too, that gastric activity, both secretory and motor, may be inhibited by the release of a hormone, enterogastrone, from the small intestine. Gastrin and secretin have no stimulant action on the output of enzymes in gastric and pancreatic juice. In addition to the well-established nervous control of digestive enzymes, these may also be influenced by hormones. Pancreozymin, present in extracts of intestinal mucosa, increases the enzyme output of the pancreas without affecting the volume of the juice, and there is some evidence for an analogous hormone for pepsin secretion by the stomach.

With the establishment by animal experiments of a number of hormones of the digestive tract, recent work has been concerned with the action of these substances in man, and with a more detailed study of the mode of their release during normal digestion. In the discussion following Prof. Brocklehurst's address, the actions and clinical uses of some of the gastro-intestinal hormones in man were considered by Prof. A. A. Harper (King's College, Newcastle upon Tyne). Three materials—secretin, pancreozymin and cholecystokinin—have so far been prepared in a form sufficiently pure for intravenous injection in man, and it has been shown that their physiological effects are the same as those in animals. To clinicians the interest of gastro-intestinal hormones lies in the possibility of their use in the diagnosis and treatment of disease. Recently, attempts have been made to treat peptic ulcer by the parenteral administration of the inhibitory hormone enterogastrone, but the majority of reports so far have been unfavourable. It has been claimed that the examination of the duodenal contents after secretin is of value in the diagnosis of malignant or chronic inflammatory lesions of the pancreas. At present, attempts are being made to increase the value of the secretin test in man by following the secretin by an injection of pancreozymin and cholecystokinin. A further improvement, as Prof. A. C. Frazer pointed out, would be to measure the activity of digestive enzymes in conditions comparable with those occurring in the intestine.

There has been increasing interest in recent years in the mechanism of the release of the digestive hormones. For the release of gastrin there is evidence of the importance of a local nervous mechanism, with a receptor in the mucosa which can be paralysed by the local application of procaine, and an efferent cholinergic fibre acting upon the cell which produces gastrin. Another line of attack on the problem is the study of absorption by the intestinal mucosa, since absorbed digestion products may carry some of the intestinal hormones into the circulation. In a discussion of the activities of the intestinal mucosa, Dr. R. B. Fisher stressed the very high metabolic rate of the mucosa, due in part to the work done in the active absorption of digestion products, and in part to the rapid multiplication of the cells of the mucosa, which in the rat may be completely replaced every thirty-six hours. It seems likely that the mucosa builds up peptides from absorbed digestion products of protein, and it is known that the hormones are also peptide in nature. Dr. Fisher pointed out that the presence of peptones in the gut leads to a build-up of proteins in the mucosa, and the application of injurious agents such as acid to the mucosa may lead to the breakdown of cytoplasmic protein. As these agents are known to bring about a release of hormones from the intestine, Dr. Fisher speculated upon the possibility that the hormones

are normal products of the breakdown of mucosal cytoplasm, and that besides their specific hormonal activities they would "possess at the same time the generalized physiological activity of a specific building stone for the normal protein of the tissues".

This discussion undoubtedly served to stress the importance of the lining of the pyloric part of the stomach and the upper part of the small intestine as a prolific producer of hormones rivalling in number those of the anterior lobe of the pituitary gland.

OBITUARIES

Prof. E. A. Milne, M.B.E., F.R.S.

THE sudden death of E. A. Milne on the morning of September 21, in Dublin, while on his way to attend a colloquium convened in the rooms of the Royal Irish Academy by the Royal Astronomical Society, removes from our midst one of the great men of our time. Mathematician, astrophysicist, cosmologist, relativist and natural philosopher, Milne was endowed with a range of abilities and a depth of insight which, combined with his incredible energy and indomitable will-power, enabled him to maintain an astonishing outpouring of research of the highest quality and originality over a period of some thirty years, despite physical tribulations and personal misfortunes of a kind which would have overwhelmed a lesser man.

Edward Arthur Milne was born on February 14, 1896, the eldest son of Sydney Arthur Milne, of Hessle, East Yorkshire. He was educated at Hymers College, Hull, and at Trinity College, Cambridge, where he was elected to a prize fellowship in 1919, after serving during the First World War with the Anti-Aircraft Experimental Munitions Inventions Department and receiving the M.B.E. (In the Second World War he served at the Ordnance Board.) In 1920, H. F. Newall appointed Milne as assistant director of the Solar Physics Observatory in Cambridge. Four years later Milne succeeded Sydney Chapman as Beyer professor of applied mathematics in the University of Manchester, a post which he held until 1928, when he was appointed first Rouse Ball professor of mathematics at Oxford and fellow of Wadham College.

During his time at the Solar Physics Observatory and at Manchester, Milne's researches centred on problems of radiative equilibrium and the theory of stellar atmospheres. In 1922 he was awarded a Smith's Prize for a new treatment of radiative equilibrium replacing the earlier investigations of Schwarzschild. This work proved to be the starting point for many subsequent investigations by others. A by-product of mathematical interest was 'Milne's integral equation', which attracted the attention of J. E. Littlewood, G. H. Hardy and E. C. Titchmarsh. In 1923 Milne began a fruitful collaboration with R. H. Fowler on Saha's theory of high-temperature ionization. By modifying Saha's technique, they deduced that the pressures of the levels in stellar atmospheres at which absorption lines were formed were of the order of 10^{-4} atmosphere, a value considerably lower than had previously been assumed. Although much of this work was due to Fowler, the original key idea was Milne's. The theory was generalized by Milne in later papers.

While still at Cambridge, Milne began his well-known investigations on the equilibrium of the

calcium chromosphere under the balance of gravitational forces and radiation pressure. He discovered that for varying radiation from below the equilibrium was unstable, so that in certain circumstances atoms could ultimately be ejected from the sun with terminal speeds of the order of 1,600 km. per sec.

Milne's numerous memoirs on the opacity of stellar atmospheres culminated in his Bakerian Lecture of 1929. In the same year Milne took up his duties at Oxford, and during the following three years devoted his main energies to elaborating a theory of stellar structure based on a constructive mathematical criticism of the pioneer researches of Sir Arthur Eddington. In 1932 he delivered the Halley Lecture on "The White Dwarf Stars".

Meanwhile his interest had been aroused in the theory of the expanding universe, and in May 1932 he began that train of investigation which became the most original, the most controversial and the most far-reaching of the many theories associated with his name. He devised a new world-model which in its augmented form with a 'statistical component' appeared to be more fruitful than any of the homogeneous models hitherto produced by the 'orthodox' relativistic cosmologists. In particular, it provided an astonishingly simple explanation of Hubble's law correlating distance and velocity of recession, and also a possible gravitational explanation for the origin of cosmic rays.

Nevertheless, it is probable that that part of Milne's work in cosmology and relativity which will prove of the most lasting significance is the theory of time measurement by equivalent observers, on the basis of which new deductive systems of dynamics, gravitation and electrodynamics were developed in rapid succession. Associated with this work were two fundamentally novel ideas: the conception of different uniform scales of time operating in Nature, and the idea which first emerged from my analysis, arising out of Milne's generalization of my derivation of the Lorentz formulæ (itself suggested by remarks of Milne), that the fundamental group of equivalent frames is more restrictive than the six-fold infinite group of Newtonian and special relativity physics. The latter idea was explored further by Milne in his final contribution to the *Proceedings of the Royal Society* last year; but much still remains to be done.

It is impossible to convey here any detailed impression of Milne's many other contributions to stellar kinematics and dynamics, the kinematics and structure of spiral nebulae, the theory of cepheid variation, etc.; it was characteristic of his courage that, although he knew his health was precarious, he made the journey to Dublin to read an exciting new paper on a relation, akin to Blackett's, connecting gravitation and magnetism, which had emerged from recent developments in kinematic relativity.

Apart from innumerable original memoirs, Milne published a long chapter on "The Thermodynamics of the Stars" in the "Handbuch der Astrophysik" in 1930 and three books: "Relativity, Gravitation and World-Structure" in 1935, "Kinematic Relativity" and "Vectorial Mechanics", both in 1948. He leaves two further books in manuscript: a life of Sir James Jeans, to be published by the Cambridge University Press, and a course of lectures which he was to have delivered at Birmingham this winter on the Edward Cadbury Foundation. He was also editor of the mathematical and physical sciences section of the series "Hutchinson's University Library".

Milne received many academic honours. He was elected a fellow of the Royal Society in 1926 at the age of thirty. He was awarded the Gold Medal of the Royal Astronomical Society in 1935, a Royal Medal of the Royal Society in 1941, and the Bruce Medal of the Astronomical Society of the Pacific in 1945. He was president of the London Mathematical Society during 1937-39, and president of the Royal Astronomical Society during 1943-45. He became an honorary member of the American Astronomical Society, a foreign honorary member of the American Academy of Arts and Sciences, both in 1947, and an honorary member of the Calcutta Mathematical Society in 1948. He was a D.Sc. (Oxon.) and an hon. D.Sc. (Amsterdam).

Milne was married twice. By his first wife, Margaret Scott (daughter of Hugh Fraser Campbell, of Dornoch, Sutherland), who died in 1938, he leaves two daughters and a son; by his second wife, Beatrice Brevoort (daughter of William Whetten Renwick, of New York), who died in 1945, he leaves a daughter.

Small in stature, Milne was outstanding in every other way. His penetrating and original intellect was sustained throughout many personal misfortunes by remarkable courage and unshakable religious conviction. Despite his brilliance of mind and widespread recognition, he retained a great humility and simplicity of character. To his research students, particularly to those of us who knew him in his prime, he was an unfailing source of inspiration. He was always the kindest and most conscientious of supervisors and collaborators. We mourn the passing of a leader among men of science and a pioneer among philosophers of Nature.

G. J. WHITROW

Dr. D. H. Bangham

PHYSICAL chemistry, and perhaps more specifically fuel technology, have suffered a grievous loss by the death on July 29, at the early age of fifty-five, of Dr. Donald Hugh Bangham, director of Research Laboratories, British Coal Utilisation Research Association. His health had not been good for some little time; but his end came rather suddenly and as a sad blow to his immediate colleagues.

The quality of his mind was evident at an early age; in 1912 he won a scholarship in natural science to Jesus College, Oxford. Two years later he was commissioned in the King's (Liverpool) Regiment, attaining the rank of captain and gaining the Military Cross for leading an attack on the Hindenburg Line defences. Shortly after returning to academic life, he graduated with first-class honours and was appointed (1919) lecturer in physical and inorganic chemistry in the University of Manchester, where he published a number of papers concerned with rate-processes at the gas-solid interface; he revealed two characteristics: careful and elegant technique and a great power of generalization.

In 1926 Bangham accepted the chair of physical and inorganic chemistry in the newly founded Faculty of Science in the University of Cairo, where he was faced with the task of planning and equipping the laboratories, as well as preparing curricula. He served as dean of the Faculty during 1927-36, and on returning to England in 1937 he was awarded the Order of the Nile with the rank of commander.

Bangham joined the staff of the British Coal Utilization Research Association in 1938, almost at