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SIR EDWARD VICTOR APPLETON

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SIR EDWARD VICTOR APPLETON

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Pontifical Academician

SVMMARIVM — Agitur de publico praeconio quod Auctor — cum Sessio Plenaria Pontificae Academiae Scientiarum haberetur — die 27 Aprilis 1968 recitavit.

Sir Edward Victor Appleton died three years ago in Edinburgh in his 73rd year. At the time of his death which was sudden and unexpected, Sir Edward had been Principal and Vice-Chancellor of Edinburgh University for sixteen years. He had been an eminently successful Principal, a most inspiring guide and imaginative leader whose services to Edinburgh University had been all the more deeply appreciated as he had presided over the University at a time of most remarkable change and expansion.

However, great as Sir Edward's distinction was as a Principal of a modern University, and, earlier, as a public servant of the first importance, his fame in the community of scientists rests, of course, on his achievements in the field

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which he largely created and which we now call ionospheric physics. Appleton was the first actually to demonstrate the existence of an ionosphere and to make detailed investigations of its structure and its variations. His work has been of profound importance for the theory of the influence of solar radiation on the ionization of the upper layers of our atmosphere and thereby on the physics of near space. It has been no less fundamental for the practical problem of long-distance radio communication.

When the Nobel prize in physics was awarded to Sir Edward Appleton in 1947, it was, as the citation said, for his work on the physical properties of the upper atmosphere and especially for his discovery of the ionospheric region called the « Appleton Layer ».

Appleton's interest in radio wave propagation started in the first Word War during which, after his graduation in Cambridge, he became a wireless officer with the rank of Captain in the Corps of Royal Engineers. In the war he had become familiar with the use of thermionic valves which were then quite new and with which relatively powerful transmitters and receivers could be built. Appleton became interested in the problem of the apparent fading of radio signals and after his return in 1919 to the Cavendish Laboratory in Cambridge which was then directed by Lord Rutherford, Appleton conceived the notion that the fading of radio waves might be due to interference between waves travelling along the surface of the Earth and others reflected from an ionized layer high in the Earth's atmosphere.

The idea that wireless waves were reflected from the upper atmosphere was not new; the existence of an electrified layer at great height had been postulated independently by Oliver Heaviside and A.E. Kennelly as early as 1902. Both had suggested that long wireless waves were guided across the Atlantic by a reflecting layer high in the atmosphere and that their reflection might account for the transmission of

wireless signals from England to Newfoundland which had been effected by Marconi. However, this was at the time nothing more than a suggestion; there was no actual indication of the existence of such a layer, let alone of its nature or its height.

Appleton's systematic work on wireless propagation was started in 1924 with the assistance of Miles Barnett who had arrived in Cambridge from New Zealand. They recorded the strength of wireless signals received at Cambridge from the Broadcasting Station in London. The signals were found to be almost constant in daytime, but variable in strength at night. Appleton suggested that this night-time variation or fading was due to interference between a wave travelling along the ground and another reflected from a layer high in the atmosphere. And it occurred to him that these experiences with radio waves were similar to what one observes with light waves when a Lloyd's mirror is used and when there is interference between a direct ray and a ray reflected from a plane mirror.

Following up this line of thought, Appleton suggested that the interference pattern of the wireless waves should depend on the wavelength of the transmitter, and that by altering the wavelength and observing the corresponding interference pattern, one should be able to determine the actual height of the reflecting layer.

The historical experiment was carried out by Appleton on 11th December 1924 using the B.B.C. transmitter at Bournemouth and receiving apparatus at Oxford, at a distance of about 100 Kilometres. The experiment entirely confirmed Appleton's interpretation of the observed phenomenon of wireless fading; it established for the first time the existence of an ionized reflecting layer above the ground and gave its height as about 90 Km.

This crucial experiment was made just after Appleton had left Cambridge to occupy the Wheatstone Chair of Phy-

sics at King's College, London, in October 1924. The experiment determined entirely Appleton's future work. He dropped all his other research interests and concentrated his energies on the detailed investigation of the ionosphere.

Appleton soon found that the degree of reflection and the height of the ionized layer depend on the varying intensity of the ionizing solar radiation. He demonstrated the change of height during the solar eclipse of 1927. He also noticed that just before dawn recombination of ions produces a reduction of ionization in the layer which makes it transparent to radio waves. He established that at such times reflection took place at a second upper layer of intense ionization at about twice the height of the original one. Appleton called the upper layer the F-layer and the lower or Heaviside layer the E-layer. It is the upper layer, the F-layer, which is frequently called the Appleton layer.

The detailed investigation of the structure and the properties of the layers engaged Appleton for the rest of his life. He soon began using the method of transmitting short radio pulses vertically and of recording their echoes to find the height of reflection. He established the fact that the Earth's magnetic field makes the ionosphere a doubly-refracting medium which leads to a doubling of the echoes.

Mention must also be made of the relation which Appleton deduced between the electron density and the critical penetration frequency. This enabled him to find the maximum electron density for any layer in the ionosphere and to investigate experimentally how this density depends upon the time of day, the season of the year, the degree of solar activity, and in general, any event which governs the rate of solar ionizing radiation. In 1937 he was able with the help of refined statistical analysis to demonstrate that there is a lunar tidal variation in the height of the E-layer which is about 2 Km. higher when the Moon is full than when it is new.

In his later years, Appleton devoted much time to a statistical analysis of ionospheric results from observatories all over the world. From such an analysis he was able to establish the fact which is now widely accepted that the structure of the upper F-layer of the ionosphere is controlled by the Earth's magnetic field.

Appleton took at all times a very active part in international investigations of the upper atmosphere such as the second International Polar Year in 1932/33, and in particular, the International Geophysical Year 1957/58 in which nearly 70 countries and more than a thousand observatories were engaged in studies of the electrical properties of the upper atmosphere, all of which may be said to have sprung from Appleton's part in U.R.S.I., the International Union of Scientific Radio of which he was President from 1934 to 1952.

Appleton was born in Bradford in Yorkshire for which he had a great affection and where he is now buried. He went to St. John's College, Cambridge, in 1911 and graduated with First Class Honours in 1914. His service in the first World War has already been mentioned, and also that immediately after the end of war he returned to Cambridge to start his ionospheric work at the Cavendish Laboratory. In 1924, at the age of 32, he was appointed to the Wheatstone Chair in London where he carried out much of his fundamental work. He returned to Cambridge in 1936 to occupy the Jacksonian Chair in which his predecessor had been his friend C.T.R. Wilson. In 1939 he became Secretary of the Department of Scientific and Industrial Research, a most important post in which almost his first task was to switch the activities of the Department from civil science to those which would assist the country's war effort. Appleton can take much of the credit for the construction of the radar defence network which allowed Great Britain to survive in 1940.

In 1949 Appleton returned to academic work as Principal and Vice Chancellor of Edinburgh University. His sixteen

years in Edinburgh covered a period in which the University expanded and changed out of all recognition. His wide experience and his intimate knowledge of both the scientific and the Governmental world made him an ideal leader at such a period. His many publications and addresses such as his Reith Lectures on « Science and the Nation » continued to command the attention and respect of a learned international audience.

Appleton took an immense interest in promising new fields of science, and it was in his room at Edinburgh University that the final discussions took place which led to the construction of the great 250 feet radio telescope at Jodrell Bank. He was immensely pleased when it became possible with the help of artificial satellites to sound the ionosphere from above. He worked on problems of the ionosphere right up to the moment of his death. It was a common experience to see Appleton at the end of a meeting concerned with University matters pull out from his drawer a set of notes or graphs and talk about his most recent findings with obvious delight. He kept in the closest touch with all ionospheric work through the Journal of Atmospheric and Terrestrial Physics which he edited and which was known throughout the world as « Appleton's Journal ».

It has already been said that Appleton was an outstanding Principal of Edinburgh University. He was a wise Chairman of incredibly retentive memory, of great patience and with a strong sense of justice ensuring to give bis due to every man. His enthusiasm for the doings of the young seemed to increase as his years advanced, and this earned him both the affection and the respect of students.

This is not the time to mention the countless honours and decorations which were bestowed on him by learned institutions and Governments from all over the world. I know that among those which he cherished most was his election into the Pontifical Academy in 1948.

The University of Edinburgh has dedicated one of its new Science Buildings to the memory of Appleton, and you will find in the Entrance Hall of the « Appleton Tower » a show case containing all the many decorations and medals which Appleton received during his life and which were bequeathed to the University by his family. Right in the centre of these and beautifully displayed is the chain of the Pontifical Academy.