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SOVIET SCIENCE: THIRTY YEARS

FOREIGN LANGUAGES PUBLISHING HOUSE
Moscow 1948

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THE THREE decades that have passed since the October days of 1917 have brought about, on the territory of the one-time Russian empire, such social and economic change, such historical developments, as to reshape the very foundations of life in the country. Never before has human history, has the development of society, witnessed such momentous revolutionary upheavals as this transformation of old Russia into a classless, socialist state based on the broad democracy of the Stalin Constitution—into a close-knit community of Soviet peoples, with a heroic army that has attained unexampled victory, with a huge new industry and an agriculture of an entirely new type.

The most far-reaching conclusions and forecasts of the teaching of Marx, Engels, Lenin and Stalin on the development of society have begun to be realized in the land of Soviets. For the first time in human history, scientific theory guides the building of a new state.

And this mighty tide of history has carried with it, irresistibly, all science as a whole. Thirty Soviet years have effected a complete metamorphosis of science, both in scope and in nature. Of the scientific traditions of old Russia, only that which was progressive has gone on into the new life.

The extent and the substance of the changes that have taken place will be more easily grasped after a brief glance at the past, at the roots from which the new conditions have produced the Soviet science we know today.

Science, in content, form, and purpose, is fundamentally social, collective. It is invariably, in its every branch, the sum of knowledge attained by many different people, by past generations and by contemporaries. It is the composite product of collective labours. The facts and conclusions which it comprises are expressed in the form of concepts, definitions, and formulae; they are recorded in writing or in print. The purpose of all this is to facilitate the communication of knowledge to other people, to one's class, one's state, to humanity as a whole. Finally, and this is most important, science is a powerful instrument helping to disclose new productive forces in nature and new means of production. It gives man the means of struggle and of defence. Therefore, science comes into being and develops simultaneously with the rise and development of society, as an inevitable consequence and at the same time an indispensable condition for this development.

In Russia, the development of science began many centuries ago. Between the tenth and the twelfth centuries, it appears to have maintained the same level as in other European countries. For this we have the evidence both of writings of that period and of material relics, particularly architectural. The invasion of the Tatars and Mongols, however, interrupted the normal growth of science in Russia. Progress was retarded for several centuries after. The rise of secular schools was hampered, and the science of the churches and monasteries pursued aims that had nothing in common with the progressive tendencies of natural science and technology. Clerical science was fettered and weighed down by Byzantine inertia and conservatism, by the "spiritual dictatorship of the church," as Engels puts it. Only in the seventeenth century did secular science begin to assert itself in Russia. One of its early expressions was the attempt of Boris Godunov to found a university in Mos-

cow—a plan realized, somewhat later, in the founding of the "Slavo-Graeco-Latin Academy," Moscow's first institution of higher learning. Initially, of course, this institution was concerned only with teaching, and not with scientific research.

Science began to advance rapidly during the reign of Peter I, when the interests of the state called for a considerable expansion and consolidation of industry, commerce, and the art of warfare. Feudal Russia was a backward state, both economically and culturally, as compared with Western Europe. This was due, in considerable measure, to political causes of an extraneous nature. It should be remembered that the effects of the Tatar and Mongol incursions were not entirely wiped out in Russia until the latter part of the eighteenth century. In the meanwhile, during the sixteenth and seventeenth centuries, Western Europe, entering the capitalist phase of its history, had witnessed the growth of a new and remarkable natural science—the science of such men as Copernicus, Galileo, Kepler, Descartes, and Newton. Under Peter, however, this science, so new both in content and in style, took root in Russia with amazing rapidity. In the middle of the eighteenth century the St. Petersburg Academy of Sciences, which Peter had founded in 1725, was the scene of the scientific labours of M. V. Lomonosov, a man whose genius and achievements have been really grasped and appraised only in recent times, after a lapse of some two centuries. Lomonosov's work and attainments in the fields of physics, chemistry, astronomy, construction of instruments, geology, geography, language, and history would have done honour to a whole academy, not to speak of one man. Pushkin called him "Russia's university." He was the Russian people's swift response to the new opportunities for scientific development which had appeared, at long last, in the reign of Peter I.

Peter's foresight in basing the new Russian science on a central academy was completely justified in the course of the eighteenth century. The new Academy soon began to render useful service to the state in questions of technology and in the study of the country's geography, population, and natural resources. It set vigorously and successfully to work on the innumerable problems that had accumulated: questions of the Russian people's history and ethnography, of Russian grammar, of the country's climate. The St. Petersburg Academy members zealously promoted high school and university training for the youth. The Academy engaged in publication to an extent amazing for that period, bringing Russian society at large its first knowledge of the finest classics of science and literature. Members of the Academy initiated the organization of new scientific institutions, universities, and associations of scientists. In 1755, a university, proposed and planned by M. V. Lomonosov, was founded in Moscow. It was not long before this university became an important and independent scientific centre.

Unquestionably, in the period between its foundation and the end of the eighteenth century, the St. Petersburg Academy of Sciences contributed fundamentally to both Russian and world science. Here, on the banks of the Neva, native Russian scientists worked in close co-operation with foreign scientists, as for example Euler and Pallas, over the most important problems of science in that period. Here a strong foundation was built up for the atomic theory. It was here that the law of conservation of matter in chemical reactions was first proved experimentally, by M. V. Lomonosov. It was here that V. V. Petrov conducted his experiments directed against the phlogiston theory, and that physical chemistry took shape as a separate science. It was in St. Petersburg that Lomonosov established

the existence of an atmosphere around the planet Venus. A wealth of important material concerning Russian flora, fauna, geography, and ethnography was compiled by S. P. Krasheninnikov, I. I. Lepekhin, N. Y. Ozeretskovsky, V. M. Severgin, P. S. Pallas, and S. G. Gmelin. Of great significance were the investigations into Russian history conducted by V. N. Tatishchev, M. V. Lomonosov, and F. I. Miller. The profundity and importance of V. K. Tredyakovsky's philological studies are only now beginning to be appreciated.

Peter's successors on the Russian throne did not share in his respect for science, did not realize its importance to the state. At best, they tolerated the Academy of Sciences as an appendage necessary for the adornment of a European court. The Academy, the universities, the scientific associations received very little real assistance, either moral or material, from the state. Men of science were left to their own resources. There was no longer that tie between science and the life of the state which Peter had had in mind in setting up the Academy.

This, at best negligent and contemptuous, attitude of the tsarist government towards the problems of science became traditional, persisting until the very eve of the October Revolution. Purely by inertia, certain appropriations for scientific work continued to figure in the state budget; but their amount would remain unchanged for decades on end. The new scientific centres taking shape in Kazan, Kharkov, Kiev, and other provincial towns had a difficult and uphill struggle to overcome, now the stubborn resistance, now the complete indifference, of the government. Scientific institutions were regarded principally as a supply centre for specialists, professors, teachers, engineers—categories that a modern European state could not very well get along without, whether it liked the idea or not.

Research, creative scientific work, inventions, as a rule were deigned no notice, and even at best received but slight support and encouragement.

But the Russian people had always been eager for knowledge, and what they had glimpsed of the nature and prospects of modern science intensified this urge. Self-taught inventors appeared. There was the famous Ivan Kulibin, of Nizhni Novgorod, and there was many another who unfortunately did not rise to fame, for lack of timely support. The provincial university newly established in distant Kazan fostered the genius of that great Russian mathematician, N. I. Lobachevsky, who is often deservedly called "the Copernicus of geometry." Let the reader pause for a moment to realize how far Kazan was then removed from all cultural centres, how backward and isolated. Only then will he fully understand how remarkable it was that such a spot should produce Lobachevsky's subtle and penetrating mathematical concepts, concepts that for decades remained above the understanding of the world's greatest mathematicians. Some time later, this same Kazan produced and developed the splendid Russian school of chemistry which gave the world such men as N. N. Zinin, discoverer of aniline; A. M. Butlerov, one of the founders of modern organic chemistry; V. V. Markovnikov, and A. M. Zaitsev.

The class composition of the men of science in pre-revolutionary Russia was distinguished by the following important feature:

It was chiefly the "lower classes"—children of peasants, commoners, petty officials—that went in for scientific work with eager interest. So it was at the beginning of the eighteenth century, and so it continued for some two hundred years. Lomonosov was not the only man of science sprung from peasant stock. Few members of the ruling classes—the wealthy

nobility and the bourgeoisie—allowed their children to devote themselves to learning. It was not a paying profession. Its prospects were hazy, and it involved hard work. Again, there were many who regarded science, not without foundation, as an ideological threat to their class rule. With the rise of the revolutionary movement in Russia, and the accentuation of class antagonisms, this feature of the composition of Russian scientific circles strongly influenced the development of Russian science, giving it a democratic trend. There was a comparatively narrow group of "official" scientists, which rendered loyal service to the forces of reaction and did its best to strangle every hint of progress and innovation in science; but the Russian scientists as a whole were in a state of constant opposition—timid and covert, it is true—to the tsarist government, which failed to realize the importance of science and the prospects before it.

Towards the end of the eighteenth century, besides the St. Petersburg Academy, as the official, court representative of science, increasing importance began to attach to scientific beginnings in other parts of the country, and particularly in Moscow. When Moscow University celebrated its centenary, in 1855, its list of staff professors for the hundred-year period comprised 254 names, many those of outstanding scientists in the different fields. The theory and history of literature: A. F. Merzlyakov, poet and scientist, himself a former student of the university, and Academy members S. P. Shevyryov and F. I. Buslayev. World history: Academy member M. P. Pogodin and Professor T. N. Granovsky. Russian history: among others, the famous Professor S. M. Solovyov. Physics and mathematics: the well-known astronomer D. M. Perevoshchikov; the mathematician and physicist N. D. Brashman; the gifted physicist, philosopher, and agricultural expert M. G. Pavlov; the eminent

physicist and meteorologist M. F. Spassky. Biology: the zoologist K. F. Rulye. Thus, science in Moscow was growing and developing in every field.

The nineteenth century, age of development of capitalism, of steam and electricity, brought a new advance of science and technology in Western Europe, which, in the latter part of the century, spread also to America and Japan. Russia, too, experienced a rising tide of scientific activity. Splendid new men came to the fore in all the country's scientific centres—in the Academy, the universities and the specialized institutions of higher learning. The work of N. I. Lobachevsky in the field of geometry, and of M. V. Ostrogradsky, Sophia Kovalevskaya, and P. L. Chebyshev in mathematical analysis, sent the fame of Russian mathematics ringing round the world. Many remarkable discoveries were made in the field of technical physics. The voltaic arc was produced, for the first time in history, by L. Y. Kraft and V. V. Petrov. Academy member B. S. Jacobi discovered and developed the technique of galvanoplastics, and constructed an original telegraph and the first motor-boat, besides many other important practical discoveries. It was in Russia that the first practical sources of electric light came into being: P. N. Yablochkov's arc candle, and A. N. Lodygin's incandescent lamp, the first of its kind. Radio was first discovered by the Russian A. S. Popov. Academy member and St. Petersburg University professor E. C. Lenz was one of the founders of classical electromagnetism (Lenz's law and rules). The greatest discovery of the nineteenth century in the field of chemistry—the periodic table of chemical elements—was made in St. Petersburg, by D. I. Mendeleyev. The Pulkovo Observatory, built towards the middle of the century, was for several decades the "astronomical capital of the world." Fundamental discoveries in the fields of embryology, microbiology, and

physiology are bound up with the names of the great Russian biologists—K. Baer, A. O. Kovalevsky, I. I. Mechnikov, S. N. Vinogradsky, I. M. Sechenov, I. P. Pavlov. Geographical, ethnographical and archeological discoveries of great importance were made by N. M. Przhevalsky, N. N. Miklukho-Maklay, P. A. Kropotkin, P. K. Kozlov, and others. Nineteenth-century Russian science made basic contributions in the fields of orientalogy, language, and Russian and world history. It is impossible in so brief an article even to list all the outstanding scientific achievements attained by Russian scientists in various fields in the course of the nineteenth century.

Surely, eloquent testimony to the Russian people's urge for knowledge, to their talent and ability!

In spite of all this, however, Russian science in the nineteenth century did not become the powerful force it might have been, did not develop into a comprehensive, consistent, and systematic movement. It was not sufficiently bound up with life, and failed to produce what might be called, in chemical terms, a "chain" process of development of science and technology in Russia. It was no more than the mechanical sum of the activities of individual outstanding scientists. Only in rare cases were scientists able to found schools, to find assistants and disciples who would carry on their work. Many an important labour begun by a Russian scientist ceased with its author's death and was consigned to oblivion. Sometimes, such works were continued—abroad. This situation was caused, first and foremost, by the tsarist government's failure to appreciate Russian science, by the contempt and suspicion in which it held native endeavour and prospects. As the need for science and technology developed, the government preferred to import them, ready-made, from abroad; and Russian scientific labours, as a rule, received none but the most insignificant material

assistance from the government. Scientific research, as a profession, was limited to a very small number of persons who were retained in the universities for post-graduate work, budget appropriations for which were less than negligible. Most of the young people graduating from colleges and universities entered the fields of school teaching or industry, or engaged in other practical activities very far removed from science. Thus, Russia in the nineteenth century had many brilliant scientists and could pride herself upon a lengthy roll of momentous discoveries and inventions; but, with only rare exceptions, she had no systematically developing national science.

This discrepancy between the people's latent abilities, their aspiration to knowledge, on the one hand, and the lack of government support, on the other, became particularly marked during the last few decades before the revolution. In this period we note numerous and broadly conceived attempts to create, besides the official science vegetating in state institutions, a science supported by the public, independent of government subsidies. Numerous private colleges appeared in St. Petersburg, Moscow, and other cities. Particularly successful in St. Petersburg were the Bestuzhev courses, and the Psycho-Neurological Institute founded by Professor Lesgaft. In Moscow, a private university for women (the Women's Higher Courses), was founded and developed rapidly. There were also the Gerye courses, and the Golitsyn agricultural courses. Each of these schools offered a systematic higher education in one or several fields. Again, besides such higher schools of the generally accepted type, institutions known as "people's universities" began to spring up, almost spontaneously, in a number of cities, particularly Moscow. The people's universities engaged in the organization of popular lectures, in cycles covering the various fields of

learning and on individual scientific problems. Delivered by prominent men of science and university professors, these lectures proved a great success, and regularly drew large audiences, not only of intellectuals, but also of advanced workers. Some of the people's universities also organized laboratory work, and even trips through Russia and abroad devoted to the study of botany, geology, archaeology, and the arts. In 1911, on funds contributed by A. L. Shanyavsky, a large building was erected on the Miuss Square, Moscow, to be used as a popular university. The Shanyavsky university had well-equipped lecture halls and laboratories, and a very good library. Active centres of interesting and useful work were the scientific societies—for example, the Society of Amateurs in the Natural Sciences, Anthropology, and Ethnography, and the Natural History Society, both in Moscow. The first-named society founded an institution, the Polytechnical Museum, which to this day promotes the dissemination of scientific and technological knowledge among the population of Moscow. A society of this type would comprise a number of groups, devoted to various ramifications of its chosen field of work. At their meetings, these groups engaged in lively discussions of the latest works of Moscow scientists. Many of the city's most prominent men of science were active participants in these societies, among them the renowned botanist K. A. Timiryazev, the eminent physicist P. N. Lebedev, and the founder of Russian aeronautics, N. E. Zhukovsky. Important work was done in St. Petersburg by the Russian Physical and Chemical Society, which united the labours of all the physicists and chemists of the period. There were also active scientific societies in Kazan, Kharkov, Nizhni Novgorod and a number of other cities. An even more vivid indication of public interest in science were the big St. Petersburg and Moscow congresses of naturalists

and physicians. In all, there were twelve such congresses, of which the last, convened in Moscow at the very end of 1909, was particularly indicative. This congress had an attendance of something like six thousand. In other words, it attracted almost all the country's scientific forces in the field of medicine and natural history, down to university students of the graduating classes. Its general meetings heard reports on the most debated scientific topics of the day: on high nervous activity, by Academy member I. P. Pavlov, and on the theory of relativity, by N. A. Umov, professor of physics at Moscow University. At a session of the physics section, P. N. Lebedev reported on his amazingly delicate and important experiments in the field of light pressure. The twelfth congress of naturalists and physicians was the last and most impressive demonstration of the vigour and the quality of Russian science before the revolution.

A year after this congress, however, Moscow was the scene of events which reflected all too clearly the tragic situation of science in tsarist Russia. Student unrest at Moscow University, which was brought to the surface towards the end of 1910 in connection with the death of Tolstoy, was seized upon by the Moscow police as a pretext for invading the university. Police officers, and even the Moscow Chief of Police himself, began to appear in the professors' stands in the lecture halls where the students held their meetings. The rectors (Professor A. A. Manuilov, Academy member V. I. Vernadsky, and Professor P. A. Minakov) and most of the progressively-minded professors handed in their resignations, which were at once accepted by the Ministry of Public Education, then headed by Professor Kasso. Thus, for many years to come—in fact, until the revolution—Moscow University was deprived of the very core of its teaching staff. Outstanding scientists were replaced

by the first chance applicants. Scientific activity declined almost to nil. In order to train young scientists, the Ministry of Public Education was obliged to select politically unsuspect groups from among the graduating students and send them abroad to study, as in the days of Peter I.

Symptomatic of the period between the revolutions of 1905 and October 1917 was the immediate public support accorded to the scientists resigning from Moscow University. Many of these men continued teaching, and resumed their research work, in the private colleges mentioned above, or in the Shanyavsky people's university. Even the Imperial Academy of Sciences, or rather, the more liberally inclined of its members, made an effort to assist them. Considerable funds were collected for the building of research institutes, two of which (the Institute of Physics, on Miuss Square, and the Institute of Experimental Biology, on Vorontsovo Polye) were actually completed just before the October Revolution. Among the men who left Moscow University was the brilliant Russian physicist and experimentator P. N. Lebedev, who has already been mentioned above. Lebedev continued his work in a basement apartment in one of Moscow's side streets (at No. 20, Myortvy Lane). This basement was the scene of his last experiments, an interesting research into the nature of terrestrial magnetism. On March 14, 1912, Lebedev died. He was only 46, and it is hardly to be doubted that his death was hastened by the tragedy of Moscow University.

Publicly supported scientific activities continued to develop, despite the obstacles which the government put in their way, and during the first world war rendered considerable assistance to the front. Such public organizations as the Zemstvo Union and the Union of Towns sponsored scientific work on the development of gas masks and organized the manufacture of X-ray apparatus, telephones, thermometers, etc. In Petrograd,

the Academy of Sciences promoted public effort by organizing a large committee for the study of Russia's natural productive forces. The numerous sections of this committee engaged in the study of problems of technical physics, geology, and chemistry, the solution of which was of great assistance to the country's war industries.

And this wartime public scientific effort subsequently became a factor in many respects facilitating the accomplishment of the tremendous tasks which confronted science immediately after the victory of the socialist revolution.

The qualitative level of Russian science in the last decade preceding the revolution was very high. Brilliant work was being done in mathematics and mechanics by A. M. Lyapunov and A. N. Krylov, and in mathematical analysis, in particular, by that outstanding mathematician, V. A. Steklov. Theoretical discoveries of tremendous practical importance in the field of aerodynamics were made by N. E. Zhukovsky, S. A. Chaplygin, and K. E. Tsiolkovsky. P. N. Lebedev's work on ultra-short radio waves and on light pressure made him famous as one of the world's finest experimentators. The attainments of the older generation of physicists were paralleled by a number of important works that brought prominence to scientists of the rising generation. Such were P. P. Lazarev, who initiated modern physical research into photochemical processes; D. S. Rozhdestvensky, who elaborated an ingenious method, since established as a classic, for the quantitative determination of anomalous dispersion of metal vapour; A. F. Joffe, who became widely known for his experiments in the field of photoelectricity and the physics of crystals. In the natural sciences, Russia could boast such men as K. A. Timiryazev, then engaged in his immortal research into vegetable photosynthesis; the famous selectionist and geneticist I. V. Michurin, and the Darwinian