radio-wave frequency. At a critical frequency, echoes from the ionosphere are lost, and this gives a clue to the maximum electron density in any layer. Layers $E$ and $F_1$ show comparatively smooth diurnal, seasonal and sunspot-cycle variations, all of which confirm the supposition that these layers are produced by high-frequency solar radiation. The long-scale variations in ionospheric reflectivity do, in fact, give a very perfect reproduction of the 11-year cycle of solar activity. The ionization in layer $F_2$, however, suffers remarkable irregularities, particularly during magnetic storms, when the ionization maximum is less than normal. The most striking type of ionospheric irregularity is that known as an irruption or fade-out, which is usually associated with a chromospheric eruption. Here the absorption is so great that the echo may be entirely lost, but the height of reflection is not usually greatly affected.

The question of the ultimate character of the short-wave solar radiation associated with these disturbances (for example, its frequency and whether it consists of continuous or line-emission) is still quite unsettled. The spectrum of chromospheric eruptions in the observable range has been found to consist of lines due to H, He and $Ca^+$. Photometric measures show that during an eruption, the total H$\alpha$ radiation from the sun increases by only a few tenths of one per cent; it is quite clear that what the spectrohelioscope observer sees is a secondary effect, and that the primary disturbance consists in the leakage of unobservable ultra-violet radiation. As Milne has pointed out, given an increase of radiation, the ejection of a stream of high-speed particles is easily accounted for by radiation pressure. Lyman emission of hydrogen is insufficient to account for all the observed effects, and it is probable that we have to deal with a mixture of line and continuous radiation. Continuous emission is not normally observed in the visible region, although a small increase at wave-length 3220 A. has been detected in one exceptional eruption.

Further analysis of ionospheric disturbances by radio sounding probably holds out greater hopes for the ultimate solution of the problem than the observation of secondary solar effects in the visible spectrum. Finally, the spectra of 'sunlit auroras' recently observed by Störmer promises a fruitful field for research into the uppermost regions, where the solar rays first strike the earth's atmosphere.

# OBITUARIES

## Sir William Pope, K.B.E., F.R.S.

WILLIAM JACKSON POPE, the great chemist, was the eldest son of William and Alice Pope who at the time of his birth (March 31, 1870) lived in New North Road in the City of London. On leaving the Cowper Street Endowed School, Pope proceeded to the Finsbury Technical College, where he was one of H. E. Armstrong's earliest pupils. He followed Armstrong to the Central Institution (now the City and Guilds' College of the Imperial College of Science and Technology), where the scheme of scientific studies having no reference to outside examining bodies did not lead to a university degree but gave Pope a rigorous training in chemistry, classical crystallography (under H. A. Miers) and in research methods admirably suited to his genius. From that time dated the unique friendship between Armstrong and Pope which was only broken by the former's death in 1937.

While still a student, Pope began his own crystallographic investigations of organic compounds. He also collaborated with F. S. Kipping, then Armstrong's assistant, in important investigations in the chemistry of camphor and on the constitution and characterization of externally compensated compounds.

Pope's first appointment (1897) was that of head of the Chemistry Department of the Goldsmiths' Institute at New Cross, and at the same time he was lecturer on crystallography at the "Central". In 1901 he became professor of chemistry and head of the Chemistry Department at the newly built School of Technology, Manchester, becoming professor of chemistry in the University of Manchester in 1905, when the School was made the centre of the Faculty of Technology, and on that occasion Pope received his first university degree; he had been elected to the fellowship of the Royal Society in 1902. Pope was elected to the professorship of chemistry in the University of Cambridge in 1908 in succession to J. D. Liveing, who had held the chair for forty-seven years, and in the following year he was elected to a professorial fellowship at Sidney Sussex College.

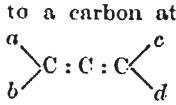
Pope's enduring fame will rest chiefly on his work on molecular dissymmetry. Pasteur had laid the foundations of stereochemistry in 1849, and up to the time of Pope's work at the Goldsmiths' Institute, all the optically active compounds studied by Pasteur and his successors contained in the molecule at least one carbon atom having an asymmetric environment. The presence of this 'asymmetric carbon atom'—a carbon atom united to four different atoms or groups tetrahedrally arranged round it—in the molecule was up to then regarded as being essential for the particular compound to be capable of exhibiting optical activity. As Pope has frequently pointed out, it is probable that the use of this

particular phrase with its narrow implication tended for many years to delay progress in stereochemistry, since it became usual to correlate the exhibition of optical activity with the asymmetry of a particular atom present rather than with the dissymmetry of the molecule as a whole. By the optical resolution of externally compensated compounds in which the atoms nitrogen, sulphur, tin and selenium had asymmetric environments, Pope was the first to show that the presence in the molecule of a carbon atom having an asymmetric environment was not essential for the exhibition of optical activity. In this classical work he had as collaborators S. J. Peachey, A. W. Harvey, E. M. Rich and H. A. D. Neville, and its success and that of numerous chemical and stereochemical investigations carried out simultaneously depended on Pope's knowledge and use of crystallography and also on his introduction of the use of the camphorsulphonic acids, first adequately described by Kipping and himself, for the resolution of externally compensated bases.

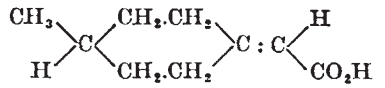
During the Manchester period, Pope had as assistants C. S. Gibson and John Read. With Peachey he prepared the first organic compounds of platinum and with Gibson those of gold, and this work, so novel and simple in its conception, was typical of Pope's knowledge and genius in attacking fundamental problems. Another striking example of this was the elegant work carried out with Read which resulted in the resolution of externally compensated chloroiodomethanesulphonic acid, CHClI.$SO_3H$. This work showed that it is only necessary for the attachment of four different atoms or groups, none of which need contain a carbon atom, to a single carbon atom to condition stable optical activity. This compound is still the simplest substance showing permanent optical activity. At this time also, Pope and Read began the work which resulted in the introduction of optically active oxymethylenecamphor as alternative to the use of the camphorsulphonic acids for the resolution of externally compensated primary and secondary amines.

Since his student days, Pope had been profoundly interested in the relation between chemical constitution and crystalline form. For many years he and W. Barlow worked on this subject, and beginning in 1906 they published a series of long and detailed papers in which the valency volume theory was developed. After some time it became evident that the fundamental conceptions on which the theory was based were too circumscribed, but the work they carried out has considerable value in the history of the subject which has been so ably developed by Sir William and W. L. Bragg and other workers.

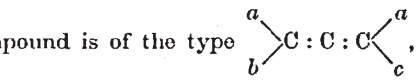
Following Pasteur, van't Hoff had realized that organic substances can be formulated which have enantiomorphous configurations and yet contain no carbon atom having an asymmetric environment. He showed that on account of the tetrahedral arrangement of the atoms or groups attached to a carbon atom, allene derivatives of the type



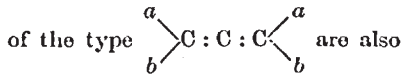
should exist in enantiomorphously related forms and therefore be capable of exhibiting optical activity. Pope realized that the compound 1-methyl*cyclo*hexylidene-4-acetic acid,



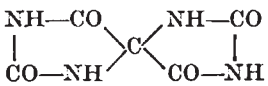
which has an enantiomorphous configuration and contains no carbon atom having an asymmetric environment, resembles the above type, and he and W. H. Perkin (then colleagues in Manchester) commenced its synthesis in 1903 and completed it in 1906. Later they were joined by O. Wallach, and adequate quantities of the compound became available for the resolution experiments. In the latter, Read played a leading part, and the successful accomplishment of this difficult piece of work constituted a most important development in stereochemistry. Actually, as Pope also showed, van't Hoff might have stated the case more generally because the above compound is of the type



and compounds of the type



are also theoretically capable of exhibiting optical activity. In immediate extension of this work, Pope and his co-workers obtained striking proof that organic compounds can retain their configuration throughout a series of reactions in which the molecular symmetry undergoes profound change. A further example of this is his work with J. B. Whitworth on *spiro*-5 : 5-dihydantoin,



probably the most complete and detailed stereochemical and crystallographic study published in recent years. Pope's work on 1-methyl*cyclo*hexylidene-4-acetic acid has been responsible for almost all the developments in stereochemistry by many workers during the last twenty-five years, owing to the fact that he defined the conditions of mirror-image isomerism, namely, that for mirror-image isomerism the molecular configuration may possess any elements of symmetry excepting a centre of symmetry or a plane of direct symmetry.

Apart from his acknowledged pre-eminence in crystallography and stereochemistry, Pope carried out outstanding work on photographic sensitizers (with W. H. Mills), on the direct synthesis of 'mustard gas' (with C. S. Gibson) and on the extension of Werner's theory of the configuration of complex co-ordination compounds to those containing tri-amines and tetra-amines (with F. G. Mann).

Pope was president of Section B (Chemistry) of the British Association (1914), president of the Chemical Society (1917–19), president of the Society of Chemical Industry (1920–21), president of the Union internationale de Chimie (1922–25), president of the Federal Council for Chemistry (1918–35), president of the Solvay Chemical Conferences (1922–36) and

Prime Warden of the Goldsmiths' Company (1928–29); he had been chairman of the City and Guilds of London Institute since 1932. He was created Knight Commander of the Order of the British Empire in 1919 and Grand Officier de l'Ordre de Léopold two years ago. He was honorary member of no less than twelve foreign academies and a member of at least ten British scientific societies. He received the Davy Medal (Royal Society), the Longstaff Medal (Chemical Society), Dumas Medal (Société de Chimie industrielle), Lavoisier Medal (Société chimique de France) and Messel Medal (Society of Chemical Industry), besides the honorary doctorate of seven universities.

All who had dealings with Pope, whether as friends, collaborators or pupils, could not fail to be impressed by the true greatness of the man. He was extremely well informed in English and foreign literature and in affairs generally; his judgment and advice were invariably sound. Actually Pope was very shy, but in conversation he was brilliant and witty and few could tell a good story better than he. He was a charming host and loved the company of his friends and life generally. He was a connoisseur and his collections of alchymical pictures, chemists' mortars and drug pots are unique; his library of chemical and general literature has long been the envy of many colleagues. Pope was a most graceful speaker in English as well as in French and German; he could easily translate the spoken word from French directly to German.

For some years Pope had been in poor health, against which he struggled with amazing fortitude, and he continued to carry out his duties and perform extra tasks which must have taxed him greatly. During the last three years he suffered intensely and he bore his sufferings in silence. The end came on October 17 and, after a quietly dignified service taken by his friend, the Master of Sidney Sussex College, his body was cremated in Cambridge.

"Post tenebras lux"

Charles S. Gibson.

## Prof. Albert Gilligan

By the death of Albert Gilligan at Storth, near Milnthorpe, on October 14, the science of geology has lost an able exponent. Born on July 26, 1874, he was educated at Wolverhampton Grammar School and at University College, Cardiff. After service as science master at Glossop County School, Gilligan joined the geological staff of the University of Leeds as assistant to Prof. P. F. Kendall. Under the influence of Kendall he became interested in physical geology, particularly that of Yorkshire, and his first published work recorded the denudational effects of a severe storm in that country. This interest remained with him throughout his life.

Gilligan had the ability to lecture in a clear and enthusiastic manner, easily understood by non-geological audiences, and in so doing, perhaps, he rendered his greatest service to the science of geology. For many years he gave series of lectures throughout Yorkshire, many to the mining community, others to societies of many kinds, and through these made many converts to geology. Gilligan also encouraged the work of local geological societies, and his services were always at their disposal for a lecture or a description in their journals of a local section.

Later, Gilligan became interested in sedimentary petrology, a branch of geology then overshadowed by the igneous side of petrology. He developed a technique of heavy mineral analysis, and turning his attention to the Millstone Grit, continued the work on its sedimentation initiated by Sorby. In 1920 he read the results of this pioneer investigation before the Geological Society of London, and in 1921 he was awarded the Murchison Fund of that Society. He had in 1920 been made reader in geology in the University of Leeds and in 1922 he succeeded Kendall in the chair of geology.

His work on the Millstone Grit had led Gilligan to the problems of Middle Carboniferous palæogeography, and in 1929 he gave, as his presidential address to the Yorkshire Geological Society, an address entitled "A Contribution to the Geological History of the North Atlantic Region" in which he summarized the evidence for a Palæozoic and Pre-Palæozoic 'Atlantis'.

From 1922 Gilligan was curator of the Cecil Duncombe Observatory, and he did much to foster the study of astronomy. He also played his part in the administration of geological societies, serving on the council of the Geological Society. In university administration he was closely concerned with student activities especially in athletics, and he did much to promote friendly relations between staff and students. He had a sincere understanding of the difficulties of students whose lack of means handicapped their studies, and many have cause to be grateful for the ready help which Gilligan so often generously gave.

Gilligan was a delightful companion in the field, keenly interested in archæology and natural history. It is the regret of all his friends that he was not permitted to enjoy, in the foothills of the Lake District, his retirement from academic labours.

R. G. S. H.

We regret to announce the following deaths:

Prof. A. Busi, professor of radiology in the University of Rome, aged sixty-five years.

Vice-Admiral Sir Percy Douglas, K.C.B., C.M.G., hydrographer of the Navy during 1924–32, on November 4, aged sixty-three years.

Mr. R. C. Lambert, librarian at the Athenæum Club during 1922–35, on November 5, aged seventy-one years.

Prof. C. F. Shaw, professor of soil technology in the University of California, on September 12, aged fifty-eight years.

Dr. J. H. T. Tudsbery, honorary secretary, formerly secretary, of the Institution of Civil Engineers, on October 10, aged eighty years.