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Toward New Successes of Soviet Physics

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IN the summary report of the Central Committee of the Communist Party of the Soviet Union, Comrade Khrushchev expressed from the rostrum of the Congress deep gratitude to Soviet scientists for their fruitful work. This expresion of gratitude received general approval by the delegates to the congress. Outstanding among the successful accomplishments of our scientists is the work done by the Soviet physicists.

Describing the progress of Soviet science, Academician A. N. Nesmeianov, President of the U.S.S.R. Academy of Sciences, stated in his address to the Congress that "the brightest accomplishments are the recent successes in the field of atomic energy and its peaceful use. It must be noted, that we deal here not with any one particular discovery or disclosure of a secret, as it usually seems to the nonspecialist, but with a vigorous, well organized, rapid advance of the entire front of science in a field that is becoming recognized as predominant in the natural sciences.

"It was possible to organize this matter within a short period because the U.S.S.R. Academy of Sciences had already been working on radioactivity, cosmic rays, and nuclear phenomena. Thus, a certain "scientific inventory" of trained personnel was on hand to make possible this development. The success was based on the use of the entire arsenal of modern physics and the trails of investigation blazed by the theories of relativity and quantum mechanics, which are the foundations of modern physics. This unprecedented advance of science has included, as particular cases, many discoveries such as the principle (developed at the Academy of Sciences) for producing accelerators that enable charged particles to reach the colossal, indeed cosmic energies of 10 bev, and many other, no less important, discoveries.

"Even in the Sixth Five Year Plan, atomic power, though still used on an experimental scale, will produce more than twice the power generated by the stations of Tsarist Russia. Ahead of us is the mastery of control of thermonuclear reactions as a result of which one can hope that the reactions that take place in the hydrogen bomb and similar reactions will become available for the peaceful purposes of power engineering.

"A by product of this tremendous work cycle is the successful study of the application of isotopes – new elements produced by the atomic industry – to the logging of petroleum wells, to prospecting for other useful minerals, to performing gamma-ray inspection of metal articles and structures, to the preservation of health, and to the penetration of the deep mysteries of the living action of organism and its control. It is thus possible, for example, to arrest the growth of potatoes for months and conversely, to induce their growth by irradiation with gamma rays.

"In the twenties and thirties of this century, solid-state physics had been developing almost exclusively as an abstract science. Later, however this development led to the creation of semiconductors for radio instruments, to thermocouple generators, and Rochelle-salt and photocell instruments. These instruments represent a new step in technological progress and are revolutionizing at the present time contempory communication, engineering, automation, computing and control machinery – literally every branch of modern engineering.

"The latest investigations of the thermoelectric

properties of semiconductors have uncovered great possibilities for power engineering, particularly in the field of direct conversion of waste products of heat into electricity. It can be hoped that the time is near when it will become possible to convert the heat and light of the deserts directly into electric energy."

The development of atomic physics and atomic power, which can now be truly considered as key sciences, was the subject of an address to the Congress by Academician I. V. Kurchatov. Academician Kurchatov reported to the Congress that he considers "the program of the Sixth Five Year Plan covering the utilization of atomic energy for peaceful purposes, will be fulfilled and overfulfilled by the Soviet people, as will be the entire Five Year Plan".

Kurchatov next told the Congress how the task, listed in the draft of the Directives, of generating 2000-2500 megawatts of electricity from atomic power will be solved in the current Five Year Plan. "The present level of nuclear engineering shows that although the capital investment per unit of installed capacity required for atomic electric stations is approximately 1.5 times that needed for coal-burning stations, the cost per kilowatt-hour generated by a large atomic and a coal-burning station can be approximately the same. This is mostly due to negligible low fuel consumption of the atomic electric. A 500-megawatt coal-burning station requires not less than 100,000 cars of coal per year, while for an atomic electric station of equal rating only several cars of uranium per year are enough.

"It is expedient to build atomic electric stations first in regions where fuel must be supplied from a distance. The present Five Year Plan calls for the construction of two atomic electric stations in the Urals with a total capacity of 1000 magawatts. A 400 magawatt atomic station will also be constructed near Moscow. The total capacity of the atomic electric stations which should be put into operation during the current Five Year Plan, is comparable with the capacity of some of the largest electric stations in the world, such as the one in Kuibyshev.

"The Congress must be told, however, although the installed capacity of the atomic electric stations is indeed large and, according to published data, exceeds the capacity of atomic electric stations planned in the U.S.A. and in England ,the atomic electric stations built under the current Five Year Plan are by nature still a large experiment, carried out by the government to determine the most technically reliable and economical ways of erecting atomic electric stations. We must determine reliably what share of the total power capacity of our socialist government must be allotted to atomic power in the Seventh and subsequent Five-Year Plans.

"Unlike the conventional coal and oil, the nuclear fuel burned in the atomic reactors yields new substances such as plutonium and others, which do not exist in nature and which in themselves are nuclear fuels. The quantity of the new products formed depends on the conditions under which the nuclear chain reaction is carried out. Under some conditions more new nuclear fuel is formed in greater quantities, than is initially consumed in the chain reaction. This process is called expanded breeding. It is as if you were to burn coal in a furnace, and recover still more coal among the ashes.

"The process of breeding nuclear fuel in atomic reactors guarantees the economic production of nuclear energy and makes possible the use of not only uranium but also thorium.

"Topics studied in detail to date are the dependence of fission probability of various atomic nuclei on the neutron velocity, the laws of transmutation of matter in neutron and gamma fields, and the laws of retardation of neutrons and their interaction with the fission products of uranium. Many such problems can be solved only in operating reactors of some type or another.

"The current Five Year Plan calls for construction of up to ten types of atomic reactors with capacities from 50 to 200 megawatts each. Reactors will be built with fast and intermediate neutrons; with medium-energy neutrons; with graphite, beryllium or heavy-water moderators; and with gas, water, and metal cooling. A large thorium reactor will be built.

"We are carrying on work on atomic reactors jointly with the scientists and engineers of the satellite nations who are producing at home, with the cooperation of the Soviet Union, atomic reactors for scientific purposes and who are planning the construction of atomic electric stations. Our joint work with the scientists of the satellite nations will increase in scope and will undoubtedly lead to outstanding results."

The concluding portion of the address by Academician Kurchatov was devoted to the tasks of Soviet scientists in the development of atomic physics. He said: "Before us is a large program of work on atomic electric stations and atomic power installations. But Soviet scientists and nuclear specialists must not restrict their activity to the solution of these problems alone. It is also essential to develop further theoretical nuclear science so as to blaze reliable new paths

for the future technology.

"We have before us an example of how Soviet scientists and engineers solved the problem of using the nuclear energy of uranium and other heavy elements. Our successes in this field are largely due to the fact that the institutes, with whose founding the great Lenin concerned himself as early as 1918-1920, carried on persistent theoretical work on the study of the laws of atomic structure, the laws of chain reactions, the laws of structure of the atomic nucleus – theoretical work that laid out the paths now followed by our nuclear engineering.

"Soviet scientists must discover new laws of nature and gain more and more knowledge of the properties of matter. We must discover the nature of the forces binding the protons and the neutrons to each other, and the basic structural elements of the atomic nuclei. It is essential to study the structure of the protons and neutrons themselves. We must construct giant accelerators for this purpose.

"The party and the government grant liberally the requests made by scientists. This year, for example, a powerful accelerator, capable of accelerating protons to an energy of 10 bev is scheduled to go into operation. The electromagnet of this installation, the greatest in the world, weighs 36,000 tons. Even larger accelerators, capable of accelerating particles to energies of 50 bev, are now being designed.

"Theoretical work on atomic and nuclear physics has uncovered the possibility of finding new ways of utilizing atomic energy for peaceful purposes, and realizing controllable thermonuclear reactions. These reactions of synthesis or fusion are now the most important general problem of science.

"The controllable thermonuclear reaction would obtain energy not from the reserves concentrated in the atomic nuclei of the rare elements uranium and thorium, but by producing helium from hydrogen, an element widely available in nature.

"The solution of this most difficult and greatest problem would relieve humanity forever of the worry over the energy resources needed for its existence on the earth.

"We now know how to create in the hydrogen bomb the conditions for the fusion of hydrogen into helium. But it is now necessary to control this reaction so as to prevent explosion.

"We, the Soviet scientists, would like to work on the solution of this scientific problem, of greatest importance to humanity, together with the scientists of all the countries in the world, including the American scientists, whose scientific and technical accomplishments we greatly value. To make this possible we need only one thing, that the government of the United States accept the proposal of the Soviet Union for which our party is constantly struggling, that the use of atomic and hydrogen weapons be outlawed."

In its Directives the Congress has adopted many important resolutions, which will contribute to the rapid development of both theoretical and practical knowledge, and will enable our physicists to develop their work even more and result in a further flowering of physical science.

Translated by J. G. Adashko
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