OF THE RUSSIAN ACADEMY OF SCIENCES

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It was autumn 1711 when Leibniz, the eminent German scientist, arrived at Torgau to participate in the wedding celebrations of the Russian Czarevitch Aleksiej, the son of Peter the Great. The Czar and the scientist met and discussed, among other subjects, the question of the establishment of the Academy of Sciences in Petersburg. The same topic was taken up during subsequent encounters of Czar Peter and Leibniz. However, the practical steps were taken only much later, in early seventeen-twenties. Czar Peter wanted the Academy to deal not only with the scientific research, but also with the training of specialists. The establishment of such an Academy was an integral part of Peter's plans providing for the development of industry, the formation of a fleet, the centralization of administration, and the utilization of natural resources.

In the course of the decade several Western scientists were approached; negotations took place with a view of inviting them to the new Academy. The role of private negotiator on behalf of Czar Peter was played by Christian Wolff. At the same time an outline of the charter of the Academy — what is called *Reglament* — was being prepared, members of the Academy were being appointed and the programme of its activities adopted. On January 22, 1724 the Senate of the Academy, presided by the Emperor, discussed the *Reglament* and a week later the decree on the foundation of the Academy was signed.

The 250th anniversary of the foundation of the Russian Academy of Sciences is now being celebrated all over the world; many scientists from many countries have joined in the proceedings. This offers a good opportunity to examine the historical importance of that event, to see what is the Academy's contribution to world science.

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Let us start with examining the contribution of the Academy to world science of the 18th century. In this connection, the encounter of Leibniz and Peter the Great is of an almost symbolic significance. The broad horizons and versatility of Leibniz philosophy, his manifold scientific and organizational activity were a reflection of the most important scientific problems of the 18th century. The basic principles of modern mathematical analysis had already been worked out. Now they had to be applied in astronomy, mechanics, physics — in all natural sciences. Moreover, since the concepts of the mechanic character of natural phenomena had already been formulated, the time had come to discover the smallest molecules of matter, the movement of which determines the sum of physical, geological and biological processes. Such sciences like atomistics were, therefore, in the centre of attention. On the basis of new scientific discoveries a synthesis had to be worked out presenting the Earth as a result of the scientifically discovered forces of nature. Finally, science had to become part of the Enlightenment which was partly accomplished in Germany in the course of the 18th century by the generation which followed Leibniz.

Czar Peter's plans were a true embodiment of the needs of the 18th century Russia in the field of industry and culture. The Czar met Leibniz in the glory of the Poltava victory, yet well was he aware of the fact that the expansion of the economic and military potential of the country called for the construction of ships and factories, for the expansion of ore mining, for the increase of agricultural production, for the construction of roads, etc. He realized very well that this required the application of mathematics, of applied mechanics, of new technologies, the exploitation of new natural resources, all of which depended on a complex research programme encompassing the whole country. Finally, Peter understood that these problems could not be solved without new scientific means.

The needs of the 18th century Russia had their counterpart in the scientific problems of that time. Petersburg Academy, the scientific centre of Russia, had thus become one of the main world centres of natural sciences.

The figure of Leonard Euler stands out among the great scientists of the 18th century, the founders of natural sciences. He was the first to come to Russia; he arrived in 1727 and he embarked immediately upon research on the basis of mathematical analysis, basic mechanics, some problems of physics, arriving in all these fields at results which are still scientifically valid. The living conditions in Russia led Euler to great discoveries in mechanics, mathematics and physics. He said later that he owed all his fame to Russia. He was extremely proficient. The work of Petersburg Academy became a source of new, extremely fertile ideas for Europe as a whole. Indeed, it is difficult to find a course of mathematical analys-

is or a course of mechanics from the late 18th century onward, even nowadays, which does not bear the imprint of Euler's work. At the same time his work reflects the influence of the Russian scientific community.

Together with mathematics, the science of that time was searching for a picture of the world, for a picture of physical and chemical processes which could allow for, at least, an approximate interpretation of experimental data. In this respect a considerable contribution was made by the great and universal Russian scientist of the 18th century, Mikhail Lomonosov.

Lomonosov was born at the shores of the Arctic Ocean. From his native village he came to Moscow and entered a seminary; later, with a group of students of Petersburg Academy of Sciences, he went to study in Germany, first in Freiburg with Henkel and then with Christian Wolff in Marburg. As a young man Lomonosov formulated a programme aiming at transforming chemistry, physics and geology on the basis of the concept of atoms and molecules. After his return to Petersburg he started working on the implementation of the original outline. Lomonosov produced the fullest, at that time; enunciation concerning the indestructability of movement, the experimental proof for the conservation of matter during chemical reactions, and a detailed presentation of the role of atoms and molecules in chemical reactions. He formulated the basic concepts of physical chemistry, of the kinetic theory of heat, of a new theory of gravitation, light and electricity. On the basis of chemical experiments he created an industry of mosaic. He defended the theory of transformism in geology, he discovered the atmosphere on the planet Venus and made a considerable number of other experimental and conceptual discoveries in the field of natural science. At the same time he wrote about demography, economics; he commented upon projects concerning polar research, and about the construction of flying machines and navigation instruments. He was famous for his scientific investigation on Russian grammar, he published works on esthetics and carried out historical research. This great scientist was also a great poet, who invented a new method of rhyme selection and who left masterpieces of Russian poetry. Finally, Lomonosov was also a great statesman who initiated important economic and cultural enterprises and founded the University of Moscow.

The Academy of Sciences made another considerable contribution to the development of world science in the 18th century. It sent numerous expeditions to various parts of the country, and especially to Siberia; the participants of the expeditions included astronomers, geodesists, mathematicians, botanists, zoologists, linguists. As a result, world science gained many geographical surveys and descriptions of mountains, rivers, natural resources, fauna and flora, peoples, languages and cultures of regions situated in extremely different climatic conditions and different environments, of regions inhabited by nations and tribes of different

speech, customs, historical background, and economy. This added to the knowledge of the interdependence of various species and various phenomena, and in particular to the knowledge of the dependence of living organisms on the environment.

The 19th century had ushered in a new era in the history of the Academy of Sciences. Natural science was dividing up, the search for specific concepts differentiating one discipline from another was going on. The organization of science changed, too. Petersburg Academy was no longer embracing all fields of science. The universities founded at the beginning of the 19th century carried out their own basic research in the fields of mathematics, physics, chemistry, geology, biology, history, linguistics, etc. The universities created schools which gave birth to discoveries of world--wide and historical significance. However, the connections between various scientific disciplines and scientific centres remained greatly important for the progress of science. The unity of science, the creative co--operation between disciplines and scientific centres was to a large extent embodied in the activities of the Academy of Sciences.

It was also in the 19th century that all the main trends of Russian experimental natural science were created and developed. Whereas in the 18th century Russia contributed to forld science mainly in the field of the mathematical natural science, and furnished the encyclopaedic knowledge of Russian territories thanks to the work of the Academy's expeditions, a century later there was hardly any branch of natural science to which Russian scientists would not make a valuable contribution through their experimental and theoretical work. At the beginning of the age V. V. Petrov discovered and investigated the Volta arc; in eighteen-thirties B. S. Jakobi discovered galvanoplastics and constructed one of the first electric engines. In the same time E. H. Lenz continued the work of Faraday and formulated one of the most important laws linking the movement of the conductor in the magnetic field with the direction of the current induced in the conductor. In the course of the second half of the 18th century, in the seventies, A. G. Stoletov developed the theory of generators and inductive engines and later built the first photomagnetic cell. As it is well known, photomagnetic cells were the very basis of great physical discoveries of the nineties, at the same time inaugurating a new era of automation in production. The discovery of the phenomenon of light pressure by P. N. Lebedev was also of great importance. Experiments carried out by Lebedev demonstrated that light exerts pressure on corps and this not only confirmed the electromagnetic theory of light, but brought about a fundamental change in the opinions regarding the bases of mechanics and electrodynamics which occurred at the beginning of the 20th century.

In mathematics Russia created an outstanding school, which in the course of the first half and the middle of the 19th century gained world-

-wide fame thanks to work in the field of mechanics and mathematical physics. The founder of that school, M. V. Ostrogradzki, belonged to those greatest world scientists whose genius contributed to the creation of the theoretical foundations of classical science and its application. In the course of the second half of the century Petersburg mathematical school founded by P. L. Chebyshev and the classical works of P. L. Chebyshev in all basic fields of mathematics placed Petersburg Academy of Sciences among the greatest centres of mathematical thought.

However, the greatest mathematical discovery of the century, the non--Euclidean geometry of Lobachevski, remained unnoticed and found no understanding with the Academy. Indeed, in his lifetime Lobachevski failed to gain the world recognition for his work. His paper on new geometry written in 1826 as well as his subsequent works have only in the 20th century been considered the foundation of the scientific image of the world. The majority of his contemporaries passed censure on Lobachevski's ideas as if they were the limit of paradox. He had the courage to assail truths which appeared immutable, constant beyond any shadow of doubt. Three hundred years before our era the axiom that only one parallel line can be drawn through a point outside a given straight line was put down as one of the basic principles of Euclidean geometry. This axiom results also in that the sum of angles in a triangle is equal to two right angles and some other conclusions which seem to express total and unassailable truth. In Lobachevski's geometry through a point situated outside a straight line there passes an indefinite number of straight lines not intersecting the given straight line, the sum of the angles of a triangle is lesser than two right angles, etc. In the 20th century it became clear that geometrical relations in the Universe are not governed by Euclidean geometry. That confirmation of the paradox, which undermined the most ingrained and basic truths, exceeds the bounds of mathematics and represents a major event in the history of human thought.

A somewhat similar situation occurred in the Russian chemical science of the 19th century. Around the middle of the century, in the laboratory of Kazan University, N. N. Zinin made a discovery which had considerable importance for industry, namely by a chemical method he produced aniline on which dyeing industry is based. This is but one of the many chemical discoveries of Russian scientists which had wide practical implications. The second half of the 19th century stands out as a period of important theoretical generalizations. In this connection one may mention the theory of structures of A. M. Butlerov. The very character of organic chemistry had to change with the discovery of the internal structure of the molecule and the division of forces linking the atoms which form part of the molecule.

However, the greatest discovery of the century in chemistry, the law of periodicity of D. I. Mendelyeev, like the non-Euclidean geometry failed

to stir the Academy. This was due to many reasons, only one, however, needs be mentioned here. The law of periodicity, the repetition of the chemical properties of elements tabulated in accordance with the growing atomic mass became the basis of research of the microworld, the basis of atomic physics, and its great achievements in the 20th century. The law of periodicity gained acceptance in eighteen-seventies when elements anticipated in Mendelyeev's periodic tables on the basis of the periodicity law were discovered. That is why the chemists of the last quarter of the 19th century recognized Mendelyeev's genius, but fell short of realizing the full significance of his discovery. It is only now that the scientists of the whole world consider Mendelyeev to be the prophet of the atomic age and concede that the law of periodicity gave birth to atomic physics.

In the field of biology the 19th century Russian science made a significant contribution to world science by the works of K. Ber and, later, by the works of A. O. Kovalevski and I. I. Mechnikov on embriology. These works had created the basis for a theory of plant and animal species. Not less important had been the research carried out by A. O. Kovalevski in the field of paleontology. At the end of the 19th century Russia became the second centre of Darwinism, with Russian scientists developing the theory of evolution. K. A. Timiryazev, the untiring advocate of Darwinism, developed new ideas in the field of physiology of plants.

The works of Russian scientists in the field of physiology of higher nervous functions had also gained world recognition. I. P. Pavlov continued and developed the work inaugurated by I. M. Sechenov on reflexes. His work on conditional reflexes had made human consciousness the object of experimental physiological analysis.

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The Great Socialist October Revolution has originated a new era in the history of mankind, a new era in the history of science, and also a new era in the history of the Russian Academy of Sciences. As early as spring 1918 Lenin presented an outline of the Academy's scientific research programme in which scientific tasks were linked to the objectives of reconstruction and re-equipment of the national economy. Later the various stages of development of the Academy's research work were closely connected with the succeeding stages of development of Soviet society and with the policies of the Communist Party of the Soviet Union. The national economic plans of the Soviet Union were to such an extent related to a far reaching economic expansion based on modern science and technology that the execution of a very wide range of scientific problems became a most urgent task. The plan of Russia's electrification, known as the GOELRO plan, drafted in accordance with Lenin's direct-

ives, gave a strong impulse to work out a programme of extensive implementation of basic research. The industrialization of the country, the expansion of industrial production, the collectivization and growth of agricultural production, the exploitation of new raw materials and energy resources have promoted the establishment of new scientific centres and the development of new directions of the scientific thought. The interrelationship of science and the socialist transformation of society can be illustrated by the following examples.

As early as in nineteen-twenties extensive research developed in the Soviet Union in connection with electrification, leading to great discoveries. At the end of the thirties the institutes of physics in the Soviet Union were carrying out research on nuclear fission of uranium which a decade later led to the utilization of nuclear energy. This was followed by research on thermonuclear reaction, the fusion of light nuclei, through which much greater energy can be obtained than by the fission of heavy nuclei.The Soviet physicists also made a considerable contribution in another field, namely in the field of basic applied sciences. They constructed lasers, the equipment producing high intensity radiation able to revolutionize communication; they promoted computer science and technology in all basic production branches.

The development of aviation, of machine building, of transport and of cosmonautics prompted research in the field of mechanics and mathematics. N. E. Zhukovski, S. A. Chaplygin, A. N. Tupolev and other engineers, constructors and mathematicians had not only created a new aviation industry, but also contributed to the progress of its theoretical basis. The works of A. N. Krylov provided the theoretical foundations for the reconstruction of the fleet.

In the field of chemistry the needs of iron and steel industry, of chemical industry, and of agriculture promoted research in such fields as physico-chemical analysis and the chain reactions theory. Soviet food industry, medical science and agriculture had relied on the development of Soviet biochemistry.

Responding to the requirements of agriculture Soviet scientists developed the theory of the origin of cultivable plants, thus contributing to world biological science. Most successful were research activities in the field of physiology where the theories of I. P. Pavlov gained general acceptance, thus influencing research in many countries.

The industrialization of the country and the rapid cultural development of the Eastern regions of the Soviet Union were accompanied by great achievements in the field of geological, geochemical and geographical research. Hundreds of newly discovered natural resources, often affecting technology and location of industrial plants, theoretical findings such as geochemical and biogeochemical theories of V. I. Vernadski and A. E. Fersman, geographical expeditions to the Arctic regions, are but some

examples of the activities of the Academy of Science of the Soviet Union which aims at gaining a better knowledge of the country and of its riches.

Never before has science demonstrated to such an extent its power residing in the organic unity of scientific thought, labour, and harmonious social structures than at the occasion of the Soviet cosmic flights. The Academy of Sciences of the Soviet Union took an active part in their preparation, placing at the disposal of cosmonautics its achievements in the field of mechanics, mathematics, physics and biology.

Still another feature of the post-revolutionary history of the Academy of Sciences has to be emphasized. Before the revolution Petersburg Academy concentrated its research on natural sciences, shunning social sciences and scientific research of social problems. At present economic, historical and social science problems in general are dealt with in connection with scientific problems of communism and Marxist-Leninist philosophy. And this explains the main reason for the rapid, unprecedented development of science in the Soviet Union. There can be no optimum development of science in modern times without an organic co-operation of social, natural and technical sciences.

The Academy of Sciences of the Soviet Union has been greatly contributing to international scientific co-operation. It carries out very important research in such fields as outer space or ecology together with academies of sciences of other countries. As far as co-operation with the socialist countries is concerned, joint research programmes carried out within the framework of the Council for Mutual Economic Assistance represent a major element of economic co-operation and socialist integration.