THE FERMI AWARD

The Atomic Energy Commission announced in April that, based on the unanimous recommendation of the Commission's General Advisory Committee, J. Robert Oppenheimer, director of the Institute for Advanced Study, has been named to receive the Commission's Enrico Fermi Award for 1963. The presentation ceremony is to take place in December.

In its announcement, the Commission stated that the award, consisting of a gold medal, a citation, and a prize of $50 000, will be presented to Dr. Oppenheimer "in recognition of his outstanding contributions to theoretical physics and his scientific and administrative leadership not only in the development of the atomic bomb, but also in establishing the groundwork for the many peaceful applications of atomic energy. Dr. Oppenheimer, the seventh scientist to receive the Fermi Award, is a former president of the American Physical Society.

The award, authorized under the Atomic Energy Act of 1954, was first given to the late Enrico Fermi, and the Commission decided that subsequent awards should bear his name. It complements the AEC's Ernest Orlando Lawrence Award in that it has no limit as to age or citizenship of the recipient and may be presented for especially meritorious contributions to the development, use, or control of atomic energy at any time in the past. During the last seven years, the award has been presented on these six occasions:

1956—to the late John von Neumann, "for his contributions to the theory, design, and construction of fast computers and to the role of computers in the control and use of atomic energy".

1957—to the late Ernest O. Lawrence, "for his invention and development of the cyclotron and for his many other contributions in nuclear physics and atomic energy".

1958—to Eugene P. Wigner, "for contributions to nuclear and theoretical physics, to nuclear reactor development, and to practical applications of atomic energy".

1959—to Glenn T. Seaborg, "for discoveries of plutonium and several additional elements and for leadership in the development of nuclear chemistry and atomic energy".

1961—to Hans A. Bethe, "for contributions to nuclear and theoretical physics, to peaceful uses of atomic energy, and to the security of the United States".

1962—to Edward Teller, "for contributions to chemical and nuclear physics, for his leadership in thermonuclear research, and for efforts to strengthen national security".

Nine years ago, the US Atomic Energy Commission, then functioning under another Administration and made up of other commissioners, released a statement to the press announcing that by a vote of four to one the members of the Commission had decided that Dr. Oppenheimer be denied security clearance and all access to restricted data. The one dissenting commissioner, Henry D. Smyth, declared flatly in his minority statement that the majority conclusion could not be supported by a fair evaluation of the evidence. The Commission's action had been preceded by a majority recommendation to deny clearance and a minority dissent submitted by the three members of a special personnel security board of the AEC which had held hearings on the case for several weeks during April and May of 1954. Testimony before the board was released in June 1954 by the Atomic Energy Commission in the form of a 992-page book entitled *In the Matter of J. Robert Oppenheimer, Transcript of Hearing Before Personnel Security Board*. The volume was offered for sale by the Government Printing Office at a price of $2.75 per copy.

The present Commission, in announcing the forthcoming presentation of the Fermi award, has also released a biographical sketch of Dr. Oppenheimer which, although shorter than the earlier volume, is more friendly in spirit. It is reproduced below.

Ulli Steltzer photo

J. Robert Oppenheimer, who has been named to receive the Atomic Energy Commission's Enrico Fermi Award for 1963

J. Robert Oppenheimer

Dr. J. Robert Oppenheimer was born in New York City on April 22, 1904, the son of a wealthy textile importer. His interest in science was first evident at the age of five when he began collecting rocks. He entered Harvard at the age of 18 and it was there that he became interested in theoretical physics. He graduated from Harvard, with honors, in three years and then went on to Cambridge and Göttingen, where he received his doctor's degree in the spring of 1927.

Dr. Oppenheimer returned to the United States in 1928 as a research fellow at Harvard and at the California Institute of Technology. In 1929 he again went abroad as a fellow of the International Education Board at the University of Leiden and at the Institute of Technology in Zurich. In 1929 he returned to the United States where he accepted concurrent appointments as assistant professor of physics at the California Institute of Technology and the University of California at Berkeley.

During his twelve years of service on the two faculties, Professor Oppenheimer added greatly to the advancement of science both as an inspired teacher of advanced theoretical physicists and as originator of several fundamental contributions to theoretical physics. In this capacity, he played a unique role in bringing American theoretical physics to maturity.

The school of theoretical physics developed by Professor Oppenheimer at the University of California and Caltech was unequaled in America and served as a magnet to draw talent in this field from all over the world. Many of his students have become leaders in theoretical physics throughout the world and many have made substantial contributions to the wartime and postwar atomic energy efforts of the United States. He was sought out by many visiting physicists from Europe as one from whom they also could learn in a mutual exchange of ideas at the rapidly expanding frontier of knowledge.

Professor Oppenheimer's fundamental contributions to the advancement of theoretical physics were far-ranging and profound. While working on his doctoral dissertation under Professor Max Born in Göttingen, Oppenheimer produced in 1927 a definitive work on the separation of different forms of energy in molecules.

This was followed, on his return to the United States, by a paper in *The Physical Review* (1930) on the theory of the interaction of field and matter. This work, in which Oppenheimer develops a method for the systematic integration of the relativistic wave equations for the coupling of electrons and protons with each other and with the electromagnetic field, demonstrated the impossibility of eliminating the interaction of the electric charge with its own field and the inapplicability of a theory of Dirac and Heisenberg to nuclear structure.

During the same year, Oppenheimer published an examination of a theory proposed by Dirac which had postulated a world consisting of a sea of positive and negative energy states. Oppenheimer's critique of Dirac's early formulation of the theory led Dirac to revise his theory. Several years later, together with Furry, he developed the Dirac theory further, gave a physical interpretation and subjected it to a number of independent tests which helped to place the theory on firm ground. This theory has now become one of the foundation blocks of contemporary physics.

The following year he published a paper with Ehrenfest on the statistics of the many-particle system (e.g., nuclei) which constituted strong evidence against the existence of electrons within the nucleus. After the discovery of neutrons by Chadwick the following year, protons and neutrons became the building blocks of the nucleus. This work also influenced Pauli's thinking and was in part responsible for his postulation of the existence of the neutrino.

In 1935 Oppenheimer and Phillips published a paper propounding a process whereby a neutron is captured from the deuteron as it passes the target nucleus but beyond the range of the nuclear force. This process, which has become known as the Oppenheimer-Phillips process, was experimentally confirmed by Lawrence, McMillan, and Thornton the same year.

From 1937 until he became involved in the Manhattan Project, Professor Oppenheimer's interests moved toward field theory, the theory of cosmic-ray showers and elementary-particle phenomena. Together with J. F. Carlson he published an authoritative theoretical treatment on multiplicative showers. This treatment of multiplicative and diffusion phenomena contributed to an understanding of such phenomena which have been so important in the development of military and peaceful applications of atomic energy.

After the war Oppenheimer's scientific interests remained strongly oriented toward elementary-particle and cosmic-ray phenomena. In 1946 he published a paper, together with Bethe, pointing out certain theoretical weaknesses in Heitler's theory of radiation damping. In 1947 in an invited paper before the American Physical Society he proposed an explanation of cosmic-ray showers which satisfactorily explains both the hard (nucleonic) and soft (Auger) components of such showers. In 1948, jointly with H. W. Lewis and S. A. Wouthuysen, Oppenheimer took the next major step after Heisenberg to develop a theory for multiple meson production. Contained in this paper was a postulation of nucleonic structure, a phenomenon confirmed in later years by Hofstadter, et al. The concepts contained in this paper, i.e., increasing multiplicity of meson yield with energy, were later extended to neutron emission.

Due to his experience and knowledge, Dr. Oppenheimer became involved in our efforts to produce atomic weapons almost at the beginning of the program. In the autumn of 1941 he participated in the meeting of the special committee chaired by Arthur Compton at the National Academy of Sciences to review the prospect and feasibility of the different uses of atomic energy for military purposes.

After this initial encounter with the prospect of atomic weapons, he began to make preliminary calculations about the construction and performance of atomic bombs and also began to consult with the staff of the Radiation Laboratory at Berkeley on the electromagnetic separation of uranium isotopes. Dr. Oppenheimer was also in attendance at the conference which established the Metallurgical Laboratory for the production of plutonium.

In the spring of 1942, Dr. Oppenheimer was requested by Dr. Compton to take charge of the work on the bomb itself, which was being done at a number of experimental laboratories in diverse parts of the country.

After a review of this experimental work, Dr. Oppenheimer and others concluded that in order to proceed rapidly with the development and production of atomic weapons, it would be necessary to pull all the experimental and theoretical work together under a central laboratory where information and ideas could be translated into action with a minimum of delay. He discussed this idea with General Groves, who had been assigned command of the Manhattan Engineer District, and showed General Groves as a possible site, Los Alamos, a boys ranch near the Oppenheimer summer ranch home. General Groves took immediate steps to acquire the site, and early in 1943 General Groves and Dr. Conant appointed Dr. Oppenheimer as director of the laboratory.

Dr. Oppenheimer's major initial problem as director of the laboratory was the recruitment of qualified scientific personnel who were understandably reluctant to come to work at a remote site on a project about which they could be told very little. In the hurried days of late 1942 and early 1943 he was also faced with the physical problems of getting the laboratory facilities constructed in the face of competition from laboratories and arms plants already geared to war production, particularly in obtaining of priorities for scarce materials. The fact that Los Alamos was some distance from major rail and transportation facilities further complicated this problem. However, due to Dr. Oppenheimer's knowledge of the location and capabilities of competent scientific personnel throughout the country he was able to recruit the necessary talent and began the formidable task of putting the laboratory together. Through his scientific and administrative leadership this difficult task was accomplished in a minimum amount of time considering the problems involved, and the actual theoretical and experimental work on the bomb itself was started under his guidance.

Dr. Oppenheimer's success in the direction and coordination of this effort, which involved the forging together of many diverse experiments and the interbreeding of ideas from a dedicated but heterogeneous staff of scientists, is a story which has been rather thoroughly related by now. The proof of this success was well noted with the explosion of the first atomic device on July 16, 1945, at Alamogordo.

Dr. Oppenheimer resigned as director of the Los Alamos Scientific Laboratory in October 1945, but was instrumental in the preparation of the legislation for the Atomic Energy Act of 1946 and in the development of the Baruch Plan for international control of atomic energy.

In 1947, Dr. Oppenheimer went to Princeton as director of the Institute for Advanced Study. During the period of 1947 through 1952 he also served as chairman of the General Advisory Committee to the Atomic Energy Commission.

He is at present the director of the Institute for Advanced Study at Princeton and is considered one of the top ten theoretical physicists in the country today. Dr. Oppenheimer is a member of the National Academy of Sciences, a fellow of the American Academy of Arts and Sciences, the American Physical Society, and the Royal Danish Academy. He served as a member of the Board of Overseers of Harvard College from 1949 to 1955.

Dr. Oppenheimer married Katherine Harrison in November 1940 and they have two children, Peter and Katherine. The Oppenheimers reside at Olden Manor in Princeton, New Jersey.

Appendix

Dr. Oppenheimer's return to the United States was followed by the publication of a succession of important papers, among which were:

1. Divergence of Field Theory: "Note on the Theory of the Interaction of Field and Matter" [Phys. Rev. **35**, 461 (1930)]. Develops a method for the systematic integration of the relativistic wave equations for the coupling of electrons and protons with each other and with the electromagnetic field. Demonstrates impossibility of eliminating the interaction of a charge with its own field and inapplicability of the theory of Heisenberg and Dirac [Z. Physik. **56**, 1 (1929)] to nuclear structure.

2. Existence of Antiproton: "On the Theory of Electrons and Protons" [Phys. Rev. **35**, 562 (1930)]. In this "Letter to the Editor" Oppenheimer examines the theory proposed by Dirac which postulates a world of positive and negative energy states. According to the present-day version of Dirac's theory, in such a world, the familiar stable particles of physics, e.g., the electron and proton, occupy positive energy states. The negative energy states are presumed to be always fully occupied. A hole in the sea of negative energy states, if there were one, would manifest itself as a new kind of particle unknown, at the time the theory was proposed (1931) to experimental physics and having the same mass and opposite charge to an ordinary electron. Such a particle was called an "antielectron". This particle was discovered the following year by C. D. Anderson and is now known as the positron. Oppenheimer pointed out a number of difficulties contained in the earlier version of the Dirac theory—in particular, Dirac's earlier formulation identified protons with holes in negative energy states. This gave rise to an infinite divergence in the electric field unless there is everywhere an infinite density of positive electricity. It also gave rise to discrepancies between calculated and observed scattering probabilities. To get around this, Oppenheimer suggested that all negative energy states are filled.

This work influenced Dirac's thinking and led him to postulate the existence of the antiproton the following year. Several years later this particle was observed to occur in nature under high-energy particle bombardment.

3. Statistics of Many-Particle Systems: "Note on the Statistics of Nuclei" [Phys. Rev. **37**, 333 (1931)]. In the early 1930's when wave mechanics was being introduced in the treatment of nuclear problems our understanding of the spins and statistics of nuclei were gradually becoming clear. However, the fundamental constituents of nuclei were still protons and electrons. Therefore, according to the Ehrenfest and Oppenheimer theorem [Phys. Rev. **37**, 333 (1931)] the N^{14} nucleus was supposed to obey Fermi-Dirac statistics. However, the determination of the statistics of N^{14} revealed that this nucleus follows Bose-Einstein statistics, contrary to expectation, and therefore constituted strong evidence against the proton-electron hypothesis. The consideration of nuclear spins led to the same conclusion and it was therefore necessary to exclude electrons from the nucleus. After the discovery of the neutron by Chadwick in 1932, the alternative nuclear building blocks became, of course, protons and neutrons—a concept to which we now hold.

This work also influenced Pauli's thinking and was in part responsible for his postulation in 1931 of the existence of the neutrino.

4. Positron Theory: "On the Theory of the Electron and Positive" [Phys. Rev. **45**, 245 (1934)]. Oppenheimer and Furry develop the Dirac suggestions postulating electrons and positrons from positive and negative energy states of matter. The theory is given physical interpretation and subjected to a number of independent tests which help to establish the validity of the suggestion. This concept of Dirac has now emerged as one of the foundation blocks of contemporary physics.

5. Oppenheimer-Phillips Process: "Note on the Transmutation Function for Deuterons" [Phys. Rev. **48**, 500 (1935)]. Because of the finite size and ready polarizability of the deuteron, Oppenheimer and Phillips show that neutron capture from the deuteron takes place as the deuteron passes the target nucleus. This process accounted for the breakdown of the Coulomb potential at large distances ($\sim 1.5 \times 10^{-12}$ cm for copper) and accounted for an appreciable probability for neutron capture even when the deuteron passed the target nucleus at distances appreciably beyond the range of nuclear forces. The process was experimentally confirmed by E. O. Lawrence, E. McMillan, and R. L. Thornton [Phys. Rev. **48**, 493 (1935)] and constitutes a significant contribution to our understanding of nuclear processes.

6. Shower Theory: "On Multiplicative Showers" [Phys. Rev. **51**, 220 (1937)] and many later papers. This work of J. F. Carlson and J. R. Oppenheimer constitutes an early authoritative theoretical treatment of the phenomenon of pair production and radiation in the domain of cosmic-ray energies and constitutes one of the forerunners of the field now referred to as high-energy and cosmic-ray physics. The article provides a theoretical basis for "shower" or "burst" buildup by multiplicative processes stemming from very-high-energy primary particles. The theoretical treatment of diffusion phenomena, carried through the analytic solution of the diffusion equations, contributed to an understanding of multiplicative and diffusion processes which has been so important throughout the development of military and peaceful applications of atomic energy.

7. Radiative Corrections: "Reaction of Radiation on Electron Scattering and Heitler's Theory of Radiation Damping" [Phys. Rev. **70**, 451 (1946)]. H. A. Bethe and J. R. Oppenheimer demonstrate in this article certain inherent weaknesses in Heitler's theory of radiation damping. These weaknesses had to do with the breakdown of quantum electrodynamics at very long and very short wavelengths and they show the need for introducing corrective terms to avoid the so-called "infrared and ultraviolet catastrophes". They postulated that a new kind of length would be involved in a correct solution, above which extant quantum theory would be valid and below which new phenomena would have to be taken into account. Current concern about the breakdown of quantum electrodynamics at very high energies constitutes one of the many challenging and interesting subjects of study in present-day high-energy physics.

8. π^0 as Origin of Auger Showers: "Creation and Destruction of Mesons" [Phys. Rev. **71**, 462 (1947)]. Auger showers, which we now believe to be the latest stage in the development of the most energetic penetrating showers produced by the primary cosmic radiation, contain both hard (penetrating narrow-cone) and soft (low-penetration, wide-cone) components. During the late 1940's such cosmic-ray showers presented a real problem of interpretation since the processes responsible for the hard component could not also explain the soft. According to the explanation of Oppenheimer, the soft component of an Auger shower is the electron-photon cascade of the decay gamma rays arising from the π^0 mesons produced in the initial nuclear collision at the top of the atmosphere. The penetrating component is the result of a nucleonic cascade of the charged π mesons and nucleons produced in the same event.

9. Multiple Production of Mesons: "The Multiple Production of Mesons" [Phys. Rev. **73**, 127 (1948)]. W. Heisenberg was the first to argue (1939) that the production of many mesons in a single nucleon-nucleon collision should play an important role at relativistic nucleon energies. The second major attempt to develop a theory of multiple meson production was made by H. W. Lewis, J. R. Oppenheimer, and S. A. Wouthuysen. In a paper which postulated nucleonic structure, a phenomenon confirmed in later years by the experiments of Hofstadter, et al., Lewis, Oppenheimer, and Wouthuysen discuss the impacts of nucleons at very high energies—impacts which lead to multiple meson emission of increasing multiplicity with energy. It was the same concept extended to neutron emission of increasing multiplicity with energy, that led to the concept of the MTA Project. In the latter case, the process proved to be physically sound, but economically unattractive.