bow of March 8, extending down to 65 km. (or possibly even less) is evident.

We are still ignorant of the precise mode in which the auroral light is produced, but it seems likely to be due to the entry into the atmosphere of charged particles from outside; the sign of the charge, and the speed of the particles, are unknown. Their penetrating power can be conveniently stated (as for α- and β-particles in the laboratory) in terms of the equivalent thickness of air at normal density which they traverse. This cannot be accurately inferred from the measured heights of the lowermost edges of auroræ, because of uncertainties as to the composition and temperature of the air at great heights; but there can be little doubt that particles which come down to 65 km. traverse at least five times as much air as those that come down to 80 km. Thus the newly observed aurora suggests that, at times, particles enter the atmosphere with a penetrating power five times as great as that of those (themselves unusually penetrating) that come down to 80 km. If this interpretation be correct, the extension in the range of our knowledge of these particles is no small one.

Another reflection is prompted by the extremely fleeting nature of this low aurora. Throughout their many years of auroral photography, Størmer, Vegard and Krogness have never measured so low an aurora; of course a great many auroræ the heights of which have not been determined have appeared during this period, and much of their work has been done at stations south of Tromsø. Apart from the red edge, which is not unique, the low bows now measured were not specially outstanding, and there was no obvious indication of their unusually low altitude. May not many such low bows, perhaps equally fleeting, have passed without recognition of their exceptional character? And may there not occasionally be still lower ones to be discovered by some fortunate or patient observer? The answer seems likely to be 'yes'.

Further, every reduction in the auroral heights substantiated by parallactic measurements increases the credibility of the reports of auroræ extending down to the ground. The gap between a height of 65 km. and the ground is a very large one, it is true, but already we have seen the lowermost measured height reduced from 100 km. or 95 km., as in Størmer's early work, to 80 km. in his later work, and, by McLennan's Canadian observations, to 75 km.; and now, by Harang and Bauer, this is brought down to 65 km.—a total reduction of 30 km. The capacity of auroræ to produce low height records—like that of the weather to surpass its own records of long standing—may be much greater than has been supposed.

In this connexion it may be appropriate, finally, to mention that a new collection of reports bearing on the audibility of auroræ, and on low altitude (ground level) auroræ, has been made by Dr. C. S. Beals, of the Dominion Astrophysical Observatory, Victoria, B.C. The reports come from the northern Canadian auroral belt, and are closely similar in tenor to those collected by Mr. J. Halvor Johnson, which I described in an article in NATURE of March 7, 1931. Dr. C. A. Chant, editor of the *Journal of the Royal Astronomical Society of Canada*, had also collected such evidence, during the years 1907–29. Dr. Beals, after discussing the evidence in his paper (which is to appear in January in the *Quarterly Journal of the Royal Meteorological Society*), regards it as reasonably establishing the occurrence, on very rare occasions, both of auroral sounds and of ground-level auroræ. S. CHAPMAN.

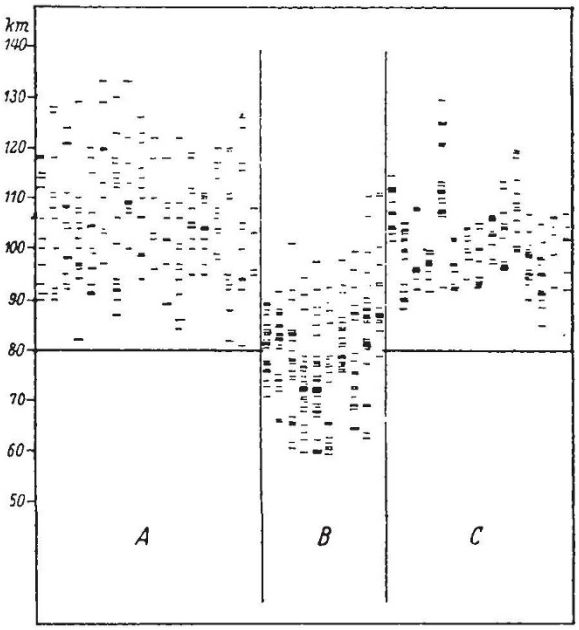

Fig. 1. Heights of auroral bows: *A*, February-October, 1929: *B* and *C*, March 8, 1932. From *Gerlands Beiträge zur Geophysik*, Bd. 37, Heft 1, 1932.

Obituary

PROF. T. GRAY

IT was with profound regret that the many friends of Prof. Thomas Gray learned of his death at Elie, Fife, on September 26. With his passing the Royal Technical College, Glasgow, has lost one of its most distinguished members.

Born at Mid-Calder in 1869, Prof. Gray received his early education at George Watson's College, Edinburgh, and entered the Andersonian College at Glasgow as a student of Prof. Dittmar in 1885. At nineteen years of age, he proceeded to the University of Jena, returning a year later to become assistant to Prof. Dittmar and afterwards to Prof. Henderson. Graduating B.Sc. in the University of London in 1890, his career as a lecturer commenced three years later at the Royal Tech-

nical College and in the same year he was appointed lecturer in chemistry at Queen Margaret College.

The summers of 1899 and 1900 were spent at Jena, where he obtained the degree of Ph.D., and in 1901 he graduated D.Sc., of the University of Glasgow. He also prosecuted his studies at Heidelberg and at the Zurich Polytechnic under Prof. Lunge.

In 1903, on the retirement of Prof. Mills, Dr. Gray succeeded to the 'Young' chair of technical chemistry at the Royal Technical College, and in 1919 was appointed director of the School of Chemistry. He instituted, in the College, the first classes giving public instruction in fuels; and to acquire first-hand knowledge of methods of manufacture and of plant construction, he spent many of his summer vacations in chemical works. During the War period he placed his extensive scientific knowledge at the service of various Government departments, and two outstanding tasks which he undertook were the supervision of the production of benzene and toluene from the Scottish gas works for munition purposes, and an extensive survey of the coals of Scotland with special reference to their suitability for use in blast furnaces and for metallurgical coke manufacture.

The importance of his services during the War and his eminence as a chemist were recognised at the University of Glasgow by the conferment of the honorary degree of LL.D.

In 1918, the Department of Scientific and Industrial Research invited Prof. Gray to supervise the design and organisation of the fuel research laboratories at East Greenwich, and from 1920 he acted as consultant to the Fuel Research Board for three years. At the time of his death he was a member of that Board.

Prof. Gray was a fellow of the Institute of Chemistry and of the Chemical Society, and acted as secretary for ten years and chairman for two years, of the Glasgow Section of the Society of Chemical Industry. Among the committees on which he served, were the Education Committee of the Institution of Gas Engineers, the Scottish Coal Survey Committee, and the Committee on Sampling and Analysis of Coal of the Fuel Research Board, of which he was chairman. His services as an examiner in chemistry were retained by the boards of various institutions, among which were the Faculty of Physicians and Surgeons of Glasgow and the Royal College of Physicians and Surgeons of Edinburgh. He was retained by the British Electric Lamp Manufacturers' Association as a consultant, and his services were much in demand as an expert witness in law cases dealing with chemical patents. Many of his scientific papers were published by the Chemical Society and the Society of Chemical Industry and in the *Berichte*.

In analytical work, Prof. Gray carried accuracy to extremes; and in research his cleverness as a glass blower, and his ingenuity in designing apparatus from the simplest material, were remarkable. An ideal teacher, he was held in high esteem by student and colleague alike. He had a quiet and attractive personality, and to have been included in his circle of friends was to have experienced an ever-increasing admiration for a very fine gentleman. W. J. SKILLING.

M. SALOMON REINACH

BY the death of Salomon Reinach, which took place at Boulogne-sur-Seine on November 4, France has lost one of her most distinguished and widely-known sons, who for more than a generation held a foremost place in the world of scholarship and archæology.

Salomon Reinach was born at St.-Germain on August 29, 1858, and, with his two brothers, also destined to attain high distinction in the world of learning, was educated at the Lycée Condorcet. He afterwards attended the École Normale and took the degrees of doctor of law and doctor of letters at the University of Paris. From that time onward his life was devoted to archæological studies, but in no narrow sense. In his view of the past he saw life whole. The breadth of his knowledge of antiquity was equalled by his understanding of it; and it should be no matter for surprise that he attained a universal reputation as an authority in classical scholarship and the history of philosophy, religion and art as well as in archæology.

In 1879 Reinach at the age of twenty-one years became a member of the French School of Archæology in Athens and later acted as the secretary of the Archæological Commission in Tunis. In 1885 he was appointed to the staff of the National Museums and in the same year published his "Traite d'Epigraphie Grecque", a Latin grammar and a handbook of field archæology. These had already been preceded by a manual of classical philology, issued between 1882 and 1884. By the time he was appointed curator of the Museum of St.-Germain and professor at the Louvre School in 1902, his monumental catalogue of the prehistoric collections of that Museum, which has recently been revised and re-issued, had won for him an established position as an authority in prehistoric archæology. Archæological studies took him to Greece, North Africa, southern Russia, Asia Minor, the whole fringe of the Mediterranean and the Danube. In western Europe his expert knowledge extended from palæolithic man to Gauls and Romans; and his acquaintance with the European museums and their contents was probably unique.

Reinach's literary output in the fields of classical scholarship, philosophy, comparative religion, art and archæology was very large. In 1902 he became the director of the *Révue Archéologique*. Throughout his life a stream of papers, monographs, books and articles came from his pen. It was characteristic of his humanistic attitude that he should also contribute to contemporary history and controversy—in this field he wrote *inter alia* a history