Nikolaĭ Nikolaevich Semenov (On his ninetieth birthday)

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On 16 April 1986 the scientists of our country and all the Soviet people celebrate the ninetieth birthday of the most prominent scientist, the creator of a new field of science, the outstanding organizer of Soviet science Nikolaĭ Nikolaevich Semenov.

It is not often that scientific discoveries and developments of fundamental significance find such rapid and widespread recognition and effective use in practice, as was the case with the discovery of branched chemical chain reactions made by Semenov in the 1920s. This discovery signified the beginning of the rapid development of a new field of science—chemical physics, it exerted a general revolutionizing effect on the development of science and aided in the solution of many practically important problems. Among them are problems of chain and thermal explosion, propagation of flame, combustion and detonation of explosives, problems of oxidation of hydrocarbons, polymerization, stabilization of polymers, obtaining of new heat-resistant materials and much more. Developments along these directions led to practical achievements of first rank significance. The entire multifaceted activity of N. N. Semenov and the inseparably connected with it work of the Order of Lenin Institute of Chemical Physics of the Academy of Sciences of the USSR created by him in 1931 is characterized by the organic merging of fundamental scientific research with the solution of important applied problems.

NIKOLAĬ NIKOLAEVICH SEMENOV

Having completed his education in physics at the Petrograd University (1917) N. N. Semenov began his scientific research activity in the State Physico-Technical Roentgen Institute (later the Leningrad Physico-Technical Institute) created by his teacher Academician A. F. Ioffe and soon became interested in chemical processes. In 1926–1927 in his laboratory critical phenomena were discovered on the example of oxidation of phosphorus, which consisted of sudden transitions from a practical absence of a reaction to a sharp increase of its rate under a completely insignificant change of conditions—pressure of oxygen, temperature, addition of inert gases, diameter of the reaction vessel.

In 1927 N. N. Semenov explained the whole set of observed facts by putting forward the fundamental idea of branched chain reactions.

Later N. N. Semenov created a general theory encompassing both branched and unbranched chain processes. The theory was based on three simple assumptions—concerning high reactive capability of active centers and the possibility of their multiplication and destruction (within the volume or on the walls of the vessel). In the predominant majority of chemical chain reactions the active centers are atoms and free radicals, the high reaction activity of which is well known. The existence of these particles within the reaction zone in higher than equilibrium concentrations was later proved by N. N. Semenov's pupils. The above assumptions turned out to be sufficient to explain many of the regularities in the occurence of chain reactions even without making more specific the nature of the active centers. The theory includes an analysis of the behavior of reacting systems under very different conditions. It turned out to be capable not only of explaining but also of predicting new phenomena which were later discovered experimentally.

All the investigations and results accumulated by the beginning of the 1930's were presented in the famous monograph by N. N. Semenov "Chain Reactions" (1934) the appearance of which is a major landmark in the history of chemistry and of science as a whole. It was the culmination of the first stage of the development of the theory of chain reactions. Two years before the appearance of this monograph N. N. Semenov was elected a full member of the Academy of Sciences of the USSR (1932).

It became evident very soon that Semenov's theory embraces a wider range of processes than just chemical reactions. Already several years after the appearance of the book

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"Chain Reactions" nuclear branch chain reactions were discovered the regularities of which are in many respects similar to the chemical ones and are adequately explained by Semenov's theory.

The same kinetic regularities also apply to processes of stimulated emission in lasers. It is characteristic that the first chemical lasers were constructed specifically on the basis of the phenomenon discovered in the Institute of Chemical Physics of the energetic branching of chains.

The second stage of the investigations of chain reactions is characterized by a further development of the theory, supplying it with concrete chemical content, in particular the study of the relationships between reaction rates and the structure of the reacting molecules. A tremendous contribution to the study of elementary chemical processes and the investigation of radicals and radical reactions (with the aid of EPR) was also made by N. N. Semenov's pupils. At the same time an intensive introduction of the scientific results into practice was continuing. During this period N. N. Semenov's second monograph was published "On some problems of chemical kinetics and reactivity" (1954; second edition-1958).

Along with the development and widespread application of the theory of chain reactions the Institute of Chemical Physics on the initiative of N. N. Semenov began the development of a number of new scientific fields which promised to be of great practical significance. Such urgent problems were solved as fermentation catalysis, low-temperature polymerization, fixation of nitrogen from the atmosphere, metal-complex catalysis, a search was begun for new effective ways of utilizing solar energy. Research was successfully pursued in the field of molecular biology: mechanisms of functioning of biologically active systems were being studied, in particular biocatalyzers and biopolymers, the kinetics and regularities of the development of pathological processes were being investigated (radiation sickness, cancer) problems of bioenergetics were being solved and many others. N. N. Semenov created within the Institute of Chemical Physics a Department of Chemical Genetics, the work of which has tremendous significance for the national economy. In it a number of new varieties of agricultural cultures has been developed, in particular high-yield grains, new highly effective species of microorganisms were developed, etc. These achievements have been successfully introduced into the practice of agriculture.

N. N. Semenov over a number of decades carried on colossal work on scientific organization, which is necessary both for realizing scientific projects, and particularly for introducing the results of research into the national economy of the country. Several years after the Institute of Chemical Physics was transferred to Moscow (1943) the necessity of its considerable expansion became evident. In 1955 N. N. Semenov put forward the idea of creation close to Moscow near the city of Noginsk a branch (now a Division) of the Institute. In a very short time this branch became a powerful scientific institution, following which nearby in the village of Chernogolovka a number of new institutes of the Academy of Sciences was established as a result of which the Noginsk scientific center of the Academy of Sciences of the USSR was formed. N. N. Semenov was appointed the Chairman of the Council of the Directors of this center.

On the initiative of N. N. Semenov within the Siberian branch of the Academy of Sciences of the USSR an Institute of Chemical Kinetics and Combustion was created the organization of which he entrusted to his pupils. A number of other scientific research institutes was created with active participation of N. N. Semenov, among them are the Khar'kov and Tomsk Physico-Technical Institutes, the Institute of Chemical Physics of the Academy of Sciences of the Armenian SSR in Erevan.

Being convinced that only large-scale collectives of highly qualified specialists are capable of solving major scientific and applied problems successfully N. N. Semenov also devoted considerable attention to the preparation of scientific manpower. Already during the war he created the Department of Chemical Kinetics in the Moscow State University which he heads to the present day. Later he participated actively in creating the Moscow Physico-Technical Institute; in it Semenov organized a special faculty designated for the preparation of specialists in chemical physics.

The fruitful and multifaceted social and political activity of the fervent patriot, communist scientist N. N. Semenov is well known to the Soviet people. He has been three times elected as a deputy to the Supreme Soviet of the USSR, was a candidate for membership in the Central Committee of the Communist Party of the Soviet Union, for many years he was at the head of the All-Union society "Znanie" ("Knowledge"). His speeches at the XXII Congress of the Communist Party of the Soviet Union and the December (1963) Plenum of the CC of the CPSU, evoked wide response, more than one generation of our students and young scientists were brought up on his vivid articles and reports now collected together in the book "Science and Society" (Nauka, M., 1981); a large contribution to the nobel task of struggle for peace, against the threat of nuclear war was made by N. N. Semenov's participation in the Pugwash movement, by his active participation in the first Geneva meeting of the Soviet and American experts (1958) which was the start of the path which led five years later to the conclusion of an agreement on the prohibition of experimental nuclear explosions in the atmosphere, in space and under water.

N. N. Semenov has an astounding ability to fascinate others by his ideas, to infect them by his own enthusiasm. During the many years of his brilliant scientific activity a numerous constellation of his followers has grown up, of devoted pupils and of pupils who have formed a strong school of Soviet chemical-physicists, the Semenov school. This school is honorably continuing the work begun by him more than 60 years ago and is highly thought of all over the world.

The indefatigable creative activity, the remarkable talent, the clearness of purpose and the personal charm have earned for N. N. Semenov universal love, admiration and deep respect. All Soviet scientists bring their warmest congratulations to N. N. Semenov on the day of his glorious ninetieth birthday.

Translated by G. M. Volkoff