PROCEEDINGS OF

THE ROYAL SOCIETY.

Section B.—Biological Sciences.

Address of the President, Prof. C. S. Sherrington, at the Anniversary Meeting, November 30, 1921.

Since the last Anniversary Meeting the roll of the Society has lost by death fifteen Fellows and one Foreign Member :

Sir William Abney.	Lord Moulton.
Mr. Spencer Pickering.	Prof. A. W. Reinold.
Dr. A. Muirhead.	Prof. E. J. Mills.
Sir Lazarus Fletcher.	Colonel J. Herschel.
Prof. W. Odling.	Mr. G. W. Walker.
Prof. L. C. Miall.	Dr. H. Woodward.
Prof. R. B. Clifton.	The Earl of Ducie.

Dr. F. A. Bainbridge.

On the Foreign List

Prof. G. Lippmann.

The Anniversary Meeting affords appropriate opportunity for some spoken reference to them.

The earliest loss was that of William de Wiveleslie Abney, a Fellow of the Society for upwards of forty years. Much of his scientific work may be summarised as being the establishment, by experiment, of photography as a science. With Sir William Abney photography was not merely a means but in itself a scientific end. The building of the image both in the wet and in the dry plate were successfully studied by him. He was a pioneer in the photography of the infra-red region of the spectrum. He suggested more than forty years ago the charging of carbons with calcium salts to enhance the arc-light beam, the flame arcs of to-day. Later he passed, so to say, from the photographic plate to the retina and investigated the relative visual intensity of different portions of the spectrum. As Advisor

to the Board of Trade he obtained, partly in collaboration with the late W. Watson, data most valuably discriminating between various types of colour vision; he contributed accurate measurements of visual differences between the foveal and para-foveal regions of the retina. His measurements of the visual luminosity curve of the spectrum stand as classical data of reference. He is remembered in the Society as a man whose personality endeared him to everyone who knew him.

The death of SPENCER PERCIVAL UMFREVILLE PICKERING removed a chemist, who at the time of his election to the Society, was one of the most arduous and prolific of researchers. The main theme of his work was solution and hydrates. A man of original view he often collided rather than moved with the scientific trend of the time, but he spared himself no pains in the pursuit of observations. His association with the Society will be happily perpetuated by the bequest from him, to become a research fund bearing his name.

ALEXANDER MUIRHEAD, whose name is connected with the duplexing of submarine cables by the artificial line with distributed capacity, also contributed perseveringly to the practical establishment of electrical standards of capacity. Much of his work was accomplished against difficulties of health which would have disheartened any but a man of remarkable courage and resolution.

LAZARUS FLETCHER was for ten years Director of the Natural History Museum. Mathematically trained, his chief scientific interest lay in problems connected with the physics of crystals, though much of his time was given to the great National Collection of minerals of which he had charge for nearly thirty years. He devoted much patient and accurate research to the meteorites in that collection. His papers that are probably best known are those on the dilatation of crystals by heat, and on the Optical Indicatrix and transmission of light in crystals. In the latter of these he showed how the optical characters of crystals could be simply developed from the geometrical properties of an ellipsoid (which he called the Indicatrix) independently of any hypothesis as to the nature of the ether. His method has now been adopted by almost all teachers of the subject. Those who knew Sir Lazarus Fletcher are not likely to forget his simplicity of manner, his quiet humour and his unfailing consideration for others.

WILLIAM ODLING, for many years Professor of Chemistry at Oxford, died there this spring at the age of ninety-two, severing a link with the chemistry of the mid-Victorian time. It was under his Chairmanship of the Institute of Chemistry that that body was granted its Charter in 1885.

LOUIS COMPTON MIALL was a biologist; a naturalist in the old sense of the word. He did good and lasting zoological research. He was one of a group, few in number but strong in personality and influence, who laid the foundation of the existing University of Leeds. He was an enthusiastic educationalist, and appreciated highly the calling and the opportunities of the primary school-teacher; he helped that calling in many ways. He himself was a strikingly successful teacher. Those who knew him will recall how he studied teaching as an art, and loved it for its own sake.

Dying at Oxford a little later in the year than Prof. Odling, ROBERT BELLAMY CLIFTON had been Professor of Experimental Philosophy there from 1865 until 1917. His first duty for his Chair had been the superintendence of the erection of the laboratory, the Clarendon Laboratory, of which Sir Richard Glazebrook writes in his obituary notice of Clifton: "it was the first built in Europe for the special purpose of experimental instruction in Physics." The fittings and teaching apparatus were largely to Prof. Clifton's designs, and he gave much time and thought to their construction, perfecting and re-perfecting them in detail. So strict a custodian of them did he become that it was sometimes humorously said they had become too precious to be very accessible for their original purpose. However that may be, under his hospitality the laboratory he had erected gave a home to a great piece of experimentation in Prof. Boys' determination of the gravitation-constant. Clifton was a man of genial personality, of much conversational gift, shrewd and humorous, and of a nature full of kindly qualities.

WILLIAM REINOLD was Professor of Physics in the Royal Naval College. He had been Demonstrator under Clifton in the Clarendon Laboratory. It was during his long activity at the Royal Naval College, and as a teacher there, that his main scientific life-work was accomplished.

In March last died suddenly Lord MOULTON OF BANK. Not an actual investigator in Science, he was yet a very real servant to the cause of scientific progress in this country. He possessed remarkable power of acquisition of knowledge, seizing rapidly and broadly the lines of advance taken by knowledge. A facile expositor of scientific themes to a lay or semi-lay audience, and gifted with an enthusiasm that never failed, he promoted the public appreciation of scientific work. Foreseeing from the outset of the War the magnitude of the strain that it would involve, he had the courage to demand a mobilisation of scientific resources adequate to that strain. The country owed much to his insistence and unsparing effort. His was a virile persuasion. After the coming of the Armistice, he turned his energies and influence toward urging a more thorough liaison between science and the industry of the country.

EDMUND JAMES MILLS held the Young Chair of Technical Chemistry in the Glasgow and West of Scotland Technical College. His papers were numerous both on applied and theoretical chemistry, and not a few of them were contributed to this Society, the first of them now more than fifty years ago. Returning to London in later life, he was for many years a frequent attendant at the Society's meetings.

Colonel JOHN HERSCHEL, a son of Sir John Herschel, and at one time Deputy-Superintendent of the Great Trigonometrical Survey of India, had been a Fellow of the Society for fifty years. He was a spectroscopic observer of a solar eclipse as far back as 1868.

GABRIEL LIPPMANN, the eminent French physicist, died while at sea on his way from Canada home to Paris. He had been a Foreign Member of the Society for five and twenty years. His interest in physics lay largely in the philosophic aspect, though his name is most familiar in connection with the capillary electrometer and with colour photography. Lippmann's capillary electrometer became, so to say, a household tool in every physical laboratory, and likewise in many biological laboratories. In animal physiology it proved of unique service for the observations of the slight and fleeting electromotive reactions of isolated nerve and muscle. Until the advent of the string galvanometer it was the only instrument which could really cope with them.

Of Lippmann's process for the reproduction of colour by photography, our Foreign Secretary, Sir Arthur Schuster, who knew him from a time when they were fellow students together, kindly writes me as follows:—"Lippmann's work on colour photography well illustrates his great experimental skill. Independently of the late Lord Rayleigh, who, in 1887, had on theoretical grounds foreseen the possibility of the reproduction of natural colours by an interference method, Lippmann conceived the same idea; but the experimental difficulties were formidable. The method depends on establishing a periodic structure in a photographic film by the interference of the direct light and its reflexion from a metallic surface. It was necessary for the purpose that the films unlike those in ordinary use, should be transparent. The production of such films appeared for many years to be an insoluble problem, but ultimately the difficulty was overcome, and in 1901 Lippmann obtained his first success; but it was several years before he could secure the equality of sensitiveness throughout the visible spectrum which is essential if the natural colours are to appear with their correct values. The photographs obtained by Lippmann cannot be reproduced in print, but may be shown with brilliant effect by projection on a screen."

GEORGE WALKER WALKER had, following on a career of high promise at Cambridge, been successively Lecturer in Physics at Glasgow University, Superintendent of Eskdalemuir Observatory, Director of the new Magnetic Survey of the British Isles, and finally chief scientific worker at the Royal Naval Mining School, Portsmouth. It was during work in that latter capacity that his fatal illness began. He united in a remarkable degree mathematical attainment and inventive capacity. By his death physical science lost, sadly early, a finely accurate experimental exponent.

HENRY WOODWARD, late Keeper of the Department of Geology of the Natural History Museum, was a distinguished paleontologist. His scientific reputation was especially as an authority on extinct representatives of the Crustacea. He was one of the founders, and for over fifty years editor, of the 'Geological Magazine.' His example and personal contact were a stimulus to many others, and the encouragement given by him to amateur workers was one of the features of his official career.

FRANCIS ARTHUR BAINBRIDGE died last month in early middle age. He had been elected a Fellow in 1919. Of delicate physique, constantly struggling against ill-health, he nevertheless accomplished, besides much routine teaching, a great deal of accurate research, some in pathology, more in physiology. He contributed to the differential recognition of the several types of paratyphoid bacilli, a matter at once of theoretical interest and great practical importance. His work in physiology opened with investigation of lymph formation, following on that of Bayliss and Starling. Then came work on urinary and salivary secretion, all of it characterised by great clearness of objective, and definiteness of plan. One of his best papers is one of his most recent. Its subject is the acceleration of the pulse, which muscular exercise constantly and so quickly induces. Bainbridge showed that the increased filling of the venous chamber of the heart, and the consequent increase of pressure in it, itself acts as a stimulus which excites through the nervous system the more frequent beating of the heart. He traced this control in part to depression of the vagus, partly to stimulation of the nerves which accelerate the heart. Bainbridge was an experimentalist of exceptional dexterity. Always cheerful, he seemed at his cheeriest when busiest in the laboratory.

LORD DUCIE, whose decease fell latest in the year, had been a Fellow for nearly 67 years. Interested in Science, he was also greatly interested in secondary education. Latterly he had given his time and abilities chiefly to the countryside where he resided. By virtue of the date of his election to the Society, 1855, he had become its Senior Fellow.

We may note that the Seniority of Fellowship of the Society has now

passed to one who has been a member of Council on many occasions, a Foreign Secretary, and Secretary, our sometime President, Sir Archibald Geikie, known among us also as the genial historian of the Royal Society Club.

It is little more than two years since the death of the late Lord Rayleigh, and this afternoon in Westminster Abbey there has been unveiled the tablet to his memory, given by subscribers from this Society and from the University of Cambridge, of which he was Chancellor. At the presentation ceremony the Society and the donors generally were represented by the Chairman of the Memorial Committee, Sir Joseph Thomson. The Society will feel it peculiarly appropriate that their representative on such an occasion should be one so closely associated with the late Lord Rayleigh in the Society, in the University which was their common *alma mater*, and in the domain of physical science itself. The recollection of the late Lord Rayleigh's personality is present with us all: to meet him was to receive the impression of true greatness. The legend on the mural tablet runs:—"*An unerring leader in the advancement of Natural Knowledge.*" To-day has seen the fulfilment of a fitting tribute, in a fitting resting-place, to a memory veneration for which the lapse of time will but intensify.

The Bakerian Lecture of the year was by Dr. T. M. Lowry and Mr. P. C. Austin on "Optical Rotatory Dispersion." The Croonian Lecture was by Dr. Henry Head. It had for its theme the disturbance of action in the nervous system due to the impairment of one part reacting on the function of another. Not unnoteworthy concerning the lecture is that, to push further the enquiries underlying it, the lecturer had subjected to surgical severance and restitching nerves of his own arm.

To Dr. Head the Society owes a most acceptable gift. The Society possessed no portrait of Lord Lister. Dr. Head, on learning this year that such was the case, offered to the Society a portrait of Lister, by Legros, in black and white, a portrait that had been given to Dr. Head by the poet Henley, in whose possession it long was,—Henley, the poet whose word-portrayal of Lister, under whom he was a patient, is extant in the famous sonnet familiar to us all. The gift was gratefully accepted by Council.

The Anniversary Meeting is naturally an occasion for retrospect; it is also one which invites some thought to the present. The present time has in it an element of considerable anxiety for those who regard the prosperity of Science. Although the recent past has, it is true, been not unfavourable.

I mentioned just now a university building, the earliest constructed for systematic experimental teaching in Physics, and that just 50 years ago. It is a satisfaction to note the multiplication of such laboratories since then. This year at the inauguration in London of the Institute of Physics Sir Joseph

Thomson remarked that now, in contrast against the early years of the Cavendish Laboratory, the study of Physics, as regards the numbers to whom it gives opening for a livelihood, constitutes in fact a profession of its own. The same can be said of the Science of Chemistry, and of the Biological sciences. Cultivation of science has been a feature of the country's progress. This has in part been adjunct to the movement for the foundation of new Universities. The number of the English Universities has doubled in the last quarter of a century. The new Universities have shown admirable energy in their departments of science. Following in the tradition of the best of the older Universities they have, in instance after instance, made their laboratories places of research. Only last year the Council of the Society stated that to increase the resources and equipment of the Universities is one of the best ways of aiding research in pure Science. The Report of the University Grants Committee in February of this year indicated that the Universities were unable to meet their existing responsibilities, and that their resources are inadequate to meet legitimate demands upon them. It is, therefore, a matter of grave concern that the Government Grant to the Universities is now to be cut down heavily. The maintenance of the Universities at the level of efficiency which they have struggled so resolutely, and with much service but poorly paid, to sustain, will thus receive a very severe blow.

Regression is the more disappointing because, during the war, there came an awakening of the conscience of the nation in regard to Science. The national need for wider and deeper interest in, and understanding of Science came home to the community as it had not done hitherto. The importance to the nation of, for instance, the national Physical Laboratory, whose parent this Society may justly claim to be, began to receive more general recognition than before. Its importance to the State became cogent to the State. Six years ago saw the founding of the Advisory Council on Research to the Privy Council, and a year later the establishing of the Department of Scientific and Industrial Research. These were not created as part of the machinery for the war, though during that common need they, like every other national organization, made their contribution. They were brought into existence to remedy deep-seated shortcomings which the war revealed in the country's organization for scientific research. Their full effect was only to be expected to come now, after the attainment of peace. It is, therefore gravely disquieting that their State support estimates are being now reduced by some 30 per cent. and that further reduction still is asked for.

Again, if we turn to the domain of Biology, and take within that the field of Medical Science, the Medical Research Committee, as it then was, had been

organised and started not long before the outbreak of the war. It had from its beginning shown its utility and brought evidence of the great field of usefulness before it. Its services during the war and since the ending of the war have been conspicuous, indeed inestimable. Public appreciation of it has enhanced. The Government has recently raised the status of the Committee, so that it is now the Medical Research Council under the Privy Council. Annual Reports indicate the quality and the volume of the work it is accomplishing. It is creating a new era of research in scientific medicine in this country. But its financial State aid is to be cut down for the coming year, and the extent of that reduction is a real anxiety to all who have at heart the progress of Medicine in this country and of the Sciences on which Medical Science itself rests.

I may say that, broadly taken, the apparatus for prosecution of research in this country is made up as follows: (1) Scientific and Professional Societies and some institutions entirely privately supported; (2) Universities and Colleges, with their scientific departments; (3) Institutions, using that term in the widest sense, directly subventioned by the State, such for instance as the Medical Research Council, the Development Commission, and the Department of Scientific and Industrial Research. Of these three categories, the first named, the Scientific Societies group, work without financial aid from the State, apart from the small though extremely useful two Government Grants distributed, mainly to individual workers, through this, the Royal Society. At the present time many of the Societies sorely need financial help to carry on their labours, and some are absolutely at a loss to know how to publish the scientific results that are brought to them. (2) The second category, the Universities and Colleges, depend in part upon Government aid. In the aggregate of twenty-one institutions of University rank, following Vice-Chancellor Adami's figures, students' fees and endowment provide about 63·5 per cent. of the total income; for the rest they are dependent on Government Grant. (3) The third category as said, draw State-support direct.

This triple system may seem a somewhat haphazard and inco-ordinate assembly. Yet in reality it is an organisation with much solidarity, and its co-ordination is becoming more assured. Its parts dovetail together. The first group, the scientific and professional Societies, is provided with a medium of intercommunication and co-action, the Conjoint Board of Scientific Societies. As to the separate categories composing the triple system itself, they also are in wide touch one with another. Between the Scientific and Professional Societies on the one hand and the Universities on the other, contact and inter-relation are secured by some degree of free and rightful

overlap, both as regards general subject matter of research and of their *personnel.* Finally, there is excellent contact between both these categories and the third, the State-subventioned institutions. A special feature of the policy and administration of these State organisations secures this, a feature which makes the whole of this subject the more cognate to the purview of our own Society. To exemplify I may turn, for instance, to the Development Commission. Its programme of Fishery Research, avoiding the terms "pure" research and "applied" research, in view of the possible implication that pure research does not lead to practical result, directs research not alone to the solving of particular economic problems. It supports more especially what it terms "free" research, investigation in this case of the fundamental science of the sea and of marine life. This term "free" research is set in its full light by words of the Lord President of the Council, Mr. Balfour, where he points out that while the State may aid research, it will only destroy research if it resolves too rigidly to control it.

Again, with the Advisory Council of Scientific and Industrial Research, its programme, gradually defined during the past six years, is laid down as having four main points: (1) the encouragement of the individual research worker, particularly in pure science; (2) the organisation of national industries into co-operative research associations; (3) the direction and co-ordination of research for national purposes; (4) the aiding of suitable researches undertaken by scientific and professional Societies and organisations. It recruits researchers by giving financial opportunity to promising students to be trained in research attaching them to experienced researchers. In short, it apprentices to research a number of selected younger workers in Universities, Colleges, and other institutions scattered throughout the country.

So, similarly, the Medical Research Council. Its Secretary, Sir Walter Fletcher, in an illuminating presidential address to Section I of the British Association Meeting this summer, said, speaking of the nexus between scientific research and the progress of Medicine, "It is the accumulating knowledge of the basal laws of life and of the living organism to which alone we can look for the sure establishment either of the study of disease or of the applied sciences of Medicine."

It is evident, therefore, that with a policy based on such principles as these, the third category in the triple system constituting the organisation for scientific research in this country, is one which has common aim and solid touch with both the others, the Universities and the Scientific and Professional Societies. One sees in short that the organisation which has come into existence and is maintaining scientific research in this country,

is a real organisation. It did not spring fully equipped from the head of Jupiter. It has grown up rather than been planned. In that respect it is an organisation essentially British, and it seems qualified to do its work for the country well. We hear of adventures, political and other, the offspring of the day. But these were no adventures, these, to my mind, welcome, long-overdue, steps forward by the State toward the succour of Science and its welfare, steps that help to strengthen and consolidate the organisation for research by such adjuncts as the Medical Research Council and the Department of Scientific and Industrial Research. One of the strengths of this organisation that has arisen is, in my view, that it interlocks with the educational system of the country. It is an organisation which proceeds on the wise premiss that, in the case of Science, the best way to get the fruit is to cultivate the tree. It is an organisation which is proving successful and economical. Its output has proved a more than liberal return on the funds at its disposal.

But essential to its own continuance is continuance of adequate financial support from the Government. A tripod cannot stand upon two legs. The State-contribution in this country is relatively not large, but it is most important. Important as it has been in the past, it has now an importance most especially great. The cost of investigation is now higher, much higher than it has been. Endowment funds carry less far than they did carry. Private benefactions and voluntary generosity, although willing, are less able to be found and less capable at this time; already gauged as inadequate of themselves alone before the War, they obviously cannot alone cope with the necessary undertakings now. The present is a time when a large-scale withdrawal of the Government's financial support must prove most formidably crippling. Such crippling will be greater than the actual measure of the sum withdrawn would entail in ordinary times.

None can fail to see the urgent need for national economy. It may be objected that the plea to which I am speaking is, in fact, one for the preferential treatment of Science. That is not so. Faced with need for stringent economy, there must, of course, be a rigorous cutting down of expenditure that is unnecessary. But a first enquiry is the discrimination between expenditure upon the inessential and the essential. Otherwise the economies seemingly effected may be no economies. The savings may be made in a fashion most costly in the end. Conceded that there must be some reduction in the moderate State expenditure on research, it would be no true economy if that reduction were pushed to the point of causing collapse of the fabric for the production of much-needed knowledge or of whole compartments of that fabric.

The necessary supply of trained research workers cannot be retained or replenished except by a steady policy pursued. If the financial provision for research is too severely cut down, that will mean the extinction of various investigations which cannot be satisfactorily continued at all under narrower limits of expenditure than are imposed at present. One feature of modern research is that it has become more largely team-work, the combined effort of an assorted group of individuals with special training. Want of volume has tended to be a weak point in our national research. Reduction of the support by Government will react most rapidly on the number of competent investigators available, the number that makes a fair volume of team-work possible. The Report of the Advisory Council states that the effect of a set-back of this kind will be long-continued and adds that it may be lasting.

To pull down under emergency what has been built up through years of careful experience and is proving efficient, can hardly be ultimate economy. It is to unlearn a useful lesson learnt. Curtailment of the State aid—relatively small in this country—given to scientific research must harm the scientific production of the country. Some curtailment, however, at this time seems unavoidable. Though extension of buildings and equipment and *personnel* is wanted, it may be necessary to withhold that extension at this time, maintaining broadly the *status quo* ready for expansion when that is once more feasible. But if research be an indispensable factor in the rebuilding of the national life, sacrifices should not be required from it disproportionately greater than from other services of a similarly essential kind. Reduction of the State's support on a scale to entail ruin to the existent organisation would be a wastage rather than an economy. Calmly viewed, what more reminiscent of the wastage of the War itself than for machinery actually constructed, assembled, and producing what is needful for a nation's strength as a pillar in the industrial and intellectual temple of the world, to be now under temporary change abandoned or broken up; and at a time when industry as a whole stands convinced of scientific research as a necessity for its recovery and well-being.

My hope would be that scientific research on its present maintenance will be considered part of the intellectual bread of the community, part of the bed-rock on which rests the efficiency, not to speak of the industrial equipment of the nation; that it will be treated as such in the measure of State-support continued to it; that the State will remember that that support has to embrace at least both the Universities on the one hand, and, on the other, the research institutions administered by the State, for this reason, namely, that the country's organisation for research, complex in origin, yet economical and effective, stands as an integral system, to whose entire existence is

essential an adequate State provision for both these constituent elements, indispensable, since they are, to the whole structure of the system.

I now proceed to the distribution of the Medals.

The Copley Medal is awarded to Sir Joseph Larmor.

Sir Joseph Larmor has long held a leading position in the British School of Mathematical Physics. There is hardly a branch of this subject to which he has not made contributions of distinct originality and great value. His earlier researches on Dynamics, on Optics, both geometrical and physical, and on Elasticity, are marked by keen insight and by the novelty introduced in the treatment of familiar subjects. In more recent periods he has written on problems of Geodynamics, with the same illuminating force. His contributions to the Theory of Electricity, in its many ramifications, are numerous and profound. His treatise on 'Æther and Matter' forms a distinct landmark in the history of the subject. In this we have the foundation of electromagnetic theory on the single principle of least action, with the electron taken into account as an æthereal structure. He was the first to establish (to the second order of velocity) the correspondence between moving and fixed electrical systems, and shares with Lorentz, the distinction of discovering the generality of this correspondence to any order. It may fairly be said that his preliminary work was of the utmost value in paving the way to the modern developments of the Theory of Relativity. In addition to his own researches Larmor has, as Lucasian Professor, stimulated the work of others with notable success. His intimate and extensive knowledge of the history as well as of the results of physical science marked him out as the appropriate editor of the works of Stokes, Kelvin, James Thomson, and Henry Cavendish, to which he has contributed most serviceable annotations.

A Royal Medal is awarded to Dr. Frederick Frost Blackman.

Dr. Blackman is distinguished for his contributions to plant physiology, and especially to knowledge of the process of photo-synthetic assimilation of carbon dioxide. In this connection he devised apparatus of great delicacy and accuracy. Later he proceeded to an exhaustive investigation on the rate of assimilation within the green leaf. He determined, under varied and controlled conditions, the inter-relationship of the external factors and their several and joint effects on the rate of assimilation, and has laid the foundation on which a good deal of subsequent work by other investigators has been rendered possible.

He was thus led to his theory of limiting factors, which has exerted much influence in both plant and animal physiology. With the help of his

co-workers he has importantly extended our knowledge of permeability, and of the influence of anæsthetics on plants. He occupies a leading position amongst plant physiologists, not only by reason of the importance of his discoveries, but also on account of the effective stimulus he has given to the school of investigators who have been trained in his laboratory.

A Royal Medal is awarded to Sir Frank Watson Dyson.

Sir Frank Dyson is distinguished not only for his enlightened and energetic administration of the Royal Observatory, but by his many important contributions to Astronomy. He has devoted special attention to investigations of the movements and distances of the stars, and of the bearing of these upon the structure of the stellar universe. He has concentrated his energies particularly on the stars surrounding the north celestial pole, and has collected or determined for this region of the sky all the different data which seem likely to aid in the solution of the stellar problem. In a long series of papers he has shown himself able not only to conceive and execute large schemes of observation, but also to deduce by graphical and mathematical analysis the theoretical conclusions which are implicit in the mass of data. Some of his investigations are remarkable for the extensive data which have been utilised; one of them involves the proper motions of 12,000 stars, and another of 26,000 stars. These researches have given Sir Frank Dyson a place in the front rank of workers on stellar distribution and movements.

He has also given much attention to the accurate determination of stellar magnitudes, and has successfully established a regular programme of work on stellar parallaxes which has yielded results of high precision for a large number of stars.

Previous to this he had been conspicuously successful in obtaining records of the spectrum of the corona and chromosphere during eclipses of the sun; his publications on those subjects are among the most valuable sources of solar spectroscopic data. It was mainly to his foresight and organizing ability that we owe the successful observations of the deflection of light by the sun's gravitational field during the eclipse of 1919.

The Davy Medal is awarded to Prof. Philippe Auguste Guye in recognition of his work on optically active organic substances, on molecular association and on atomic weights.

In his early work on Organic Chemistry, Prof. Guye was led to investigate the question whether a quantitative relationship exists between the molecular rotations of optically active substances and their chemical constitution. Although the answer proved to be in the negative, the attempt to establish

such a relationship was yet productive of much valuable research on optical isomerides in his own laboratory, and stimulated the efforts of many investigators in that branch of physical chemistry, particularly in this country.

Shortly after he had put forward his theory of the "product of asymmetry" he was attracted by the problems connected with Van der Waal's equation and the critical state, and, from his interest in these, two important lines of investigation opened out. The one had relation to the degree of molecular complexity of matter in the liquid state, and occupied his attention mainly between the years 1893 and 1911. The other led him at the beginning of the present century to advocate, with much energy and persistence, the advantages of the physical method of determining atomic weights. In this field of work he became one of the foremost investigators; his work on the calculation of precise gas densities was followed by chemical studies of the atomic weights of nitrogen, silver and chlorine, and by inquiries into sources of error, hitherto little recognised, in atomic weight determinations.

The Hughes Medal is awarded to Prof. Niels Bohr.

Prof. Bohr is well known to all physicists as the author of the conception to which the name "Bohr-atom" has been attached. A decade ago it became clear, from the researches of Sir E. Rutherford and others, that the atom of any element is formed out of an excessively minute positive nucleus of electricity, round which circulate a number of negative electrons equal to the atomic number of the element. Bohr discovered a mechanism for the motion of these electrons, which solved immediately the long-standing puzzle of the Balmer series of hydrogen, and which, after development and discussion, appears likely to provide a complete explanation of the spectra of the various elements. In this way he has opened up a line of investigation which has already attracted to itself many of the ablest mathematicians in Europe, and of which the success, in the simplest cases of the two light elements hydrogen and helium, is even now little short of perfect.