that dissemination of life in the cosmos occurred by transport of forms of life in the cosmic dust must be rejected, because solar radiation (in a high vacuum) would decompose 'biospores' just as it decomposes cosmic dust. The possibilities by which a spore might travel through space inside meteorites involve so many improbabilities that they do not justify special consideration at this stage.

(4) *Development of complex molecules*. The basic problem concerning the origin of life is how complex molecules (on the Earth they are based on carbon) came to be built up and become replicated. It is conceivable that the interior of the Moon dust may provide some valuable clues in this direction. It is not beyond the bounds of possibility that some 'pre-life' processes may be occurring on the Moon, and these may be similar or different from those which have taken place on Earth. If there are such processes, then the introduction of 'foreign' macromolecules from the Earth may cause a serious upset in the lunar processes. Macromolecules from the Earth might under lunar conditions act as templates and provide new foci for 'pre-life' growth. If such events were started indiscriminately all over the Moon, the pattern might be distorted. It is important to emphasize that living cells are not envisaged for this process, and that in this connexion a dead bacterium from an aseptic rocket would be as harmful as a live one. The occurrence of any such growth reactions is remote and does not justify the imposition of any irksome restrictions on lunar exploration, but where reasonably possible it should be borne in mind. A simple precaution against endangering future studies might be to limit the areas of landings on the Moon and thereby to localize the effects—if any—of terrestrial templates.

OBITUARIES

Sir Owen Richardson, F.R.S.

IN Sir Owen Richardson, whose death occurred on February 15, Britain lost one of her most eminent physicists.

Owen Willans Richardson was born in 1879 at Dewsbury in Yorkshire. He won scholarships, first to Batley Grammar School, thence to Trinity College, Cambridge. He was soon absorbed in research among the famous company inspired by J. J. Thomson. By the age of twenty-two, the results of his first investigations had been published, and for more than thirty years there followed a flow of papers—attacking fundamental problems of the times—at a rate which can seldom have been exceeded.

Early at the Cavendish Laboratory, Richardson carefully observed the temperature variation of the saturation electron current from a hot platinum filament (at low pressure). From considerations of kinetic theory, he quickly developed a clear explanation based on the evaporation of conduction electrons through a potential barrier at the metal surface. He obtained the formula $i = AT^{1/2}(\exp(-b/T))$, agreeing with his experiments and related formulæ, derived, apparently, about the same time by J. J. Thomson and H. A. Wilson from thermodynamical arguments. About 1903 he was elected a Fellow of Trinity College and became Clerk Maxwell Student. He was awarded the London D.Sc. in 1904.

Throughout the first fifteen or so years of Richardson's career, phenomena of thermionic emission, in the broadest sense, retained a central position in his interests; they were complicated by the inadequate vacuum and cleaning-up techniques of the times. Largely by his efforts and those of his friend, H. A. Wilson, the thermionic emission was finally formulated by $i = AT^2(\exp(-b/T))$, which is scarcely distinguishable experimentally from the original formula. Although the electron gas concept of the conduction electrons became modified, ultimately, by Fermi–Dirac statistics and wave mechanics, the second equation, Richardson's Law, remains. The early developments are described in his book, "The Emission of Electricity from Hot Bodies", first published in 1916. For his work in thermionics, a term he himself coined, he was awarded the Nobel Prize in Physics in 1928.

While still at Cambridge, Richardson's thermionic investigations led to studies of ionic recombination, of the diffusion of hydrogen through palladium and platinum and to the theory of the diffusion of dissociated gas in solution and to other projects. He had great mathematical facility.

In 1906 he was appointed to the chair of physics at Princeton University. Papers followed on the pressure shift of spectrum lines, the gyromagnetic effect, the ratio of the charge to the mass of positive ions, the energy distribution of electrons emitted by hot bodies, which, with F. C. Brown, he proved to be Maxwellian. Work followed on the reflexion of slow electrons by metal surfaces, gravitation and electron theory, theory of dispersion and residual rays, diffusion of neon through hot quartz and various projects on problems related to the work function, including the heating and cooling effects accompanying thermionic absorption and emission with H. L. Cooke, the theory of contact e.m.f., thermo-electricity and the photoelectric effect. With K. T. Compton he played a large part in the verification of the Einstein photoelectric law. He made many pioneer studies, some in collaboration with C. J. Davisson, C. Sheard and others, on the emission and properties of positive ions from heated metals and salts. He may have been the first to observe the emission of secondary electrons by positive ion impact. He also wrote on the asymmetric distribution of electrons produced by X-rays passing normally through a metal plate, etc.

In 1914 Richardson returned to England to become Wheatstone professor of physics at King's College, London. His book, "The Electron Theory of Matter", based on his Princeton lectures, was first published in the same year. It takes its place as a landmark in the history of physics. It is a model of the *ab initio*, not too contracted presentation, which university students like and deserve. Papers followed on absolute photoelectric yields with F. J. Rogers; metallic conduction, photochemical action and (1916–17) spectroscopic researches with C. B. Bazzoni. Limiting frequencies in the spectra of hydrogen and helium for 800-V. electrons were observed at 950–830 A. and 470–420 A. and compared with Bohr's calculations. Further theoretical work on the gyromagnetic ratio followed. In 1924 he was appointed Yarrow research professor of the Royal Society, thereby being relieved of teaching duties. He began extensive investigations of the spectrum of molecular hydrogen with T. Tanaka, K. Das, P. M. Davidson, T. B. Rymer and others, and he himself made major contributions to the analysis of this most difficult of all molecular spectra. His book, "Molecular Hydrogen and its Spectrum", published in 1934, was based on his Silliman Memorial Lectures at Yale University. He retained interest in the H_2 triplet fine structures, on which he had unpublished high-resolution data, almost up to the time of his death. His last paper appeared in 1953 ; he had retired from the Yarrow professorship in 1944. Other work at King's College included an attempt, very early in the era of wave mechanics, to calculate the cold emission from metals under intense fields, and, in collaboration with H. T. Flint, interesting speculation concerning a least proper time.

Soft X-ray spectra of several metals were studied, especially with the late F. C. and Mrs. Chalklin. Extensive investigations of the emission of electrons during chemical reactions were undertaken, first with the late L. G. Grimmett and later with A. K. Denisoff. He acquired a splendid reflexion echelon for measurement of the wave-numbers and structure of the Lyman α line of H. He collaborated with W. E. Williams and J. Drinkwater in first measuring the wave-numbers and structures of the $H\alpha$ and $D\alpha$ lines to test the Dirac theory. Regrettably, a mysterious error crept into these observations. The results misled physicists until the Lamb–Retherford experiments. He made a notable study (1944) with the late Irena Gimpel of the reflexion of very slow electrons by copper, with apparatus earlier perfected by A. M. Crooker.

Richardson received honorary degrees of the University of Leeds (D.Sc.), St. Andrews and London (LL.D.) ; he was an honorary Fellow of King's College, London, and Trinity College, Cambridge. He was knighted in 1939. He was president of the Physical Society during 1926–28 and its honorary foreign secretary during 1928–45, which capacity included entertaining many distinguished foreign visitors.

There will be many who will recall his generous hospitality, and his first wife, the sister of H. A. Wilson, who was a most gracious hostess. He had a beautiful home with the finest English period furniture and a dazzling collection of paintings by Dutch and other old masters, fit for any national collection. About the house were several grandfather clocks, one in his library, by a contemporary of Thomas Tompion. They were wound once a week by the local clock-maker.

Sir Owen was a quiet and kindly man of few. well-chosen words, but he had a keen sense of humour, He was exceedingly proud of his northern origins and could speak the Yorkshire dialect. His forebears of Dewsbury were manufacturers, in the trade of the district. One of his stories (generally true, with a good moral) concerned two of these individuals, engaged in the development of a machine for processing cloth. After much time and effort and failure in getting the machine to work, one remarked despondently to the other, "It wearnt go". After some thought, the other replied firmly, "It mun go !" The work proceeded. In due course the machine was perfected. It was called the Mungo machine.

Richardson was versed in botany and nearly took up this subject at Cambridge instead of physics. He kept a fine garden. About the outbreak of the Second World War he bought a large farm, some miles from his home at Alton, Hampshire, and supervised this for several years. He bought it as an investment, as a war effort, and, he said, to try and get back the fortune lost there by some of his ancestors who had migrated south to that part.

His two sons and a daughter and his second wife survive him. His elder son is professor of physics at Bedford College, London. E. W. Foster

Dr. W. H. Mills, F.R.S.

The sudden death of William Hobson Mills on February 22, at the age of eighty-five, deprived Cambridge chemistry of its last link with the nineteenth century. Mills went up to Jesus College from Uppingham in 1892, and took first classes in both parts of the Natural Sciences Tripos. After his election to a research fellowship in 1899, he went to Tübingen to work with von Pechmann, and there began his life-long friendship with N. V. Sidgwick. Upon his return to England he left Cambridge to become head of the Chemistry Department at the Northern Polytechnic in London, and during his ten years there he began the stereochemical work which was to gain for him an international reputation. He returned to Cambridge in 1912 as a Fellow of Jesus and demonstrator to the Jacksonian professor (then Sir James Dewar), and he remained there until his death.

Mills's achievements in the field of stereochemistry will always rank among the most powerful contributions made to the subject, for he had a flair for planning and carrying out a decisive experiment. By the synthesis and resolution into optically active forms of suitable compounds, he and his colleagues successfully demonstrated the non-linearity of carbon, nitrogen and oxygen in the oximes, the tetrahedral distribution of valencies in substituted ammonium ions and zinc complexes, and the planar configuration around 4-co-ordinated dipositive palladium and platinum. He played a great part in developing the steric theory to account for the optical activity of certain ortho-substituted diphenyls, and he later extended the idea of steric hindrance to free rotation to naphthalene, quinoline and benzene derivatives. Mills and Maitland, by their demonstration of optical activity in 1 : 3-diphenyl 1 : 3-di-α-naphthylallene, confirmed a prediction made fifty years earlier by van't Hoff and, as a writer in the "Annual Reports on the Progress of Chemistry" put it, "realized one of the ambitions of all stereochemists". Mills also made important discoveries in connexion with the chemistry of cyanine dyes and alkyl-substituted pyridines and quinolines.

Mills was elected to the Royal Society in 1923, and he received the Davy Medal in 1935 ; he was appointed to a personal readership in stereochemistry at Cambridge in 1931, and he was George Fisher Baker Lecturer at Cornell in 1937. Unfortunately, he could never be persuaded to publish the lectures and, indeed, throughout his life he seldom published anything but self-contained original papers. He was president of the Chemical Society during 1941–44. After his retirement, he seldom visited the laboratory, but he retained a wide interest in scientific matters, and his 1942 Pedler Lecture on "The Basis of Stereochemistry" anticipated much that has since been written on that subject.