and I share the honor with my co-workers past and present."

The development of the cyclotron has taken the united efforts of many most capable and willing workers, but it is the ability and the inspiration of Lawrence that have brought these workers together, and have held them together, in spite of every obstacle, until to-day the Radiation Laboratory represents as fine a piece of cooperative effort as exists in the annals of science. I therefore pay tribute to Dr. Lawrence not only as a scientist of real distinction, but as one who exemplifies the best in scientific ideals.

RESPONSE

By Dr. ERNEST O. LAWRENCE

PROFESSOR OF PHYSICS AND DIRECTOR OF THE RADIATION LABORATORY, UNIVERSITY OF CALIFORNIA

Mr. President, Mr. Consul-General, Professor Birge, Ladies and Gentlemen:

WORDS fail me in giving expression to my thoughts on this occasion. To convey to you, Mr. Consul-General, and through you to the Royal Swedish Academy of Science my profound gratitude for this great honor would be giving expression to only a part of what is in my mind; for I am mindful that scientific achievement is rooted in the past, is cultivated to full stature by many contemporaries and flourishes only in a favorable environment. No individual is alone responsible for a single stepping stone along the path of progress, and where the path is smooth progress is most rapid. In my own work this has been particularly true. From the beginning of the Radiation Laboratory, I have had the rare good fortune of being in the center of a group of men of high ability, enthusiastic and completely devoted to scientific pursuits. I wish it were possible this evening for me to pay tribute individually to them all, for it was our joint endeavors that made possible the work which has been so magnificently recognized by the Nobel award; but I must content myself with accepting this great honor with the happy thought that I am the representative of these valued associates and friends.

I know also that I speak for my colleagues in the Radiation Laboratory as well as for myself when I take this felicitous opportunity to acknowledge with sincere gratitude the generous help we have received from many sources. The day when the scientist, no matter how devoted, may make significant progress alone and without material help is past. This fact is most self-evident in our work. Instead of an attic with a few test-tubes, bits of wire and odds and ends, the attack on the atomic nucleus has required the development and construction of great instruments on an engineering scale. This has been possible only through generous assistance from several quarters—notably the Research Corporation, the Chemical Foundation, the Rockefeller Foundation and from the late William H. Crocker, regent of the university. These benefactors share the honor of this occasion because without their help the work of our laboratory could not have been brought to its present fruition.

I have suggested that scientific progress requires a favorable environment. The University of California rightfully takes pride in the Nobel award because the university as a whole has contributed immeasurably in diverse ways to the work of the Radiation Laboratory. I shall always be grateful for the wise and generous guidance and help that our work has received from the University Board of Research, and especially from Professor Leuschner, chairman of the Research Board, in the early years of organization of the laboratory, and above all may I acknowledge my deep appreciation of the support of the president of the university, who whole-heartedly has been all along such a stimulus to our activities. It may truly be said that this Nobel award is yet another tribute to his great academic leadership.

It is a source of gratification to us all that we have been able to contribute a little to our understanding of the nucleus of the atom. We are glad that already in these early beginnings discoveries have emerged of immediate practical significance—for, as Professor Birge has so graciously said this evening, the new radiations and radioactive substances have opened vistas for all the sciences, especially in medicine. And in the Radiation Laboratory we count it a privilege to do everything we can to assist our medical colleagues in the application of these new tools to the problems of human suffering.

At the same time we have been looking towards the new frontier in the atom, the domain of energies above a hundred million volts, for we have every reason to believe that there lies ahead for exploration a territory with treasures transcending anything thus far unearthed. To penetrate this new frontier will require the building of a giant cyclotron, perhaps weighing more than 4,000 tons—twenty times larger than the new medical cyclotron of the Crocker Laboratory. We have been working on the designs of such a great instrument and are convinced that there are no insurmountable technical difficulties in the way of produc-

ing atomic projectiles of energies well above one hundred million volts, but of course such a great instrument would involve a large expenditure, and there is therefore a very considerable financial problem. Perhaps I might say that the difficulties in the way of crossing the next frontier in the atom are no longer in our laboratory; we have handed the problem over to the president!

Professor Birge has alluded to the very great importance of this project. As he has indicated, there are substantial prospects that it will be the instrumentality for finding the key to the almost limitless reservoir of energy in the heart of the atom. Certainly, it may bring to light such a deeper knowledge of the structure of matter as to constitute a veritable discontinuity in the progress of science.

Therefore, Mr. Consul-General, I believe that in this instance the award of the Nobel Prize is accomplishing to an unusual degree the purpose intended by Alfred Nobel—the encouragement of fundamental scientific research. For it goes without saying that such a great recognition at this time will aid tremendously our efforts to find the necessarily large funds for the next voyage of exploration farther into the depths of the atom, and let us cherish the hope that the day is not far distant when we will be in the midst of this new adventure.

In closing, may I again give expression to a profound feeling of gratitude and appreciation for this great honor, which I share with the university and with all those outside who have contributed to make our work possible and above all with my valued colleagues and co-workers, both past and present.

OBITUARY

FERDINAND ELLERMAN

FERDINAND ELLERMAN, a member of the staff of the Mount Wilson Observatory from its establishment in 1904, died of pneumonia on March 20, 1940, at the Queen of the Angels Hospital in Los Angeles, California. With a heart in a somewhat weakened condition, his strength was insufficient to rally from an attack of influenza which developed rapidly into the more serious disease. His wife, Hermine Hoenny Ellerman, and daughter, Louise Ellerman Burnett, survive him.

Ellerman was born at Centralia, Illinois, on May 13, 1869, and received a high-school education. For a few years he was in the employ of a commercial firm in Chicago, where he acquired marked skill in photography and in the use of machine tools. Dr. George E. Hale, himself but one year older than Ellerman, was at this time organizing his private observatory at Kenwood in Chicago and, needing an assistant, offered the position to Ellerman. This was in 1892, and the relationship begun at this time continued for nearly half a century until Hale's death in 1938.

Although without early training in astronomy, Ellerman rapidly gained a wide knowledge of its physical aspects and especially of solar spectroscopy. He was a remarkably skilful observer, and during the years at the Kenwood Observatory, 1892–1895, he contributed greatly to the notable work in solar physics in which Hale was engaged. Particularly in the development of the spectroheliograph, which Hale had designed, Ellerman's instrumental ability proved of the greatest value.

With the establishment of the Yerkes Observatory Ellerman went with Hale into the larger field of activity which the equipment provided. He aided in the design, construction and use of the Rumford spectroheliograph, which on the 40-inch telescope yielded some of the finest photographs of prominences and the upper solar atmosphere ever obtained. He also took part in solar and stellar spectroscopy, and his observations of N-type stars form an excellent illustration of a difficult investigation carried out with extraordinary patience and ability.

In 1904, when Dr. Hale decided to test observing conditions on Mount Wilson in California, Ellerman's observational skill and resourcefulness were called into play and were invaluable during the development of the observatory under the pioneering conditions of those early years. He took an active part in the investigations which led to the brilliant discoveries of solar vortices, the magnetic field of sunspots and the general field of the sun; and in later years to the discovery of the reversal of the sign of the magnetic field of spots with the sunspot cycle. He made many observations of sunspot spectra, and the Mount Wilson map of the sunspot spectrum was prepared by Ellerman almost wholly from his own negatives. His photographic skill, his inventive ability and his love of experimentation made numberless contributions to the successful operation of the observatory, and every one of his associates benefited extensively through his wide experience and friendly cooperation. The honorary degree of A.M. was conferred upon him in 1927 by Occidental College in recognition of his services to astrophysics.

Ellerman had many interests outside of his scientific work. He was fond of sports, of mountain climbing and of nature in all its aspects. Life on a mountain top was a constant delight to him. Although for nearly forty years he had suffered from the loss of