tivities in the field of radio astronomy, communication and radar. Especially, in radio astronomy where the signal strength is much smaller than the noise of the presently available amplifiers, this new principle of amplification would have very fruitful applications. Masers can be designed to oscillate at very stable frequencies, thus providing highly accurate time standards.

A. JAYARAMAN.

MAX PLANCK

THERE are events in the development of Physics which reach far beyond the boundaries of science and have a decisive influence on the fate of humanity as a whole. Max Planck's *Quantum Theory* is an example of such a revolution of thought. Twenty-third April 1958 marks the 100th Anniversary of the birth of one of the greatest theoretical physicists of our times. Max Planck was born in Kiel on April 23, 1858, of family which had produced many government officials, jurists and scientists. When he was nine years old, his family moved to Munich. There, he attended the Maximillan Gymnasium and studied at the University for three years, acquiring a solid knowledge of Physics. However, the real spirit of research in Physics became apparent to him, only when he first came into touch with the work of Helmholtz, Kirchhoff and Clausius in Berlin.

Until 1877, Max Planck was a University Instructor in Munich. Two years later the Philosophy Faculty of the University of Berlin offered him a chair. Thus, Planck came in a world centre of science to work at the side of his venerated and admired Helmholtz. Here he advanced his thermodynamic research and arrived, thereby, at an entirely new field—Thermal Radiation.

From 1896 onwards Planck's principal goal was the theoretical derivation of the Laws of Radiation. Entropy had always appeared to him to be the essential concept of the Thermal Theory. Planck then turned to radiation and discovered the famous Radiation Formula which he made public at a Meeting of the Berlin Physics Society on October 19, 1900. He recognized that radiated energy was not arbitrarily divisible, but had a type of atomic structure, or, as Planck said, exists in an ascertainable fixed quantum. The radiated energy quantum of a fixed frequency is proportionate; the proportionality factor signified by letter 'h' is a universal constant, which Planck called the efficiency quantum—usually called simply "Planck's Constant".

In 1905, Einstein took up the quantum idea. He showed that Planck's first interpolative derivation of the Radiation Formula can be so expanded that the existence of the energy quantum appears to be an inevitable result of the observed spectrum of thermal radiation. He further showed that there are many other phenomena of an entirely different sort where the quantum comes under observation directly, as light quanta—or, as it is called today, a Photon—for instance in photo-electric effect.

At the insistence of Planck, Einstein was called to Berlin in 1913 to a special position in the Prussian Academy where he could pursue his research without the burden of teaching duties.

Through the united efforts of Planck and Einstein, Berlin was the world centre of theoretical physics for almost twenty years. Two of the most eminent of them, Max von Laue and Lise Meitner, also worked in Berlin in this period and contributed to the lustre of physics in that Capital. Students who wished to hear Planck's famous lectures streamed in, from every land. These lectures were printed in six small volumes and contributed much to the dissemination of Planck's ideas. Planck was made permanent Secretary of the Mathematics and Physics Department of the Berlin Academy and gave much time and effort to this task. In 1928 at the age of seventy he retired from his teaching position at the University of Berlin. His successor was Erwin Schrödinger, one of the discoverers of wave mechanics. However, Planck retained the leading position at the Academy.

When the National Socialists seized power in 1933 and began to dismiss many officials and professors because of political unacceptability or Jewish ancestry, Planck, as President of the Kaiser Wilhelm Society, attempted to intervene with Hitler on behalf of various colleagues. He had no success. Einstein announced his withdrawal from the Academy and thereby spared his friend the humiliation of having to inform him of his expulsion. Schrödinger, although uncontested, resigned his Professorship of his own free will and went abroad. The great period of theoretical physics was over in Berlin.

The final stage of the war brought Planck his most severe trial. His son, Erwin, the only surviving child of his first marriage, was involved in the attempt on Hitler's life on July 20, 1944, and condemned to death. Then, Planck stood before the most difficult decision that can confront a man. A reprieve was offered to his son provided Planck signed an oath of loyalty to Hitler. He refused the signature and his son was executed.

Planck's house in the Grunewald, a suburb of Berlin, was destroyed in an air raid and all his possessions including his valuable library were lost. Together with his wife, he took refuge on an estate of a friend at Rogätz near Magdeburg. There, they were caught between the advancing Allied armies and the retreating German army. The battle roared around them for days, until finally they were brought to Göttingen by American troops. Planck found a new, simple home in Göttingen, but hardly ever came to rest there since he felt it his duty to accept invitations to lecture, which carried him on long and strenuous journeys.

In 1946, Planck took part in the observance of the 200th anniversary of Newton's death (postponed), which was arranged by the Royal Society in London, and was honoured as the founder of a new research period in physics. Honours of every sort were heaped upon him—Doctorates of all Faculties in many lands; memberships or honorary memberships in leading Academies; the Nobel Prize of 1919; the Goethe Prize of the City of Frankfurt for 1946, and many other prizes, orders and medals.

A great celebration was planned in honour of his ninetieth birthday. However, a month prior to this day, Planck's health broke and he died in Göttingen on October 4, 1947. A memorial service was held on April 25, 1948, in Göttingen in which representatives from all over the world as well as from all parts of Germany participated.

Today, more than fifty years after his great discovery, the significance of Planck's life work can well be assessed. Through Planck's thought, nuclear physics has become an exact science, with its own laws which differ in a characteristic manner from those of the classical theory. With the passage of time these laws have been systematized under the names Quantum Mechanics and Quantum Electro-Dynamics, to a perfection equalling that of the classical Celestial Mechanics which until 1900, was considered to be the model of an exact theory. The Nuclear Age, on the crest of which we stand, with all its hopes and dangers, would be unimaginable without the theoretical equipment provided by the Quantum Theory.

NEW TYPE OF REFLEXES

THE discovery of a new type of reflexes has been announced by Leonid Krushinsky, Professor of Physiology, at Moscow University.

Krushinsky has been studying reflexes in animals for a long time and his experiments have led him to the conclusion that animals, besides having conditioned and unconditioned reflexes, have a third type which he calls extrapolationary or prognosticating reflexes. This type is the basis of rational activity and of the ability of highly organised beings to conceive a picture of a process as a whole, to compare individual phenomena and foresee future events whose causes are sensed by the organs of the animal.

He has established that certain species of animals and birds possess extrapolationary reflexes in varying degrees of development which is a direct result of their environment. They are innate, but become manifest when sufficient experience has been gained.

Krushinsky believes that the basis for the emergence of these reflexes is the existence in the cortex of the brain of special neuron apparatus—"an operative memory"—which selects and records the natural regularity of certain changes, the direction and speed of movements in particular. It is the knowledge of these regularities that makes it possible to forecast (extrapolate) the subsequent changes and to react to them properly.

Thus, this new type of reflexes, in contrast to the conditioned and unconditioned, is not a direct reaction to a stimulant acting at a given moment. Moreover, in certain cases they may clash with conditioned reflexes since the latter form the basis of more or less stereotyped action.

According to the degree of development of its extrapolationary reflexes, the animal is capable of solving problems of varying complexity. Experience has shown that an animal compelled to solve problems above its possibilities develops a nervous breakdown and sickness. Overstraining the extrapolationary reflexes results in neuroses.