for example, those of Chalcidice, Corinth and Heraclion in Crete, etc.

The need for compiling a general geological map, even on the scale of 1 : 300,000, which would be of fundamental assistance to the various State services and to private individuals requiring general knowledge of the geological formations of each area, led me to begin the publication of such a map in 1936. In this work I made use of all the geological surveys made by foreign and Greek geologists published up to that time. All my maps were produced to a scale of 1 : 300,000 with identical conventional signs. So far only six sheets of this geological map have been published.

I have studied the geological formations and the hydrogeological conditions of the region of the dam and artificial lake of Marathon, from which the city of Athens to-day is supplied by water. I have also made geological surveys of some river valleys to investigate the possibilities of building dams to harness these rivers for electric power.

The Geological Survey now has a fully equipped chemical laboratory for the chemical analysis of the ores and rocks of the country and also for the physical, chemical and physico-chemical study of the mineral waters of Greece.

Greece is extremely rich in hot springs. The principal springs had already been examined chemically and classified, but on an out-of-date scientific basis ; the Geological Survey has therefore classified each spring on modern scientific principles. These studies brought to our knowledge for the first time new varieties of spring as, for example, the radioactive springs of Kammena-Vourla (with a radioactive capacity of 120–300 Mache units) and of the Island of Icaria (with a capacity of up to 400 Mache units).

The Geological Survey of Greece has also carried out purely scientific studies. It observed and studied the two eruptions of the volcano of the Island of Santorin which took place in 1925–26 and in 1928. The results of the investigation of these eruptions were published, together with those made by the German Scientific Mission which came to Santorin, in Berlin in three volumes under the title "Santorin".

I organised a special section within the Geological Survey for the study of Greek soils. This section examined and classified the various soils in Greece and published several original monographs on some of the types of soil.

In my capacity since 1936 as professor of mineralogy and petrology in the University of Athens I have studied the phenomena of the latest eruptions (1939–41) of the volcano of Santorin. Only one provisional paper, read before the Greek Academy of Sciences, has been published so far. The study of the prehistoric volcanoes of the Egean Sea and their lava flows, begun by my predecessor, Ktenas, has been continued by me.

In the last twenty years, a number of posts for scientific workers have been created in the Laboratories of Mineralogy, Petrology and Geology of the University of Athens. Here students are working with enthusiasm and energy on the minerals, rocks and geological formations of the country. Thus an adequate scientific geological staff to-day exists in Greece, able and willing to give its services in the study of the soil of Greece and to evaluate its wealth in the new era of struggle now beginning for my country—the struggle for the reconstruction of Greece and the creation of a new and higher Greek civilization.

OBITUARIES

Dr. Francis William Aston, F.R.S.

Aston's name is associated in the minds of men of science with the mass spectrograph and the discoveries concerning isotopes to which it led. In the history of British physics it is rare that a man's work should thus be associated with an instrument, though it is common enough to be almost the rule among the great names of American science. Though, in fact, in Aston's case the instrument was devised to test a specific theory and not developed for its own sake, it is yet true that Aston's mind was fundamentally that of an instrumentalist to whom experimental methods and actual manual dexterity are a joy in themselves approaching that to be gained from the results they give. This habit of mind can be traced throughout his life, and the skill of hand that went with it found expression as well in games and in music.

F. W. Aston was born in September 1877 at Tennal House, Harborne, Birmingham, which is still occupied by a member of the family. He was the second son and third child of a family of seven. From an early age he showed a passion for mechanical toys. After a preparatory education at Harborne Vicarage School, he went for two years to Malvern College, where he began the study of science. He left in 1893, head of the school in chemistry and physics and in the highest mathematical set, to enter Mason College, Birmingham. Here he worked under Tilden and Frankland for chemistry, and under Poynting for physics, of whom he often spoke with affection in later years. At Birmingham, too, he laid the foundation of his skill as a glass-blower which was to be so important to him later on. In 1898 he was awarded the Forster Scholarship and worked on the preparation and optical rotatory properties of a complex tartaric derivative, the results of which were published in collaboration with Frankland in 1901. For financial reasons he then took up fermentation chemistry and was engaged for three years at a brewery in Wolverhampton. During this period his thoughts were turning to physics under the influence of the new science that followed the discovery of X-rays. Quite naturally his interest expressed itself in terms of apparatus. He designed and made a new pattern of Sprengel pump, and with it exhausted small focus tubes, made from chemical test tubes, in a tiny workshop at home. The Sprengel pump led to a Tœpler, also of new design, and he discovered a type of rectifying valve depending on a gas discharge.

In 1903 Aston definitely returned to physics, with a scholarship to the University of Birmingham, as Mason College had by then become, where he worked on properties of the gas discharge, in particular of the dark space. His measurements of the length of the Crookes' dark space and its variation with current and pressure are still classical and appeared in the *Proceedings of the Royal Society* of 1905. Two years after, he discovered the narrow region which appears in some gases inside the Crookes' dark space and is known as the 'Aston dark space'. Then came a tour round the world, as the result of a legacy, which confirmed him in a love of travel, and especially of ocean travel, that never left him and was the source of much happiness.

In 1909 Aston took the step which, as it turned out, determined his future scientific career, by accepting the invitation of J. J. Thomson to work as his assistant in the Cavendish Laboratory, a post which left him time for independent research. By then Thomson had developed the parabola method of analysing positive rays, and produced for the first time clear evidence that atoms and molecules were, at least in certain cases, of definite weights for any particular substance. Besides continuing his own work on the dark spaces and measuring the distribution of force in this region of discharge, Aston helped in the further development of the analysis of positive rays. Among the photographs taken on his improved apparatus were some showing a curious effect with neon. Instead of a single parabola due to the atoms of this gas there were two, corresponding to weights of about 20 and 22 units. Isotopes among radioactive substances were already an accepted fact, due to the work of Soddy, and Thomson, not without some hesitation, attributed the two lines to isotopes of neon. The lines were undoubtedly due to neon, since they only occurred when this gas was present. The alternative was to suppose the weaker 22 line to be due to a compound NeH_2 (in this early work it was practically impossible to get rid of hydrogen). Such a compound was contrary to chemical ideas, but since the method of positive rays had already disclosed several compounds which violated the ordinary laws of valency, the chemical evidence was not very strong, and the decision had to rest on the character of the second line, its variation with conditions, and in particular the appearances of a corresponding line showing a double charge for which there was then no precedent among compounds.

Aston set to work to decide the question. There were two ways of doing so. The first was to try to separate the isotopes if they really existed. The second was to compare the values of e/m of the positive rays with that to be expected from the density of the gas, which gave an atomic weight of 20·2. If the weaker line was due to a compound, the stronger should show a mass of 20·2; if to an isotope, the weight 20·2 must be a mean and the stronger line have a smaller mass, probably about 20. The parabola method was not accurate enough to decide between these possibilities.

Aston started with the first, and as we should now think it, the harder method. At first, indeed, he had some slight success, and an ingenious apparatus for fractional distillation, which of course he made himself, had given a positive result just outside the experimental error when the First World War broke out. During this War Aston worked at Farnborough at the Royal Aircraft Factory, as it then was, as a chemist studying the peculiarities of the doped canvas with which aeroplanes were then covered, and its preservation by pigments. All the time, however, he was thinking over the neon problem. He lived in a civilian mess known from its location first as 'Arnold House' and then as 'Chudleigh'. Here he discussed physics and the then new quantum theory in its relation to isotopes with Lindemann (now Lord Cherwell), with results which appeared shortly after the War in two joint theoretical papers in the *Philosophical Magazine*. The 'Chudleigh' atmosphere was conducive to the spread of ideas, among the others who lived there from time to time being Sir Geoffrey Taylor, Sir Melville Jones, F. M. Green, then chief engineer of the Factory, Prof. E. D. Adrian, W. S. Farren, later director of the R.A.E., D. H. Pinsent, a young man of great brilliance killed during an experiment in the air, H. Glauert, and myself. Aston was inclined to be shy in discussing his work, and the ability to do so with men with whom he was really intimate was probably valuable to him. Certainly he always referred to those times with pleasure in after years.

The end of the War brought a great disappointment. Two successive pieces of apparatus designed to achieve the separation of the neon isotopes by diffusion failed to do so. It says much for Aston's faith and courage that he was undeterred by these failures, which must have been particularly hard after his previous partial success. The failures were due, not to any error of principle, but to insufficient mixing in the diffusing bodies of gas.

Aston accordingly turned to plans which he had developed while at Farnborough for an attack on the problem by the second method. He devised the well-known apparatus with which his name is so closely associated, in which the ingenious use of electromagnetic focusing of a special type makes great improvements possible in intensity, dispersion and resolving power. The more delicate parts, such as the slits, of this new apparatus he made himself. The new mass spectrograph, as he called it, was an almost instantaneous success. Not merely did Aston show that neon is indeed a mixture of isotopes, but also that the same is true of chlorine and many other elements.

Aston's discovery was quickly acclaimed. He became a fellow of Trinity in 1920, where he lived ever after until his death. He received the Nobel Prize for chemistry and the Hughes Medal of the Royal Society within two days in 1922; he had been elected a fellow of the Royal Society in 1921.

The earlier work with isotopes was done with gaseous compounds, and many of the metals were missing. In order to get beams of metallic ions, special methods have to be used. Dempster in 1921 analysed magnesium, and soon after Aston and I, simultaneously but independently, discovered means of analysing lithium, which was closely followed by many of the other metals of the early groups of the periodic classification. Later on, Aston succeeded in producing beams of ions from most of the remaining elements, even including the rare earths. In all but a few cases he made the first isotopic analysis.

The original mass spectrograph, now in the Science Museum, South Kensington, analysed more than fifty elements during its active career and established the whole-number rule. The task of its successor was to measure the deviations from this rule which are so vitally important in nuclear physics, and in especial for atomic energy.

The new mass spectrograph was accurate to 1 in 10,000. It was characteristic of Aston that to ensure the complete reliability of a battery of 500 small lead accumulators which supplied the field for the deflector plates, he decided to make them himself. He was now concerned with high accuracy, and exerted his ingenuity to devise methods of comparing masses with the utmost precision. These measurements are extremely difficult and in some cases, as might be expected, appreciable alterations had to be made in the results first obtained. By a curious accident a mistake in the ratio of the masses of helium and oxygen stimulated the discovery of heavy hydrogen by Urey and Brickwedde by predicting a larger discrepancy between the physical and chemical atomic weights of hydrogen than in fact exists.

Aston never forgot his early training as a chemist;

and his next task, that of determining the relative abundance of isotopes, interested him partly because of its connexion with the atomic weights of chemistry. His method was a photographic one, in which exposures were adjusted to make the blackening caused by two isotopes the same or nearly so. His last apparatus, the third mass spectrograph, aimed at an accuracy of 1 in 100,000, and though it did not have quite the resolving power he had hoped for, it achieved valuable results in fixing the mass defects of a number of important isotopes.

Though in the later years, work of equal quality was being done in the field of mass spectrography by Dempster, Bainbridge, Neier and others in the United States, there are few instances in modern science in which the first discoverer of a major field of research has had it so much his own way for such a long time. This is evidence of the technical difficulties involved, not only, or even perhaps mostly, on the measurement side, but also in the production of beams of ions of all sorts of elements with measurable intensity. For this, Aston's training in chemistry and in the peculiarities of the gaseous discharge were of the greatest value. But to this training he added that combination of patience and intuition which marks the great experimenter. There is scarcely a research in nuclear physics which does not use his work, directly or indirectly, and usually many times over. The use of isotopes as tracer elements both in chemistry and in biology is only in its early stage, but even now the results are highly important and it is difficult to put a limit of the possibilities of this field. It is true that most of the isotopes used for this purpose are either radioactive or were discovered by the analysis of band spectra, but the method would scarcely be possible without the knowledge of the isotopic structure of ordinary elements which we owe to Aston. Nor is it likely that the rare isotopes of the light elements, such as heavy hydrogen, which his method is not well fitted to discover, would have been found without his work.

Outside his work Aston's interests were most strongly held by sport, by travel and by music, though any sort of mechanical or scientific device attracted him. In sport he was an ardent skier and made almost yearly visits both to Switzerland and to Norway. He preferred expeditions, often long ones, to trick turns, though he had jumped a little. He liked to do his own climbing and to be independent of funiculars. It was perhaps the greatest grief of his life that a strained heart produced by skiing in the winter of 1934–35 put a stop to winter sports. But skiing was only one of many sports. As a young man he once cycled two hundred miles in twenty-two hours; he was a good lawn tennis player of tournament class, a good swimmer and used to say that the surf-riding he learnt at Honolulu was in many ways the finest sport in the world. He was a golfer well above the average, and the Sunday four with Rutherford, Fowler and Taylor was an institution. During the First World War he took up rock climbing. On several occasions he led courses classed as of 'exceptional severity'. Among his miscellaneous activities were photography, bridge and the special Trinity game of vingt, and the collection of Chinese porcelain. He played the piano and violin, but gave most attention to the 'cello.

His love of travel was intense, especially sea travel, and he contrived to combine it with science by going on eclipse expeditions and on British Association visits, though these were by no means his only journeys.

Aston was a man in whom a great zest for life was combined with a simplicity of character almost approaching naïvety. He was interested in people, especially his numerous friends, and probably more interested in things and places. This gift of interest in the outside world made him an ideal holiday companion. The pleasure he clearly took communicated itself to the rest of the party. He was precise in his habits, though it would be unfair to call him old-maidish, for he enjoyed changing from one routine of life to a totally different one. Though a good occasional lecturer, he had no gift for teaching and a few early attempts were not persisted in. He enjoyed scientific meetings, but was essentially an individualist and never attempted to form a school. I think he realized that much of his skill was incommunicable, and that in any event he needed quiet to work his best. His attitude to physics was essentially that of the experimenter and visualizer. He preferred the model to the equation; the concrete to the abstract. The philosophical aspect did not appeal to him. He was a Conservative in politics as in life, and though he would admit that a change might be good, he preferred it to happen as gradually as possible. I last saw him when he received the Duddell Medal of the Physical Society. In a characteristic speech he remarked with some feeling that his researches would never have been passed by any competent planning committee.

In addition to many papers in the *Proceedings of the Royal Society* and *Philosophical Magazine*, Aston's principal published work was his book on "Isotopes", of which the first edition came out in 1922, the second in 1924. In 1933 the name was changed to "Mass Spectra and Isotopes", though much of the material was the same; in 1941 it appeared in final form. He was twice on the Council of the Royal Society, was awarded a Royal Medal and gave the Bakerian Lecture in 1927. He was an honorary member of the Russian Academy of Sciences, and of the Accademia dei Lincei. He received an Hon. LL.D. from the University of Birmingham, and an Hon. D.Sc. from Dublin. He took a prominent part in the work of the International Atomic Weights Committee.

G. P. Thomson.

Prof. F. Záviška

František Záviška, whose death due to neglect and dysentery occurred on April 17, 1945, a few days after his liberation from the concentration camp at Osterode, was an eminent Czechoslovak theoretical physicist.

Záviška was born on November 18, 1879, in Velké Meziříčí, Moravia, and studied at the Charles University, Prague. After a brilliant career there, he was appointed assistant at the Technical High School in Brno. In 1903 he returned to Prague, where he obtained his doctorate.

Záviška's first important researches were on Fresnel's laws of birefringence and on the polarization of boundary lines of total reflexion. In 1906 he became a *docent* of theoretical physics and obtained a grant which enabled him to proceed to Cambridge, where he worked in Sir J. J. Thomson's laboratory on the influence of X-rays on condensation of water vapour. He returned to Prague, where he successfully worked on the theory of the Hall effect. In 1914 he became a temporary professor, and in 1919 a permanent professor of theoretical physics in the Charles University in Prague.

Záviška's subsequent work was chiefly concerned