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37. The work from our laboratory was supported by grants from the National Institutes of Health (NB-02944) and the U.S. Air Force Office of Scientific Research (AFOSR-334) and by a Public Health Service postdoctoral fellowship to one of us (A.S.). We thank Baerbel Boettger for histological assistance, Doreen Davis Masterson for drawing the reconstructions, and Joanna T. Hanawalt for help with the experiments and in the preparation of the manuscript. Dr. D. M. Wilson provided us with the facilities of his laboratory for some of the histological work, and we have benefited from countless discussions with him about the problems of motor output control. Finally, we thank Drs. E. A. Kravitz and A. O. W. Stretton for making their dye-injection method available to us in advance of publication.

Atoms for Peace Awards

Six scientists are honored for their contributions in development of peaceful uses for the atom.

Robert E. Marshak

The award ceremony this year assumes a very special character. The Trustees had originally intended to take this occasion to present the last Atoms for Peace Awards to both the elder statesman of the peaceful atom, President Eisenhower, and to a relatively younger group of scientists and engineers whose recent achievements illustrate in striking and contrasting ways the peaceful uses of atomic energy. While President Eisenhower is unfortunately no longer with us, Dr. Killian's eloquent words confirm the validity of our original conception, namely to honor a group of scientists and engineers whose contributions will deeply influence the directions of research and practice for years to come in the field of atomic energy.

The selection of the six recipients of the last Atoms for Peace Award was not a simple task, and, when I complete my summary of individual contributions, I believe that it will become quite clear why the Trustees take so much satisfaction in the choices that they made. First, consider that the power and the terror and the beneficence of atomic energy all flow from the tremendous strength of the so-called nuclear force. A knowledge of the properties of the nuclear force is therefore basic to an understanding of the fission of heavy nuclei by neutrons and the fusion of light nuclei with each other.

Two Awards in Nuclear Structure Theory

It was in connection with an attempt to explain certain properties of heavy nuclei that Professors Aage Bohr and Ben Mottelson developed their famous unified collective nuclear model. The unified collective model of the nucleus reconciles in a beautiful way the shell model, developd in 1949 by Maria Mayer and J. H. D. Jensen, and the liquid drop model, developed as early as 1936 by Niels Bohr. The idea of Aage Bohr and Ben Mottelson was to retain the essential features of the shell model for the protons and neutrons inside the nucleus but to argue that, because of the collective action of the nucleons, the surface of the nucleus behaves like that of a liquid drop. By recognizing the interplay of independent particle and collective modes of motion, Bohr and Mottelson were able to explain a wide range of nuclear phenomena, such as the intrinsic deformation of heavy nuclei and the enhancement of quadrupole transitions in such nuclei. The Bohr-Mottelson theory also explains subtleties in the fission process and in the theory of superheavy nuclei. Apart from its own intrinsic importance, the work of Aage Bohr and Ben Mottelson inaugurated a new era in nuclear structure theory which has had, and will continue to have, far-reaching consequences for our basic understanding of the processes involved in the controlled release of fission energy.

Professor Aage N. Bohr was born in Copenhagen, Denmark, in 1922 and holds a Ph.D. from the University of Copenhagen. After World War II, he spent several years at the Institute for Advanced Study in Princeton and at Columbia University before returning to the Institute for Theoretical Physics of which his father, Niels Bohr, was director. In 1963, Aage Bohr succeeded his father as director of this institute,

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since renamed the Niels Bohr Institute, and he holds this position today. For his scientific accomplishments, Professor Aage Bohr has already been honored with the Dannie Heineman Prize of the American Physical Society, the Pope Pius XI Medal, and honorary degrees from the universities of Manchester and Oslo.

Professor Ben R. Mottelson, the youngest of the award recipients, was born in Chicago in 1926 and received his Ph.D. from Harvard in 1950. Like the proverbial "Man Who Came to Dinner," Professor Mottelson went to Copenhagen on a postdoctoral fellowship in 1950 and has been there ever since. In 1957, he became a professor at the Nordic Institute for Theoretical Physics and the Danes have since honored him with foreign membership in the Danish Royal Academy of Science. May the joint Atoms for Peace Award to Professors Aage Bohr and Ben Mottelson be taken as the expression of our hope for many more years of fruitful collaboration between these two distinguished scientists in the realm of nuclear structure physics.

Two Awards in Nuclear Engineering

A basic understanding of nuclear matter and a precise knowledge of the properties of heavy nuclei do not guarantee, of course, the economic viability of atomic power. The initial optimism after World War II that atomic power would be competitive with fossil fuels was soon tempered by the realization that major engineering developments were required to fulfill the hope of economic atomic power. As a result of the efforts of many applied scientists and engineers in government and industrial laboratories throughout the world, the prospects of abundant atomic power brightened about a decade ago and it is clear that atomic power will soon displace fossil fuels as our major source of energy. Two of the award winners have made major technological contributions to the success story of nuclear fission power. They are Floyd L. Culler, Jr., assistant director of the Oak Ridge National Laboratory and Compton A. Rennie, until last year chief executive of the High Temperature Reactor Project sponsored by the European Nuclear Energy Agency.

Mr. Culler was born in Washington, D.C., in 1923 and earned his chemical engineering degree from Johns Hopkins University in 1943. He has devoted his entire career to the atomic energy program at the Oak Ridge National Laboratory. During World War II, his first job was to design a processing plant for chemical purification of enriched uranium; this plant performed. In the postwar period, Mr. Culler progressed, by dint of his technical competence and leadership, to the directorship of the Chemical Technology Division at Oak Ridge. For more than a decade, Mr. Culler and his group continued to lead the way in solvent extraction technology. They received data furnished by chemists and designed processes for the separation of zirconium from hafnium, the benefaction of low-grade uranium ores, and the reprocessing of irradiated fuels. The processes developed by his group have been widely accepted in large-scale operation. This is an enviable record of achievement in the application of chemical engineering to operating processes for the production of atomic power and in the attainment of fission plants to yield low-cost electricity. At present, in addition to serving as assistant director of Oak Ridge, Mr. Culler is director of the Study of Nuclear-Power–Agro-Industrial complexes. These nuclear agro-industrial complexes—in which nuclear reactors will be used to produce both electricity and desalted water for use in industry and agriculture—ought to play a key role in raising the standard of living in underdeveloped regions of the world. Mr. Culler seems to be ever alert to the beneficient uses of atomic energy and it is only fitting that an Atoms for Peace Award be added to his other honors, which include the Lawrence Award in 1965.

In Compton Rennie, we pay tribute to an applied scientist and outstanding leader of men who started his career as a theoretical physicist. Mr. Rennie was born in Southampton, England, in 1915 and took his degree in mathematics from Cambridge University. He gained his first experience in atomic research as a member of the joint United Kingdom–Canadian team at Chalk River, Canada. He then held several positions of responsibility at the Atomic Energy Research Establishment in Harwell until 1959 when he became the head of the High Temperature Reactor Project sponsored by the European Nuclear Energy Agency. This so-called Dragon Project was a cooperative undertaking among 12 European countries to carry out research and development on helium-cooled ceramic fuel reactors and to meet the "American Challenge"! As chief executive of this pioneering project, Mr. Rennie demonstrated many remarkable qualities. Not only was he thoroughly familiar with all the theoretical, experimental, and design features of the project he was heading, but he also showed an unusual ability to assemble and direct an international staff from the participating countries. Mr. Rennie's firm belief in the Dragon Project and his tact, diplomatic skill, and sound political judgment led to several prolongations of the agreement and to the successful completion of the project in 1964. The experience gained in the Dragon Project has been of great value to the American "Peach Bottom" project and to the German "Pebble-Bed" reactor project at Karlsruhe and will permit a full assessment of the economic potential of high-temperature power reactors. Mr. Rennie left the Dragon Project as its manager last year and is now acting as a consultant on this reactor type which he considers to hold such great promise for the future of economic atomic power. The Trustees of the Atoms for Peace Award take great pleasure in recognizing Mr. Rennie's outstanding contribution to the atomic power industry through his rare combination of technical, administrative, and political talents. Our award follows humbly upon the CMG (companion of the most distinguished order of St. Michael and St. George) which Mr. Rennie received at the beginning of this year.

Two Awards for Medical and Chemical Applications

In addition to atomic power, the public has heard a great deal about the use of nuclear radiations as an investigative tool in biological and chemical studies and of their great versatility for diagnostic and therapeutic purposes in medical applications. In many ways, these facets of the peaceful atom comprise some of the most dramatic contributions to the welfare of mankind. The two remaining Atoms for Peace Award winners are in this category of outstanding performance. Dr. Henry S. Kaplan was born in Chicago in 1918 and received his M.D. from Rush Medical College and his M.S. in radiology from the University of Minnesota. He has been professor and executive head of the Radiology Department at the Stanford Medical School since 1948 and served for some years as director of the Stanford Biophysics Laboratory. At Stanford, Dr. Kaplan has made important research contributions to our understanding of the mechanisms by which exposure to x-radiation induces leukemia in mice and he has also done much to elucidate the repair process in DNA damaged by irradiation. His development of the "cancer gun" using a linear accelerator has had a profound effect on the radiation therapy of cancer and, in particular, on the modern methods of treating Hodgkin's disease, once an invariably fatal disease. By insisting on the introduction of basic radiation biology into clinical radiation therapy training programs, Dr. Kaplan has exerted a strong influence on the training of radiation therapists throughout the world. Dr. Kaplan has been honored with the Hollow Brooks Medal of the New York Academy of Sciences, the Modern Medicine Award, and with a chevalier of the French Legion of Honor. We take great satisfaction in adding our recognition of Dr. Kaplan's very outstanding medical applications of atomic energy.

My citation of Tony Turkevich has been left for last for several reasons. First, Tony must accept the fact that he is an old friend and can be treated less graciously than the other award winners. Second, it is always pleasing to a physicist to be able to call attention to a brilliant application of physical techniques in a sister science. And finally, the fact that Professor Turkevich's application of nuclear techniques involves the exciting frontier of space exploration is a fitting climax to a recital of the exceptionally rich variety of talent represented by this year's award winners. Anthony L. Turkevich was born in 1916 in New York City, received his Ph.D. from Princeton in 1940, and is now the James Franck Professor of Chemistry at the University of Chicago. The idea of analyzing the surface of the moon by means of instrumented landing became of interest to Professor Turkevich during the mid-1950's. He decided to use as his detection method the Rutherford scattering of alpha particles from strong alpha emitters (the transuranics) and alpha-proton reactions. Dr. Turkevich showed, by means of careful testing in his laboratory, that all of the light elements through iron could be analyzed by this method within an accuracy of a few percent. His experiments achieved remarkable success in three Surveyor missions in 1967, when it was established that the surface of the moon closely corresponds chemically to basalt rock. This result has had important bearings on theories of the origin of the moon. Dr. Turkevich has demonstrated his research versatility as a radiochemist by studying high-energy nuclear reactions on complex nuclei, cosmic ray–induced radioactivity in meteorites, and the radioactivity of the atmosphere. He has also made important applications of nuclear chemistry to the control of atomic weapons and served as a technical adviser to the U.S. delegation in the negotiations which led to the test ban treaty. Dr. Turkevich was the recipient of a Lawrence Award in 1962 and we are proud to honor a scientist who has devoted all his knowledge, insight, and wisdom to insure that the atom will serve man and not destroy him.