NATURE

SATURDAY, MARCH 24, 1928.

## CONTENTS.



*Editorial and Publishing Offices:*
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.



## New Statutes for the University of London.

THE second draft of the proposed Statutes for the University of London has been published by the Commissioners appointed under the University of London Act, 1926. This Act directed that statutes for the University were to be made by the Commissioners "in general accordance with the recommendations" contained in the Report of the Departmental Committee appointed by the President of the Board of Education (Mr. Trevelyan) in 1924, "subject to any modifications which may appear to them to be expedient"; and the first draft implemented these recommendations, save in one or two particulars, for example, two women's colleges—the Royal Holloway College and Westfield College—were added to the list of colleges accorded direct representation on the Senate, thus ensuring further representation of the special interests of women; and the Principal of the University was made *ex officio* a member of the Senate.

Both before and after the publication of the first draft, voluminous representations were made to the Commissioners. One subject on which representations were made, of special interest to readers of NATURE, is the recognition of research as an important activity of the University. The new draft Statutes provide for the recognition of research institutes as 'Schools of the University' and divide the 'Schools' into three categories—(1) Incorporated Colleges, the title curiously given to the two colleges, University College and King's College, which have ceased to be 'incorporated' in the legal sense; (2) Colleges; (3) Research Institutes. The division of the existing 'Schools' has been carried out by the Commissioners in an amateurish way, for the category 'Colleges' as published includes some professional schools, and the category 'Research Institutes' includes institutions such as the School of Pharmacy and the School of Oriental Studies, the chief work of which is instruction rather than research.

The title of the body charged with the control of the finances of the University has been changed from 'Council'—a name possibly suggesting a body subordinate to a larger body—to 'Court,' a more appropriate title for a body created *ad hoc* with powers both independent and concurrent.

The most important change introduced by the second draft of the Statutes is the complete abrogation of the direct representation of colleges on the Senate. Objection was taken to the principle of

college representation on the ground that a university is traditionally a self-governing guild, not a federation of colleges, and that the members of the supreme governing body in academic matters should not *represent* independent or *quasi*-independent institutions. Huxley gave his views on this question to the Gresham Commissioners in 1892 with his accustomed clearness. "Unify without fettering" expressed his ideal of the relation of university to college. He advised against giving the professoriate a preponderant representation on the Senate and said he would certainly object to any system "by which institutions whether called colleges or by any other names got the whip hand of the University." He would not "cumber" the Senate with representatives of the colleges—referring no doubt especially to lay representatives.

This view has been accepted, on re-consideration, by the present Commissioners. The alternative adopted is the appointment of the heads of the nine named colleges, together with two deans of medical schools to be selected, as official members of the Senate. Even those who objected on principle to college representation recognised that the heads of colleges, by reason of their wide knowledge and experience, were most eligible on personal grounds for membership of the Senate. Apparently it was not possible to avoid giving permanent seats to the heads of the selected colleges—a method which has disadvantages in a democratically constituted governing body—though in the case of the medical schools a system of selection has been adopted.

In addition to the Chairman of Convocation, who is a member *ex officio*, the representation on the Senate of the graduates in Convocation has been increased by one member (from 16 to 17), who is allocated to science; and similarly an additional representative has been accorded to the Faculty of Medicine, composed of teachers (an increase from two to three), the effect being to increase the number of Faculty representatives also from 16 to 17. Past controversies, as well as the relative importance of scientific and medical interests in the University, justify this change. The total membership of the Senate as re-constituted will be 52 (or possibly 53).

The appointment and dismissal of members of the financial and administrative staff of the University is, by a new draft Statute, to rest with the Senate, except as to the Principal, who is to be appointed by the Senate with the concurrence of the Court. This is a new and surprising provision, its effect apparently being to prevent the Court appointing its own officers for the discharge of its onerous duties in relation to finance, including the obtaining of benefactions and public grants for the University.

Another surprising innovation is the proposed acceptance, as internal students, of students who have not matriculated in the University, including students preparing for degrees of other universities (for example, medical students preparing for degrees at Oxford and Cambridge) and students preparing for the diplomas within the purview of the Academic Council. The definition of internal students is contained in the schedule to the Act of 1898, and the Departmental Committee recommended no change in this important matter. It is a wide departure from established practice to register internal students without any prescribed educational standard, though it must be remembered that Huxley was opposed to all matriculation tests, and there will be great advantages in enabling all regular students of colleges to register as internal students. The registration of external students, a much-needed reform, is authorised by a new draft Statute, but not directed.

On the difficult question of an 'appointed area' for the University, the Commissioners have not found enlightenment, retaining the illogical and unscientific London County Council area for the admission of new 'Schools,' except as regards institutions "wholly or mainly devoted to the pursuit of some branch of University study which cannot, in the opinion of the Senate, be adequately pursued within that area," for which no area is prescribed. The present thirty-mile radius for institutions at which teachers can be 'recognised' disappears, the recognition of teachers under the new conditions being without restriction of area. Is it to be inferred from these new arrangements that places like Wimbledon, Watford, Chingford, Chislehurst—admirably situated for day and residential colleges for London students—are outside the sphere of influence of the University of London and are at liberty to create new universities? Even at this late hour, it may be hoped that the Commissioners will find inspiration for a better definition of the 'London area' in respect of higher education.

The Commissioners announce April 30 as the last day for receiving further representations, and it is to be presumed that renewed controversy is not expected. In view of the important new issues raised by the amendments to the first draft of the Statutes, the time allowed for further discussion appears to be unduly restricted.

## Economic Ornithology.

*The Practical Value of Birds.* By Prof. Junius Henderson. Pp. xii + 342. (New York: The Macmillan Co., 1927.) 10*s.* 6*d.* net.

ALTHOUGH we in Great Britain are only just beginning to realise the importance of avian economics, other countries have long been cognisant of the important part played by wild birds, and none more so than the United States of America. Since 1885, when investigations were commenced under the ægis of the Government, there has been a long series of distinguished investigators whose work has been published in upwards of two hundred memoirs. Valuable as these works are to all engaged on similar researches in this particular branch of science, they are scarcely the literature desired or to be understood by a large body of the general public who are anxious to learn something of the economic status of the wild bird fauna. It is therefore most fitting that the results of these invaluable suggestions should be summarised, and a résumé provided for those generally interested, for such cannot fail to bring home to a wide circle of readers the extent and national value of this long and brilliant series of investigations.

Prof. Henderson's work is divided into two parts, the first dealing all too briefly with the principles involved and the more important groups of facts. The seventeen chapters are contained in about one hundred pages, and, while full of interest, scarcely do justice to the voluminous literature on the subject. The second part consists of a systematic discussion of "the more significant data" relating to American economic ornithology. The author has not only included a very full bibliography, but also, unlike many present-day authors, has credited every author quoted with an actual reference.

The work that has emanated from the Bureau of Biological Survey is so thorough and reaches such a high standard that we wish the author had confined himself to an epitome of this alone. We question whether the results obtained by Aughey fifty years ago have more than historical value. As all investigators know, odd notes on the food of one or two specimens of a bird observed at a particular season and district are really of very little value, and in the present case they only tend to detract from the valuable results obtained by workers of long experience. Any further advancement in the subject of the economic status of any species of wild bird will only be made as the result of a systematic examination of the stomach contents of a large series of specimens obtained during each month of the year and from various districts. This is clearly indicated by the work of Barrows, Beal, Fisher, Judd, Kalmbach, McAtee, Oberholser, Wetmore, and others, who have laid a sure and lasting foundation for economic ornithologists.

Useful as are the details given under the various species as to the volumetric percentages of the different food items, in our opinion they are insufficient for the general reader and others for whom this book is intended. As McAtee has so pertinently remarked, such figures are merely "convenient handles to facts" and require interpreting. Significant as they are to one versed in the study of animal economics, they convey very little information to others. The reader is left to decide for himself whether a species is beneficial, injurious, or neutral in its relationship to mankind. It is to be regretted that the author has not summarised the economic status of either individual species or the family as a whole. This is such a prominent feature in the works of Beal and other writers that we are rather surprised at the omission, for it is obvious that the general reader wishes to learn the conclusions arrived at after the prosecution and completion of a long, highly technical, and extremely difficult investigation.

As American workers have since 1885 employed the volumetric system of expressing the volume of food contained in a bird's stomach, we should have expected a more precise method of stating the quantities of food required by birds; unfortunately such is here absent. If a bird requires the cubic capacity of its stomach filling four or five times a day, it is surely important to know what that cubic capacity means in grains and ounces, when such information is obtainable, in order that the volumetric analyses of individual stomachs or the total averages of such may be rightly understood. We are fully aware that, unfortunately, such figures do not exist for all species, desirable as they are, but Beal gives these for many species, and other writers have estimated the weight of the total bulk of food required in a year.

One fact which is brought out by these researches is that of upwards of five hundred species of birds, the stomach contents of which have been examined, very few indeed are proved to be wholly injurious. Species that are injurious in one part of the country during a season are just as beneficial, or even more so, in another district during a later season, all of which only tends to show how very exhaustive an inquiry should be before any species is condemned.

If we seem to have dwelt upon the shortcomings

of this work, it is not because we do not appreciate its good points, which are many and obvious. Should a further edition be called for, we trust the above criticism will be considered helpful. Although confined almost entirely to American birds and the work of American workers, the general principles enunciated hold good for practically all countries, and all interested in the economics of wild birds will find a wealth of material for careful consideration. Prof. Henderson's book is a valuable addition to the literature on economic ornithology, and he is to be congratulated on meeting an obvious need.

WALTER E. COLLINGE.

## Science and Faith.

*Adventure: the Faith of Science and the Science of Faith.* By the Rev. Canon Burnett H. Streeter, Catherine M. Chilcott, John MacMurray, and Dr. Alexander S. Russell. Pp. ix+247. (London: Macmillan and Co., Ltd., 1927.) 7*s*. 6*d*. net.

THE book, Canon Streeter tells us, arose out of a series of informal conferences at which the relations between science and religion were discussed, mainly by the "scientists and philosophers of the post-War generation in Oxford." The essays have, therefore, somewhat of a common viewpoint, and it is a novel and stimulating one. The title is intriguing. We do not as a rule associate the idea of adventure with religion, or very often with science, and books about their relation are apt to be dull and platitudinous. The present volume does escape that reproach, and does treat the question from a new viewpoint.

Dr. A. S. Russell, who writes the first paper, on "The Dynamic of Science," has little difficulty in showing that the spirit of adventure is active in science at the present day, particularly in the physical sciences.

"At the present day," he says, "the student of natural science does not allow himself to be deterred from a theory merely because it appears incredible or incompatible with all that has gone before. To such theories indeed he is attracted. The spirit of adventure is strong in him. During the second half of last century the development of science was away from adventure and towards a form of intellectual pharisaism. All the great principles appeared to have been discovered and correctly formulated, and the scientist was inclined to believe that all that needed to be done, especially in physics, was to improve the petty details. This point of view changed rapidly when it was realised that the details were not petty, but capable of leading to astounding conclusions" (p. 18).

It is the facts themselves that have shaken the old conceptions—the facts discovered by bold and patient experiment. Nature is much more remarkable than our theories or imaginings admit. Dr. Russell writes mainly from the point of view of the physicist, and we miss in the book any equivalent treatment of biology. Or is the spirit of adventure, of revolution, less manifest in this domain?

What of adventure in religion? Mr. MacMurray considers this in a really remarkable essay entitled "Beyond Knowledge," in which he deals in a penetrating way with the relation of 'faith' to 'knowledge.' He rejects the common view that faith is a kind of knowledge—that it is belief opposed to reason, or based upon intuition, or on mystical experience. He considers it to be an attitude of will, a way of acting in the face of uncertainty or ignorance. This is, he maintains, what faith means in the New Testament, and he discovers the same attitude at the root of scientific endeavour.

"Modern science," he writes, "rests upon an attitude of will which meets the impotence of mere thought by a continuous reconstruction through criticism and experiment. This attitude of will, we have argued, is the presupposition of all living knowledge, and we have suggested its identity with faith" (p. 37).

It is action—the experimental and courageous grappling with practical difficulties—that is "beyond knowledge." Purely rational and "careful" thought does not take us very far; there must be constant testing by experiment, constant adventuring into the yet unknown complexities of Nature. Science and religion are both based upon this attitude of faith, and "Such a life of faith lies beyond knowledge, because it is the transcendent spirit of knowledge, the courageous life of creative adventure" (p. 45).

It is perhaps rather unfair to Mr. MacMurray to attempt to present his point of view in a few sentences. The whole essay, which is closely reasoned and rich in suggestion, must be read. There is much in it open to criticism, but it does present a vital and stimulating point of view,—all the more stimulating if one does not fully agree with it.

The remaining essays in the book take us rather beyond the scope of subjects appropriate for discussion in NATURE. There are three theological essays by Canon Streeter, Mr. MacMurray, and Miss Chilcott, and a long article on "Moral Adventure" by Canon Streeter, in which the problems of sex morality are dealt with in a broad and sane, but not very adventurous, way.

E. S. R.

## Pascal as a Man.

*Portrait of Pascal.* By Mary Duclaux (A. Mary F. Robinson). Pp. 232. (London: T. Fisher Unwin, Ltd. (Ernest Benn, Ltd.), 1927.) 10*s.* 6*d.* net.

THIS new short life of Pascal—for we must call it that in spite of Mme. Duclaux—will take its place suitably beside the little books on Newton and Descartes which have been recently noticed in our columns. In some ways the Pascal book ranks above the others, because Pascal was so much more interesting as a man than either Newton or Descartes. He died younger, less than forty years of age, and he had all the fascination for his contemporaries of a dreamy delicate man, full of great thoughts and divided in his allegiance between his passion for physical experiments and mechanical inventions and religious solicitude for the welfare of his soul. It was the latter interest that finally prevailed, and—with all reverence be it said—it was not the higher interest, for the religion of Port Royal, which carried off first his sister Jacqueline and then himself from the parental moorings, was not of the highest or most inspiring order. It was morbid and introspective, and put the salvation of the individual sinner above all other thoughts, human or divine. That Pascal was equally open to the other side of religion and morals—the social and humane—is evident from the tenderness of his private life and many strains in his writings; but for eight years before he died the pietistic strain was uppermost. The root cause was physical. He had suffered from childhood from a paralytic nervous weakness, and this was aggravated by a carriage accident in 1654, from which he never really recovered.

It is the struggle and the contrast between the two sides of Pascal's nature which gives the penetrating charm to all his writings, and especially to the "Pensées." Something like Shelley in personal appearance, he was like him too in the conflict between the positive and the dreamy tendencies in his thinking, but whereas Shelley sets free his imagination in picturing and glorifying the powers and future of man, Pascal is oppressed by the thought of the infinite pettiness of the individual, face to face with the immensities of space and time. The seventeenth article of the "Pensées" gives the best expression to this feeling. It ends with the quietist doctrine, that being unable to comprehend the whole or pass beyond that middle point between nothing and the infinite, true wisdom is to be found in repose, each in the place where Nature has placed him.

As the man of science it is difficult to estimate Pascal's contribution with certainty, owing to the share taken by others in his most famous work. The first idea of the pressure of the air, which was suggested by Torricelli's tube, came no doubt from Galileo. Pascal plunged into the discussion with all the ardour of his scientific, inquisitive nature. It was he probably who first thought of the decisive experiment on the Puy-de-Dôme, though Descartes claimed the credit in a conversation with Pascal. Such questions are often insoluble, when some new question is being eagerly canvassed by a group of men in close contact with one another. We may be quite sure of one or two points in this much-discussed story. One is that Pascal, being the retiring and self-centred person, was likely to have thought much more about it than others who made more noise in the world, and that he was the indefatigable experimenter on any subject in which his interests were engaged. He made fifty models of the calculating machine which was to help his father in reckoning the taxes payable by the individuals in his district. Above all, it is certain that, had his life been prolonged and had he been free from the religious obsessions which secluded him for years, and took up most of his writing time, he would have done far more for the advance of physical science.

At twelve, Pascal had been found by his father making out for himself the thirty-second proposition of Euclid on the equality of the angles of a triangle to two right angles. At sixteen he had written a complete treatise on conic sections. Nothing but good health and concentration were needed to make him the greatest geometer of modern times, the 'New Archimedes,' as Father Mersenne called him. As it was, he remains a brilliant and tragic figure, the broken column in the history of science. Mme. Duclaux catches this aspect of him admirably in her book, but she should have found a prominent place for the inspiring thought which he develops at some length in the preface to the "Traité du vide": "Toute la suite des hommes, pendant le cours de tant de siècles, doit être considérée comme un seule homme qui subsiste toujours et qui apprend continuellement." This he points out is the distinguishing characteristic of human intelligence. The 'fragile science' of bees and ants does not grow greater with the generations. But man is born for infinity. It was the thought which, had he followed it throughout, would have given the grand consistent purpose to his life.

F. S. MARVIN.

## Discharge-tube Physics.

*Handbuch der Experimentalphysik.* Herausgegeben von W. Wien und F. Harms. Band 14: *Kathodenstrahlen*, von P. Lenard und A. Becker; *Kanalstrahlen*, von Wilhelm Wien. Pp. xiv + 788. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1927.) 72 gold marks.

IN contemplating this massive volume of nearly eight hundred pages, one's thoughts irresistibly fly back to Sir J. J. Thomson's pioneer little book containing his Princeton lectures on "The Discharge of Electricity through Gases," which, published in 1898, was followed five years later by his monumental "Conduction of Electricity through Gases." This latter work not only collected and discussed in masterly fashion the relevant knowledge to date, but also by its suggestiveness served as an inspiration for the next generation of workers. There must be very many who have regretted that no recent revised edition has been forthcoming, though one realises how formidable the task would be to preserve the original degree of completeness in all the ramifications which the subject has since assumed.

Some of the developments are fraught with importance to the general community; others have contributed vitally to the more abstract aspects of scientific work. A few of these developments, which have resulted from or been influenced by investigations on gaseous ionisation, come to mind at once — thermionics and the hot-cathode valve, X-rays, cathode rays, positive rays, radio-activity, photo-electricity, electric lighting. The list might be greatly extended. In each of the subjects an enormous literature has come into being. Take, for example, the present volume on *Kathodenstrahlen* and *Kanalstrahlen*, terms, we may recall, which were introduced by Goldstein, the former in 1876, the latter in 1886. Prof. Lenard and Dr. Becker's treatment of cathode rays alone extends to above four hundred large and closely printed pages, while Prof. Wilhelm Wien's discussion of positive rays is no less impressive. These contributions bear testimony, were it needed, to the epochal stimulus to physics which followed Sir J. J. Thomson's isolation of the electron thirty years ago, and recall Maxwell's far-seeing prediction in the early 'seventies of the great potentialities of the discharge tube contrived by Hauksbee more than two centuries ago.

As would be anticipated from the standing of its authors, the book under review is characteristically complete, authoritative, and exact, and, so far as we have been able to test it, fair in its recognition of work carried out in other countries. There are more than 100 tables and nearly 500 figures. The volume is indeed a mine of information and remarkably up-to-date despite its size. In so comprehensive a work we find it difficult within the compass of a short review to single out any particular aspect for comment, but the treatments of their own investigations by Prof. Lenard and Prof. Wien respectively have a conspicuous interest and freshness of outlook. The latter's generous recognition of the work of Sir J. J. Thomson and Aston on positive rays calls for particular notice.

We confess we see little or no advantage in the plan of combining what are two independent treatises in one volume. Even now they are separately indexed, and the paragraphs, figures, and tables in the two sections are separately numbered. If each section had been issued independently, we venture to think it would have been in the interests of both the public and publisher. As it is, the volume, in view of its costliness, will mainly find a home on the shelves of institutional libraries. The publishers deserve commendation for the excellence of the printing, binding, and general 'get-up.' G. W. C. K.

## Our Bookshelf.

(1) *Das elektromagnetische Feld: ein Lehrbuch.* Von Prof. Emil Cohn. Zweite völlig neubearbeitete Auflage. Pp. vi + 366. (Berlin: Julius Springer, 1927.) 24 gold marks.

(2) *Quelques idées sur l'électrodynamique: théories nouvelles sur l'oscillateur de Planck et le mouvement autonome exposées devant la Société française de Physique.* Par R. Ferrier. Pp. 48. (Paris: Albert Blanchard, 1927.) 5 francs.

(1) THIS book is a second edition of the author's work of the same title published in 1900. It is much smaller in size than the first edition, but the arrangement of the subject matter is more carefully balanced, and the thread of the general argument is not now broken by frequent incursions into the realm of the practical realities of the subject. The whole treatment—as in the first edition—is based on the Hertzian view of an electric field which recognises matter only indirectly by its influence on the electric and magnetic properties of the ether. This view would never have persisted in face of the much greater simplicity of the modern electrical theory of matter, were it not that certain of the general critical results deduced in it seem to be supported by certain results in the more modern development, which are nevertheless, in spite of their persistence, erroneous. We refer in particular to the expressions for the energies and tractions in the field. Never-

theless, this book can still be recommended to those who wish to become acquainted with every side of a subject which has perhaps not yet reached its ultimate form.

(2) An ingenious illustration pointing the last remark of the previous notice is provided by R. Ferrier's little pamphlet. By a slight and apparently insignificant mathematical modification of the fundamental equations of Maxwell's theory—supported, however, by very cogent physical argument—certain extraordinary possibilities are opened out, which the author very ingeniously connects up with the question of the structure of the ether and the origin of the discontinuities of the quantum theory. New types of radiation fields—associated with such an old friend as the Hertz-Planck oscillator—are exhibited and their physical significance indicated. The ideas are of course merely tentative and very highly speculative, but they serve to illustrate the alternative possibilities of a theory, one half of the theoretical development of which is probably still nothing but pure conjecture. G. H. L.

*Collected Physical Papers.* By Sir Jagadis Chunder Bose. (*Bose Institute Transactions*, 1927.) Pp. xii + 404. (London: Longmans, Green and Co., Ltd., 1927.) 10*s*. net.

SIR JAGADIS BOSE has brought together in this volume a number of papers, mainly on physical subjects, written between 1895 and 1925. They include some of his papers on the applications of physical methods to the study of living matter. Of recent years he has devoted himself mainly to this branch of the subject. His early researches were on the optical properties of electric waves. They were made soon after Hertz's experiments, and his success was largely due to the method he perfected of generating electric waves, the wavelengths of which were within a few octaves of the waves forming visible light. Sir Jagadis obtained important results in this field on such subjects as coherence, polarisation, double refraction, and rotation of the plane of polarisation.

When working with receivers for electric waves, the author found that the sensitiveness of metallic detectors disappeared when they were subjected to continuous stimulation. When, however, they were allowed to rest for a sufficient period, they regained their normal sensitiveness. The records he obtained of the successive responses of metallic detectors were very similar to those he obtained when experimenting on the fatigue of an animal muscle. Thinking that prolonged rest would make a metallic detector more sensitive, he laid it aside for several days. On again testing it, he was surprised to find that it had become inert. A strong electric shock, however, made it sensitive again. He concludes that this experiment indicates two opposite treatments for fatigue from overwork and for inertness due to long passivity. No break was found in the continuity of the phenomena.

Sir Jagadis Bose considers that there is no line of demarcation between the physical phenomena and the physiological phenomena. It is impossible to say whether a phenomenon is one shown by dead matter or a vital phenomenon peculiar to the living. The book contains brief accounts of many interesting and suggestive experiments.

*Operational Methods in Mathematical Physics.* By Dr. Harold Jeffreys. (Cambridge Tracts in Mathematics and Mathematical Physics, No. 23.) Pp. vii + 101. (Cambridge: At the University Press, 1927.) 6*s*. 6*d*. net.

THE operational methods of Heaviside for the solution of differential equations have the advantage of proceeding direct to the result in terms of given boundary conditions. Bromwich's interpretation of the operators by means of contour integrals have led to a generality and convenience of application which will ensure a warm welcome from mathematical physicists of Dr. Jeffreys' lucid and interesting exposition. Moreover, this is the only available connected account of Heaviside's methods, and is illustrated by a variety of applications. The value of the book is enhanced by the inclusion of a chapter on dispersion, with a description of the method of 'steepest descents.'

*Éléments de géométrie infinitésimale.* Par Prof. Gaston Julia. Pp. vi + 242. (Paris: Gauthier-Villars et Cie, 1927.) 45 francs.

THIS is an interesting course on differential geometry of three dimensions, which occupies an intermediate place between Darboux's "Théorie des surfaces" and such accounts of the subject as are to be found in most treatises on analysis, Goursat, for example. The emphasis is rather on the analytical than on the geometrical side, and a good deal of attention is given to the theory of contact and envelopes. The theory of congruences of lines is developed in some detail and, in particular, there is a discussion of singular lines as affording an application of singular integrals of differential equations.

*The Romance of Chemistry.* By Prof. William Foster. Pp. xvi + 468 + 31 plates. (London: George Allen and Unwin, Ltd., 1927.) 12*s*. net.

PROF. FOSTER'S book is clearly written and gives an interesting account of many parts of chemistry and of its border-line subjects which should appeal to the general reader. Many of the examples chosen will, no doubt, be more familiar to American than to European readers, but the book can be recommended as a very good popular account of some of the generally interesting parts of modern chemistry.

*Vorlesungen über Differential- und Integralrechnung.* Von Prof. R. Courant. Band 1: *Funktionen einer Veränderlichen.* Pp. xiv + 410. (Berlin: Julius Springer, 1927.) 18·60 gold marks.

THIS is simply an ordinary text-book of calculus, without any freakish ideas and without undue elaboration of any special point leading to lack of balance. The volume does not, however, contain anything of importance not accessible in current English mathematical literature.

## Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### The Activation of Cholesterol at Liquid Oxygen Temperature.[1]

AT the temperature of liquid oxygen ( – 183°), most bimolecular chemical reactions are largely inhibited. The rates of these reactions, in general, decrease rapidly with decreasing temperature. At very low temperatures the rates become too small to be measured, and for practical purposes it may be said that reaction ceases. This is especially true of oxidations, since, for example, neither sodium nor phosphorus immersed in liquid oxygen undergoes any apparent oxidation. However, the rates at which photo-molecular changes take place decrease more slowly with temperature. With this in mind, the irradiation of activatable cholesterol was carried out in liquid oxygen with the object of obtaining evidence as to the nature of the change involved. It was found that cholesterol of ordinary purity even at liquid oxygen temperature becomes antiricketic upon exposure to ultra-violet light.

The cholesterol used in these experiments melted clear at 149°. An investigation of its absorption spectrum by Dr. W. A. MacNair demonstrated that it contained 1·2 parts per thousand of ergosterol. Preliminary biological tests proved it to be highly activatable, although not antiricketic prior to irradiation. Our biological technique (line test) is described elsewhere.[2]

Irradiation was performed as follows : A cylindrical brass tube 42·5 cm. long and 4·5 cm. in diameter, closed at the lower end, was immersed in liquid oxygen contained in a silvered Dewar flask. The depth of immersion varied between 25 cm. and 15 cm. on account of evaporation of the oxygen. To prevent the condensation of water vapour in the tube and the settling of frost on the sample to be irradiated, the open, upper end of the tube was covered with a quartz plate thermally insulated from the metal by a ring made from asbestos board. A thin disc 4·2 cm. in diameter bearing 200 mgm. of pulverised cholesterol was lowered to rest on the bottom of the tube, and allowed to cool to liquid oxygen temperature. A quartz mercury vapour arc was adjusted a few centimetres above the tube and operated at 120 volts with about 30 ohms resistance in series. After irradiation for 105 minutes, the cholesterol was allowed to warm to room temperature, then dissolved in ether and evaporated on to McCollum's Diet 3143. Before and after irradiation the cholesterol was carefully protected from ultra-violet light. A similar experiment was made with the same apparatus, but at room temperature. On account of transportation, etc., a week elapsed between the preparation and administration of the modified diets.

The cholesterol irradiated at room temperature induced advanced healing of rickets when administered at 1/10 per cent., or even at 1/100 per cent. in the diet. The cholesterol irradiated at liquid oxygen temperature induced advanced healing at 1/10 per cent., but failed at 1/100 per cent. Thus it is evident that cholesterol is readily activated at liquid oxygen temperature, although the product obtained under the conditions of this experiment was not so potent as the product of irradiation at room temperature.

We regard these data as a strong confirmation of the evidence which has been accumulated recently by Rosenheim and Webster,[3] Windaus and Hess,[4] and Bills and McDonald,[5] that the activation of cholesterol (or ergosterol) consists not in an oxidation, but in an isomerisation—a rearrangement at the double bond or an *Elektronenverlagerung*.

In the activation of sterols by ultra-violet rays, it is important to consider the temperature coefficients of both the vitamin formation and accompanying destruction. For the formation the coefficient is evidently low. We find, however, that the spontaneous deterioration of (unactivated) ergosterol has a high temperature coefficient. If activated ergosterol also exhibits a high coefficient in its decomposition, then the way is clear for the preparation of a vitamin D of greater potency than has hitherto been attained.

CHARLES E. BILLS.
Research Laboratory,
Mead Johnson and Company,
Evansville, Indiana.
FERDINAND G. BRICKWEDDE.
Cryogenic Laboratory, Bureau of Standards,
Washington, D.C.

[1] Publication approved by the Director of the Bureau of Standards of the U.S. Department of Commerce.

[2] Bills, C. E., Honeywell, E. M., and MacNair, W. A., *Jour. Biol. Chem.*, **76**, 251; 1928.

---

### Cholesterol and Vitamin D.

BILLS, Honeywell and MacNair have recently demonstrated (*Jour. Biol. Chem.*, **76**, 251 ; 1928) that both ergosterol and ordinary purified cholesterol, in addition to the previously observed well-defined absorption bands at 293·5, 281·5, and 270 $\mu\mu$ (Morton, Heilbron and Kamm, *Biochem. Jour.*, **21**, 78; 1927), exhibit a faint but distinct band at 260 $\mu\mu$. They have also discovered that cholesterol purified by a thrice repeated conversion into the dibromide and recovery from same by treatment in boiling alcohol with zinc dust (so-called cholesterol E) can, contrary to the contentions of Windaus and Hess (*Nach. Ges. Wiss. Göttingen, math.-physik. Klasse*, 175 ; 1927) and Rosenheim and Webster (*Biochem. Jour.*, **21**, 389 ; 1927), still be activated by ultra-violet rays. According to the American workers, this activatability is associated with faint absorption bands at 315 and 304 $\mu\mu$ as well as the three characteristic ergosterol bands.

We are able to confirm the existence of a faint band at 260 $\mu\mu$ in ergosterol, but this is only detected with certainty when a continuous light source is used. As regards the newly observed bands, however, we desire to direct attention to the bands found by us in cholesterilene, which is characterised by selective absorption with maxima at 294, 304, and 321 $\mu\mu$ (*Jour. Chem. Soc.*, p. 47 ; 1928). The first of these coincides with the 293·5 $\mu\mu$ band of ergosterol, whilst the others are in close agreement with the two found by Bills, Honeywell and MacNair in their specially purified cholesterol. Bearing in mind the known instability of cholesterol dibromide (Lifschütz, *Zeit. physiol. Chem.*, **106**, 271 ; 1919), and also the complex nature of its decomposition, we suggest that the two bands observed in cholesterol E may well be due to traces of cholesterilene formed during the purification process. The amount of this hydrocarbon which would be necessary to show the selective absorption

[3] Rosenheim, O., and Webster, T. A., *Biochem. Jour.*, **20**, 537; 1926.

[4] Windaus, A., and Hess, A., *Nachr. Ges. Wiss. Göttingen, math.-physik. Klasse*, 175 ; 1927.

[5] Bills, C. E., and McDonald, F. G., *Jour. Biol. Chem.*, **72**, 13 ; 1927.

under the conditions employed by Bills, Honeywell and MacNair is of the order of 0·01 per cent.

The above suggestion in no way invalidates these authors' results regarding the slight activatability of their purified cholesterol, but simply dissociates the phenomenon from the absorption bands at 315 and 304 $\mu\mu$, for cholesterilene is not rendered active by irradiation.

I. M. HEILBRON.
R. A. MORTON.
W. A. SEXTON.

The University, Liverpool.

### The Nebulium Spectrum in New Stars.

IN NATURE of Jan. 28, p. 136, Mr. S. R. Pike makes an objection to the density which I have found, by the 'expanding shell' theory for novæ, to be necessary for the production of the nebulium spectrum. Mr. Pike applies the formulæ of the theory of thermal ionisation and finds that it is inconsistent to have the spectra of hydrogen and nebulium present at the determined density and both existing under the same temperature. For coexistence of these substances, defined as 0·1 per cent. H atoms and 0·1 per cent. $O^{++}$ atoms, he finds that a density of about $10^{-7}$ gm./c.c. is necessary, as against the density of about $10^{-17}$ gm./c.c. given by me.

I believe that the entire discrepancy is due to the inapplicability of the theory of thermal ionisation. This theory as developed assumes a condition of thermal equilibrium, and it does not seem possible that equilibrium would have been reached in a few days after the outburst of a nova. Also, one might expect that photoelectric ionisation would be an important factor, especially in considering gases of very low density near a hot star. Furthermore, Mr. Pike's arguments might be extended to the nebulæ as well as the nova shell, in which case one would expect densities of the same order of magnitude, about $10^{-7}$ gm./c.c. Such a density would be comparable with the mean density of the giant stars, and would indicate that the masses of the nebulæ are enormously greater than has been generally accepted.

It seems to me that a method for studying the coexistence of spectra in novæ would be similar to that followed by Milne (*Mon. Not. Roy. Ast. Soc.*, **84**, 354; 1924) in his study of the life of a $Ca^{+}$ atom, and combining with it some additional suggestions given by Eddington (*Mon. Not. Roy. Ast. Soc.*, **88**, 134; Dec. 1927), where he shows that the dilution of the exciting radiation may account for the 'forbidden lines' of an atom being as strong as its ordinary lines. The problem is very difficult, as one knows nothing of the extreme ultra-violet radiation of novæ.

I should like to take this opportunity to correct a statement in my communication in NATURE of Jan. 7, p. 12. Referring to the coefficients of $\rho_0 r_0^2$ in the densities of the nova shells, it was stated that the constancy indicates that the novæ originate from stars of similar physical conditions. That statement can apply only to the radius of the star and the density of its atmosphere.

C. T. ELVEY.

Dearborn Observatory,
Evanston, Ill.

### Science Teaching in Schools.

IN NATURE of Feb. 25 appears a stimulating article by H. E. A. on "The Range of the Scientific Faculty," with most of which all interested in the pursuit of science will agree. In directing attention to the absence of scientific appreciation on the part of the literary man, a view so ably propounded by Sir Richard Gregory in his presidential address to the Science Masters' Association in January last, the author is performing a public service. Unfortunately, it is doubtful if NATURE, despite its literary charm, will find its way into the temples of those deficient in 'factor X.'

What, however, are we to say of H. E. A.'s indictment of the schools in the latter part of his article? He writes . . . "The teaching of science is a failure, because it is parrot work . . .; because it is so far beyond the common intelligence and the teacher's." Again, . . . "No attempt is made in the schools to teach the simplest elements of scientific method. . . ."

Surely H. E. A. cannot mean these statements to be taken seriously. If he does, we are entitled to ask where he has been hiding during the last twenty years. Has he fallen asleep like Rip van Winkle and just wakened up thinking things are still as when he commenced his slumbers?—and meanwhile the precious leaven of Armstrong's heuristic method has been at work with far-reaching effects on science teaching in the schools. Still more important, has he ever tried to teach in a modern school, and has he visited several of these much maligned institutions and seen the science masters at their work?

The brilliant young researchers at the National Physical Laboratory and kindred places, and those making good in the field of industry and in the fight against disease, drawn as they are from all types of secondary schools, are in themselves a tribute to the work of the science masters, who have been responsible for introducing them to the method of science.

The chief canon of scientific method is to make generalisations only when supported by overwhelming evidence.

Is it not as necessary for H. E. A. to be scientific in the full sense of the word when passing judgment on a section of the community as in expressing opinions regarding the effect of 'hydrone' in chemical combination?

E. NIGHTINGALE.

St. Albans, Mar. 3.

SEVERAL recent leading articles in NATURE have criticised the scope and character of science teaching in schools, and with much justification. In a leader in the issue of Feb. 25, two statements are made by H. E. A., namely: that

(1) "the schools say they are in the hands of the universities, whilst these retaliate that they are subject to the schools."

(2) "The Science Masters' Association has neglected great opportunities in the past half-dozen years of discussing the problems, when at Oxford and Cambridge, with the authorities."

Both these statements are true, and something should be done at the next meeting of the S.M.A. at Cambridge. A haphazard discussion is, however, useless. Definite proposals must be made, and if possible a select committee appointed to discuss them. NATURE, being almost the only authoritative journal read by dons and schoolmasters alike, could urge this most effectively.

Science masters may suggest, but they cannot act alone. The pace in the schools is set partly by the School and Higher Certificate Examinations, but principally by the entrance scholarship papers. No school can afford to ignore these without penalising its potential scholars. The same *impasse* has been reached as in disarmament conferences; all desire to reduce the standard, but each is afraid to begin.

How furious the pace is in the schools is not realisey by everyone, least of all perhaps by the university examiners. The School Certificate is a very elementary

examination; and it is right that it should be. A specialist course at most schools starts after the School Certificate has been obtained, or an equivalent standard reached, and lasts on an average for two years before the scholarship examination is taken. In this short space of time it is apparently thought desirable that an amount of knowledge should be imparted, which, if really digested, would certainly assure the candidate a first-class degree in natural science without any further preparation whatsoever. Looking through a few chemistry papers set recently at one group of Cambridge colleges, I find questions on the alloys of mercury and potassium, ionic transport numbers, the manufacture of lithopone, and the synthesis of dimethylacetic acid. Remember that at least two other subjects have to be taught as well, that practical work is involved, and that the school time-table will certainly include some study of literature and modern languages.

I submit that to set questions of this kind, and to talk in the same breath of the necessity of acquiring a sound grasp of scientific method (which would of course involve a considerable amount of historical work), imply either insincerity or a painful lack of imagination. Many science masters, it is true, do their best to impart method and principle, but they have to do so always with one eye on the clock. Certain examiners, again, are endeavouring to set questions which seek to probe the 'chemical sense' of examinees; but little advance can be made in this direction until some sort of agreement and uniformity are obtained. At present a really promising boy may be taught—on paper—the reactions of ethyl acetoacetate; he may remember (with luck) how to calculate a transport number; he may even, if he has worked very hard, be able to analyse successfully a mixture of sodium stannate, nickel chromate, and cobalt phosphate. But he will almost certainly be unable to bore a cork or to investigate a simple inorganic reaction unless he knows the answer beforehand; and he could not possibly explain the essential points of difference between the atomic theories of Dalton and Demokritos. Conversely, if he can do these things, he will be woefully ignorant of lithopone and the mercury-potassium alloys.

It is to be hoped that NATURE will not cease from castigating schools and universities until some return to sanity is effected; and that that return will come speedily, before our more progressive pedagogues start teaching quantum mechanics and stellar chemistry in anticipation of the scholarship papers of 1935.

A. K. GOARD.

Marlborough College,
Mar. 5.

---

NO one could be better qualified than H. E. A. to write upon the value of a mind which combines scientific and literary gifts, for we all read his essays and discourses with interest and pleasure. I regret, therefore, that he should have dragged into his essay "The Range of the Scientific Faculty," which appeared in NATURE of Feb. 25, his well-known views upon the science teaching in universities and schools. He says, "The teaching of science in our schools is a failure, because it is parrot work, not scientific; because it is confined to special subjects—chiefly chemistry and physics—geology, botany, and biology being all but neglected."

I have formed the impression that H. E. A. objects strongly to deductions which are not derived from scientific observation and reached by scientific method. He says, "No attempt is made in the schools to teach the simplest elements of scientific method." Could H. E. A. give us the observations and facts on which his statements about the methods used and the subjects taught in schools are based? Would it be fair to ask him how many schools he has personally visited and inspected during the last five years? And is his opinion that the schools "are controlled by people who only know the old knowledge and are without understanding of scientific method" based on personal acquaintance with the heads of schools, or at least on first-hand knowledge of their methods? I am interested to know whether in making these statements he has conformed to his own canons of scientific method.

I cannot claim to have first-hand acquaintance with the work of more than a few schools, and I agree that our work in science could be improved by co-operation with the universities. But, lest a wrong impression of the work of schools should be left by H. E. A.'s remarks, I do think it fair to say that, to the work of some schools, H. E. A.'s statements do not apply, at least so far as the subjects taught and the aims sought are concerned. My own impression—which I cannot claim to be more than impression—is that H. E. A.'s generalisation upon the science work of schools and their heads at the present day fails to do them justice.

F. S. YOUNG.

The College, Bishop's Stortford,
Herts, Feb. 25.

---

MY cordial thanks are due to the writers of the above letters for their welcome support. The evidence I have of the general accuracy of my indictment is so overwhelming that I must ask that it be taken seriously. If anyone will tell me of schoolwork in progress anywhere to teach the elements of true scientific method, *as applied to ordinary life and to ourselves*, I shall endeavour to see it and be more than glad if I can report that there are exceptions that 'prove my rule,' showing that such teaching can be and is given. Probably I differ from most in my definition of 'scientific method' and shall not easily be satisfied. Reference is made to the heuristic method. Surely this was ruled out years ago, at least by Mr. Wells, as 'food unfit for the Gods,' because of the time needed to digest it. He has never found this, I judge.

I do not blame teachers in schools but the callous system which produces them and the immoral system under which they are forced to work. Nearly everywhere they are the tools of the class deficient in factor X. I particularly blame those who have taken the life and morality out of education and both professionalised and commercialised it from top to bottom. As factor X now governs the world, the class which has it not must be relegated to offices which it can hold with efficiency; we cannot with safety remain much longer under the governance of ignorance. The late President Woodrow Wilson seems to have been an outstanding example of the class. From his "Biography" it is clear that he all but went out of his way to avoid reading anything which would have informed him of the modern advance of knowledge. We need not wonder that we were led into such quandary at Versailles.

My desire was not to direct attention to the absence of scientific appreciation from the literary man. Considering his inborn limitations, he is a good enough, companionable fellow in his way, far more so generally than he who is bitten with the scientific afflatus. My essential contention is, that he is an ear out of which the purse embracing 'science' contemplated by Sir Richard Gregory cannot be made. In the epilogue to Vol. 2 of Sir Sydney Lee's Biography of our late King Edward, we are told—"Literature

and science he could not appreciate. . . . *Son métier était Roi.*" So it is with most of us—each of us has his inborn *métier* and must cultivate his own special garden with its peculiar soil. Sowing words, the literary can only reap words.

The chief point I desire to make is, that the body scientific has its fate in its own hands and must be trained to do its own literary work. Frenchmen show us that this is possible. Our Royal Society *Proceedings*, at the present moment, are standing proof that the oncoming generation, especially that raised at the ancient universities, has not yet 'learned the trick' of sane and satisfactory expression. It indulges in fatuous futilities of language which cannot be rationally construed. The practice would be of small consequence were it not that the use of an ill-conceived jargon by scientific workers is producing an ever-widening breach, not only between us and our literary brethren and the public but also within our own ranks. Unfortunately, those who thoughtlessly so misdemean are thereby aiming at inclusion within the Society—once within its ranks they will but spread the disease. On the other hand, a secretary of the Society can entrance an audience with a polished rhapsody upon 'Candle-ends,' whilst his rival at Cambridge outvies him in declaiming the merits of their Snarkian variant, 'Toasted cheese'; he is even acclaimed of *The Times Literary Supplement*, because of the perfection of the language in which he depicts the vagaries of the fully stripped proton (sex undetermined) in presence of a crowded following of loose electrons. Sir J. J. Thomson, in like manner, can thrill the young things at Girton with an account of the new shingled electron and its waved front.

Such is the power of words—owing to this high-brow advocacy, Candle-ends, Toasted-cheese and Electrons, shared and unshared, shingled and unshingled, are now made the standard diet of the schools. Meanwhile, the boy leaves unable to bore a cork and with no proper regard for energy, for water, for air, for coal, for food, let alone his own body. *Moral*: in attempting in schools to teach what we are pleased to call science, we must also give training in the art of simple direct expression; only in this way can proof be given that what is learnt *is* learnt. Does any teacher anywhere do this? They all say 'there isn't time.' At least, we might seek to rank with the notable profession of bath-chair propellers, who are notorious, we have been told recently, for their literary tastes.

It is imperative that the schools and the universities now discuss the problem of examinations together. A beginning should be made at the next meeting of the Science Masters' Association at Cambridge. As a past-president, if the Association will so charge me, I am willing to undertake to present a considered report upon the situation, to include constructive proposals, if possible. Such a report might serve as the basis of a general discussion. A beginning must be made somewhere and by someone, if we are ever to secure an efficient scientific service in the schools. The decision should be made forthwith, as the task of preparation will be a long and difficult one.

H. E. A.

---

### The Nature and Function of Golgi Bodies.

IN the *Proceedings of the Royal Society*, B, vol. 97, 1924, is a paper by Prof. Subba Rau, Dr. Rogers Brambell, and myself, entitled "Observations on the Golgi Bodies in the Living Cell." In this paper (unnoticed by Prof. Walker) we have given photomicrographs of the Golgi apparatus in living and stained cells. More than this we cannot do, except to ask those zoologists and physiologists who may be interested in this problem to read this paper and to examine the material we have used ourselves.

With regard to Dr. Ludford's letter in NATURE of Feb. 4, p. 169, I might point out that Golgi bodies are visible not only in molluscs, but also in annelids. In the ovary of the common earthworm both mitochondria and Golgi bodies can be followed throughout oogenesis, in freshly dissected ovaries, untreated by stain or fixative (Gatenby and Vishwa Nath, *Quart. Jour. Micr. Sci.*, vol. 70, Part III. Sept. 1926).

Prof. Walker in his latest letter (NATURE, Feb. 25, p. 279), as well as in his former ones to NATURE, takes the view that because certain emulsions treated by modern cytological techniques reveal objects resembling Golgi bodies, therefore the latter are artefacts. This is a curious position to take up, especially in view of the fact that in his last letter Prof. Walker shows that he has not examined Helix ovotestis cells. As a matter of common knowledge to all cytologists who have taken the trouble to examine such cells, the *nebenkern* batonettes (Golgi bodies) and mitochondria alone show well in fresh cells, the archoplasm being too transparent to be seen easily. This fact is proven by the paper of Rau, Brambell, and myself, by means of photomicrographs of dead and living cells, and can be confirmed by any student of microscopy who cares to examine snail spermatocytes, fresh, stained in Janus Green or Dahlia, or treated by any of the modern techniques for the cytoplasmic inclusions.

Now Prof. Walker's original position was that *both categories of cytoplasmic inclusions are artefacts.* In his printed paper he merely claims that the Golgi bodies alone are artefacts. But how does he explain the fact that with the technique upon which every modern text-book account of spermatogenesis is based, *both mitochondria and Golgi bodies appear constantly side by side*? The technique I refer to is chrome-osmium iron hæmatoxylin, with which almost all the work of Bowen in America, Schütz in Russia and Switzerland, and Hirschler in Poland, was done, and which the British cytologists have used constantly. This technique is merely the old Flemming and iron hæmatoxylin with the acetic acid left out or much reduced (Meves' fluid). How does Prof. Walker explain this fact? How could the Golgi bodies be artefacts if the mitochondria are not also?

How does Prof. Walker explain away the following fact? If one takes a fresh preparation of snail cells, and runs chrome-osmium fluid under the cover-slip, one can see the Golgi bodies and mitochondria being fixed *in situ* and in the light of day. The subsequent staining in iron hæmatoxylin merely blackens the same bodies one saw *intra vitam*. Will Prof. Walker explain where the catch comes in? Has he tried this experiment himself?

How does Prof. Walker explain the following fact? Take any tissue, from invertebrate or vertebrate, fix and stain by a Golgi apparatus method, and if the method has been used properly, a Golgi apparatus always appears in the same place in the same kind of cells. It is *not* a matter of a precipitate here or a precipitate there, haphazard. How then does Prof. Walker explain the constancy of position of these Golgi bodies in given cells?

Will Prof. Walker explain the following fact? Golgi bodies have been described by workers in every civilised country, *from all orders of animals.* The work of Bowen on plants brings the latter into line with animals. Will Prof. Walker say that all this work is incorrect? Prof. Walker has criticised modern cytological technique. Will Prof. Walker explain at what step the artefacts are produced, and

*indicate a technique which he considers better?* Is it corrosive acetic or Bouin's fluid, or is it Carnoy?

Was the Moore and Walker paper on mammalian spermatogenesis ("Liverpool Cancer Report," 1906) done with a better technique than we have to-day? I think not! The cells described and drawn by these workers are merely wrecked skeletons of their former selves! The proteid structures are twisted and distorted, and there is scarcely any lipoid left in the cells.

Now it would be regrettable if anyone, zoologist or non-zoologist, were to entertain the idea that Prof. Walker has any support from cytologists. His views, so far as modern cytology goes, are unique. They will remain unique as time goes on, for modern cytological technique is logical and takes into account our biochemical knowledge of the solubilities of lipoids and other subtle cell bodies. We can explain every step in what we do. We get results which agree with the intra-vital appearance of the cell, and it is unlikely that further gross improvements in cytological technique will be made. J. BRONTË GATENBY.

Trinity College, Dublin, Feb. 28.

---

CERTAIN of Prof. Walker's assumptions (NATURE, Feb. 25, p. 279) are opposed to direct observation. Thus his idea that the archoplasmic vesicles and Golgi bodies are one and the same thing is quite untenable in the light of recent work (see J. Hirschler, *C.R. Soc. Biol.*, **98**, No. 2, 145-6; 1928).

Prof. Walker has ignored one significant feature, that in many cells, for example, gland cells, the Golgi apparatus occupies a definite position between the nucleus and the lumen. When the gland is stimulated to activity the Golgi apparatus enlarges, while still retaining its relative position with regard to the nucleus. That is to say, we have within the cytoplasm a specific area capable of precise experimental modification. On the basis of Prof. Walker's own views, one would have to assume that the lipins of the cell are collected in this specialised area. It is this part of the cytoplasm that is called the Golgi apparatus. R. J. LUDFORD.

Laboratory of the Imperial Cancer Research Fund, Queen Square, London.

---

### James Gregory, John Collins, and some early Scientific Instruments.

DR. R. T. GUNTHER has described (*Archæologia*, vol. 76, p. 273) scientific instruments belonging to the University of St. Andrews which were exhibited in the Lewis Evans Collection at the Oxford meeting of the British Association. The St. Andrews instruments include the two-foot astrolabe by Humphrey Cole, dated 1575, "the finest extant Elizabethan scientific instrument"; an armillary sphere, also by Cole, 1582; an old Dutch or Flemish circumferentor; and a sea-astrolabe, or mariner's astrolabe, with one quadrant divided diagonally, inscribed "Elias Allen Fecit 1616."

Ever since Dr. Gunther directed attention to the value of these instruments, I have been puzzled to account for the way in which they came into the possession of the University. Facts have recently emerged which go far to establish the theory that they were purchased by James Gregory, the inventor of the Gregorian telescope, in 1673. A Commission from the University authorities "to Mr. James Gregorie, Professor of Mathematics," dated June 10, 1673, empowers him to select and buy "such instruments and utensils as he with advice of other skilful persons shall judge most necessary and usefull for the above-mentioned design" [providing ane observatory]. An interesting sidelight on this episode is afforded by an extract from the Burgh Records of Aberdeen for Oct. 15, 1673, from which it appears that "seeing the said professor was ane town's man heir . . . the councell . . . appoynts ane collectione to be at the Kirk dores . . . the nixt or subsequent Lord's day for the forsaid effect [for the Observatorie at Saint Andrews]."

In a letter to Collins, dated Feb. 15, 1669, Gregory had asked for a divided quadrant and a brazen sector, and in letters written in 1672 and 1673 he speaks of visiting Collins in connexion with the purchase of mathematical instruments. In a letter from Newton to Collins, Sept. 17, 1673, the former writes: "I understand that Mr. Gregory is at London, and intends to make Cambridge in his way into Scotland" (Rigaud, "Corr. of Scientific Men," vol. 2). On April 30, 1674, Gregory writes to Rev. Colin Campbell: "It wer tedious to write down particularlie all the instruments I have brought home, yea a larger letter would not contein all ther names and sizes, for I have of all sort: our largest quadrant is of oak, covered with brasse, 4 foot in radius and actually divided in minutes, of which we can judge $\frac{1}{3}$ or $\frac{1}{4}$: we have two semi-sextans, all of brasse, 6 foot in radius, diagonally divided, in which we can judge $\frac{1}{6}$ or $\frac{1}{7}$ of a minut: our largest telescope is 24 foot long; which magnifys one dimension of the object 100 times" ("Archæologia Scotica," vol. 3, p. 275, 1831). Gregory says: "the instruments ar keeped in the bibliotheck," but of those mentioned there is now no trace, although Gregory's clock is still in the University Library and through the building passes a meridian line which he constructed.

The observatory at St. Andrews never materialised, and in 1674 Gregory received a call to the College of Edinburgh, which he accepted. He died suddenly before he had been a year in his new home.

The suggestion that the Cole astrolabe was purchased by Gregory during his visit to Collins is supported by the fact that the instrument of 1575 is accompanied by a tablet inscribed "John Marke fecit lat. 56° 25′." Dr. Gunther remarks that John Marke flourished about 1668 at the sign of the Golden Ball, near Somerset House, where he sold Collins's quadrants of paper gummed on plates of copper and varnished (*Phil. Trans.*, 1668). The latitude of St. Andrews is actually 56° 20′, but it is doubtful whether Gregory had instruments for an accurate determination before his visit to London. Even after his return he writes, "the latitude here is 56° 22′."

I take this opportunity of correcting a mistake in my article in NATURE of Feb. 18, p. 238, to which my attention has been directed by a correspondent. Relying upon A. G. Stewart's "Academic Gregories" (p. 28), Collins was referred to as a secretary to the Royal Society. He was elected a fellow of the Society on Oct. 24, 1667, but was never secretary.

H. S. ALLEN.

The University, St. Andrews.

---

PROF. STANLEY ALLEN has put forward a very satisfactory working hypothesis to account for the presence of these early English instruments at St. Andrews. The additional plate supplied by John Marke proves that the Cole astrolabe was in the hands of this eminent maker in London about the time when Prof. Gregory was collecting scientific instruments there. May I add that the finest picture of Cole's great astrolabe was published in colour in the *Illustrated London News* for Aug. 14, 1926.

R. T. GUNTHER.

The Old Ashmolean, Oxford.

### Light and Sight.

IN a recent number of NATURE (Jan. 21, p. 95), Sir John Parsons, referring to the duplicity theory of vision, says without qualification that the "rods are responsible for scotopic, the cones chiefly for photopic vision," though he later refers to 'difficulties' in this formulation.

Current theories of colour vision may be divided into two groups: Young-Helmholtz (three-colour processes, all positive) and Hering (two-colour processes, with positive and negative conditions, and white). The first logically leads to a postulate of three photopic light-sensitive pigments, and a fourth for scotopic vision.[1] Following this scheme, it is logical to assign the four pigments each to a separate series of organs, and to assign scotopic vision to the rods, which alone have been recognised as possessing the scotopic pigment. The photopic pigments should be present in such minute amounts as to be undetectable with our present crude methods.

The Hering theory, with its negative as well as positive colour-processes and its double maximum for the red process, leads as naturally to some physical (refraction, interference or diffraction) separation of the colours, and a single, indifferent photopic pigment is sufficient (the same which any theory seems to demand for the peripheral retina). In this case there is no obvious reason why the two pigments, photopic and scotopic, should coincide in distribution with the presence or absence of the special structures leading to colour separation, and Sir John Parsons's statement is no longer obvious.

In fact, the existence of an acute colour sense in the middle range of adaptation[2] (that of ordinary lamp-light), where the rapidity of adaptation shows that the scotopic pigment is functioning, seems incapable of explanation unless this independence is assumed. Under the Helmholtz theory, the colour-processes, being dependent quantitatively on the minute surviving amount of photopic pigment, should be completely overshadowed by the ten or a hundred times greater activity of the 'rods.'

I have recently worked out in some detail a hypothetical separation of the colour-sorting and photosensitive processes on this basis of independence, with a physical basis (interference) for one and a chemical (photosensitive pigment) for the other (*American Journal of Psychology*, **40**, 1-25; 1928).

As to the foveal 'cones,' it should be noted that they are really organs of intermediate character, at least in the monkey and man, and could just as well be interpreted as modified *rods*.

WM. T. M. FORBES.

Cornell University, Ithaca, N.Y., U.S.A.

### The 'Dative' Chemical Bond.

WAVE mechanics notwithstanding, the electronic conception of valence in chemistry is serving a useful purpose. It is true that we know little in regard to what we symbolise by a shared pair of electrons, but even less was ever known of the inner meaning of the single bond of organic chemistry, although nobody would deny that the conception of such a bond has been a useful one.

In recent years, a clear distinction has been drawn between two types of co-valence involving a pair of electrons shared by the atoms *A* and *B*. In the first type, 'normal' co-valence, each of the two atoms contributes one of the two electrons. In the second type, one of the two atoms, say *A*, contributes both electrons. Since *B* gains a share in the pair, it gains in negative charge; while *A* loses in negative or gains in positive charge. Because of this separation of charges, the molecule is rendered polar.

Various names have been suggested for the second type of co-valence here described. So long as the conception remains a useful one, by all means let us have a good name for it. One of the earliest names, suggested in 1921 by Perkins in the *Philippine Journal of Science*, was a 'borrowing direct union.' Lowry proposed the names 'mixed' or 'ionised' double bonds, because the union partook of the nature of electro-valence as well as of co-valence. These names have been adversely criticised by Porter, Rankine, and others. Sugden in 1925 proposed the term 'semipolar double bond,' which is perhaps unduly polysyllabic. Realising that none of these names is entirely satisfactory, Sidgwick called this type of bond the 'co-ordinate' link or bond. But this is apt to lead to confusion, in such a typical case, for example, as the following. In considering the compound $[Co\,Cl(NH_3)_5]Cl_2$, chemists now universally follow Werner's usage and speak of the chlorine and the five ammonia molecules within the square bracket as being co-ordinated with the central cobalt atom. But of these six co-ordinated entities, only five are attached by 'co-ordinate' links.

Adopting a useful terminology, Sidgwick has called the atom *A* above a 'donor' and the atom *B* an 'acceptor' atom. To this it cannot be objected that the names savour overmuch of electro-valence, where one electron is given and taken, for the second type of co-valence has indeed a close analogy to electro-valence, and this may rightly be indicated in the nomenclature. In consonance with this idea, I wish to suggest that the second type of co-valence bond described above be called a 'dative' bond or link. 'Dative' is a short word, and unspoiled by previous usage in chemistry. ALAN W. C. MENZIES.

Princeton University, Feb. 4.

### Luminescence of Mercurous Chloride of Standard Purity.

ON studying the photochemical changes of a pure and dry mercurous chloride, prepared in a dark room, a greenish-white luminescence was observed when this was stirred by a dry glass rod. This phenomenon was noticed in glass, porcelain, and metallic crucibles for about five seconds, and it was not possible to produce it with the same rod again unless the rod was cleaned of its deposit of mercurous chloride powder. The luminescence was produced also for about the same length of time if the rod itself with its thin mercurous chloride cover was slightly rubbed with a dry cloth. The foregoing illumination of the sample has no effect on the duration and quality of the excited light.

The experiments so far made show that the dryness of the sample treated plays an important rôle in the intensity and the duration of the phenomenon described. On the other hand, one could not increase the duration of scintillation, although all traces of water and other impurities were most carefully excluded both in preparation of the chloride used and during the operation with it.

So far as could be proved, the phenomenon observed is not caused by electric charge produced by rubbing, nor is it a case of phosphorescence or crystalo-luminescence, since it is affected neither by a previous illumination nor by a perfect pulverising.

The details will be published elsewhere after the experiments have been completed. J. KŘEPELKA.

The Institute of Inorganic Chemistry,
Charles University, Prague, Feb. 22.

[1] It is necessary to assume for the peripheral retina either a fifth pigment or an equal mixture of the three colour pigments in the individual rods.

[2] I propose to call this middle range of adaptation 'mesopic.' Most experimental work is done within it, but may be reported either as 'photopic' or 'scotopic,' causing much confusion of interpretation.

## The New Science Museum.

THE Science Museum, which is the national museum of science and industry in Great Britain, dates from 1856, when the various collections which had been acquired by the Royal Commission of the Exhibition of 1851 for the purpose of illustrating the application of science and art to industry were brought together and arranged for exhibition at South Kensington. The exhibition so formed was housed in temporary buildings and was known as the South Kensington Museum, which title it retained for more than half a century. In 1909, that part of the collections pertaining to art was transferred to the newly constructed Victoria and Albert Museum, and the science collections which remained were brought under a separate administration. The Science Museum from that time ceased to be a purely departmental institution and became a national one; its new aspect was emphasised by a Departmental Committee, which reported in 1911 and 1912 on its scope and aims, recommending the erection of new buildings to provide a very considerable addition to the area of the exhibition galleries. The erection of the first block of the new buildings was begun in 1912, but, owing to the War, its completion was indefinitely postponed and the development of the collections was retarded. This portion, the Eastern Block, has, however, now been completed and was opened by His Majesty the King on Mar. 20.

The main object of the Museum is to illustrate science and the application of science to industry, and for this purpose the collections are grouped broadly under four divisions: (1) Industrial engineering; (2) stationary engines and land transport; (3) water transport and air transport; (4) science and scientific apparatus. This classification (and that of the many groups within these divisions) is not strictly logical, but is determined largely by the conditions of space and by the history of past development, and will be subject to revision when that is possible. In the various groups or sections development takes place in accordance with a system introduced by the present Director, Sir Henry Lyons, which provides approved schemes of development to include a historical series of critically selected objects which will illustrate the most important stages in the past development, and also a series illustrating current practice. Without some such clear plan, museum collections tend to become ill-balanced, some parts being over-represented and

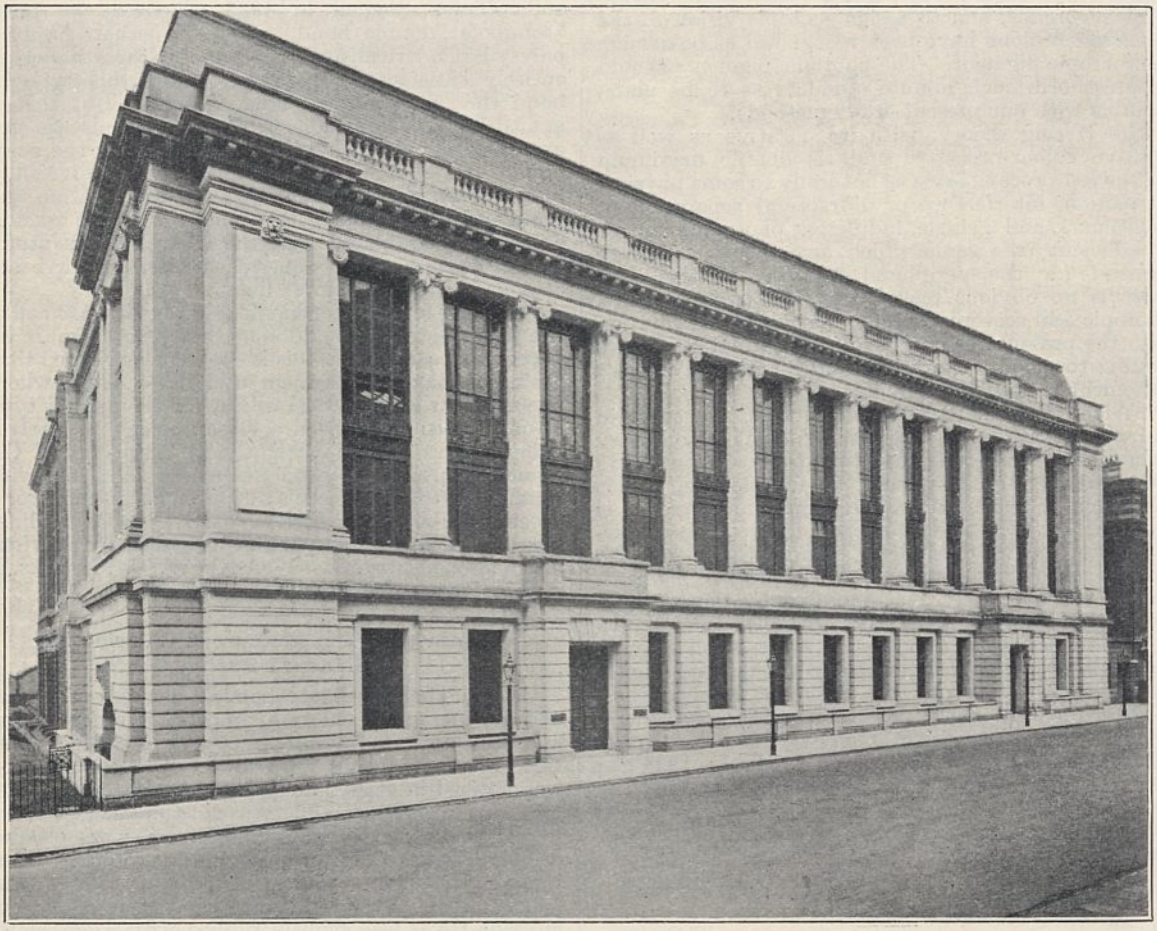


FIG. 1.—New buildings of the Science Museum, South Kensington. East block, from Exhibition Road.

others comparatively neglected. The historical series changes but slowly, and should contain all objects of enduring importance; in the representation of current practice the objects are of necessity changed frequently, being replaced by newer or more efficient examples as these are produced. In this way it is possible to maintain the collections representative in character without their becoming unmanageable in size.

The objects forming the collections are obtained by gifts, loans, purchases, or by construction in the Museum workshops. During recent years the number of acquisitions annually has been from about 1200 to 1500, and of these 90 per cent. are gifts and loans. The funds allotted for the purchase of objects are only £800 per annum, so that the number of exhibits thus acquired is small. A descriptive label, which gives both a general and a technical description of the exhibit, is placed with every object, and illustrated catalogues of the various sections are published. Models, apparatus, and machinery are shown in motion whenever this is practicable; in many cases exhibits are sectioned in order that the internal construction may be seen. The collections of the Science Museum are very rich in examples of original historical apparatus; they contain full-sized machinery and apparatus whenever possible, and accurately executed scale models when space must be restricted.

The new building has galleries providing an exhibition area of approximately 143,000 square feet—a little more than one-third of the area recommended as ultimately necessary—a main entrance hall, demonstration rooms, offices, workshops, and stores. The exterior is in Renaissance style, while the interior is simple and devoid of ornamentation, giving a suitable setting for the exhibition of machinery and scientific apparatus. Particular attention has been paid in the design to the special needs of the Science Museum; the average ratio of glass to floor area is about 1 : 4, excluding glass roofs, and the floors are provided with an elaborate system of ducts which accommodates the lighting, gas, and compressed air mains, and enables the power necessary for operating models, etc., to be available readily.

The main entrance in Exhibition Road opens direct into a reception hall from which access is given immediately into a top-lit lighting hall 120 feet long and 40 feet wide, roofed at third-floor level and bounded on all sides by other exhibition galleries. This hall is devoted normally to stationary engines, and contains, among many historical exhibits, three of the original engines designed by James Watt. The important inventions of Richard Trevithick in the development of the high-pressure engine are well represented, but the collection covers the whole period from the primitive application of animal power, wind and water wheels, to the modern steam turbine and internal combustion engine.

A roof-lit gallery adjacent is devoted to railway engineering generally, and contains a very representative series of models illustrating many types of locomotive engines as well as the original *Puffing Billy*, *The Rocket*, and other historical engines. At the west end of this gallery is a reproduction of James Watt's attic workshop, in which at Heathfield, Birmingham, he did experimental work on sculpture-copying machinery during the latter years of his life. The contents are placed exactly as they were left by him at the time of his death in 1819.

Another gallery on the ground floor accommodates the aeronautical collection, which includes, among several historical machines, the original Wright aeroplane of 1903—the first man-carrying aeroplane to make a free flight under power—and the Vickers-Vimy trans-Atlantic aeroplane of 1919. A series of more than one hundred models illustrates the development of lighter-than-air and heavier-than-air craft up to the present day, and the progress made in aero-engine design is adequately shown.

FIG. 2.—Stationary engines and prime movers.

The collections illustrating electrical engineering, electrical communication, hand tools and machine tools, mining and metallurgy, textile machinery, and a part of ship construction are shown in the first-floor galleries. In electrical engineering there is a valuable collection of early dynamos and electrical machinery, with examples of modern practice. A modern automatic telephone exchange system is arranged for demonstration and may be operated by the public. A receiver for radio telephony is

arranged also for operation in order to demonstrate modern distortionless reproduction. In the hand and machine tool collection the development of some of the more common tools is shown from the earliest civilisations down to the present day. Textile machinery is represented by some very valuable original machines made by Arkwright, replicas of Hargreaves' spinning jenny and Crompton's mule, with models and actual machines showing the various stages in spinning and weaving.

The Eastern Gallery on the first floor contains a historical series of models tracing the development of the sailing ship from the Viking long-ships to the great three-deck sailing ships of the Crimea War on the naval side, and to the Australian wool-clippers on the mercantile side. Many of the models are contemporary, such as that of H.M.S. *Prince*

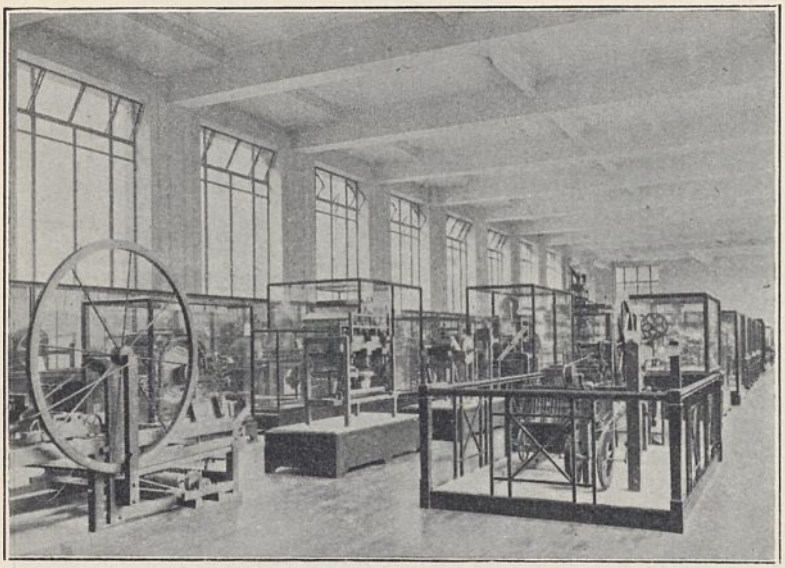


FIG. 3.—Textile machinery.

(1670), and have been made in the actual yards when the ships were built. Another series of models shown here illustrates, in considerable detail, the development of the armoured battleship from H.M.S. *Warrior* of 1861 up to the super-Dreadnought, H.M.S. *Monarch* of 1912, while sectioned models show advances made in internal construction.

The corresponding gallery on the second floor contains a series which illustrates the development of the merchant steamship from its infancy to the present day. A particularly fine series of Cunard models shows the growth and improvements of Atlantic liners, while cargo vessels, tank steamers, and their special systems of construction are well represented. The Eastern Gallery on the third floor is devoted to a collection of small craft from all parts of the world, and it gives special facilities for the study of the results produced both by race and environment. The various types of fishing vessels peculiar to the different portions of the British coasts, and now fast disappearing, are illustrated by some models, most of which are at least forty years old. Junks and sampans from China and from Japan, Arabian dhows and dahabias from the Nile, are well represented, while a collection of yacht models traces the development from the Dutch yachts of Stuart times and the pilot cutters of the early nineteenth century to the highly specialised racing yachts of to-day.

Other collections to be found on returning to the second floor are those illustrating meteorology, geophysics, electrical instruments, mathematical instruments, time measurements, pumping machinery, and building construction. In meteorology the development of the various meteorological instruments is shown in a historical series, and the method of computing and producing the daily weather reports of the Meteorological Office is illustrated. The group illustrating geophysics, including atmospheric electricity, terrestrial magnetism, seismology and gravity, is represented by instruments ranging from Choko's seismoscope of A.D. 132 to the modern Milne-Shaw seismograph and the latest models of the Eötvös torsion balance.

The section relating to time measurement includes examples of water-clocks, sundials, clocks, watches, and chronometers, ranging in period from the time-measuring devices of ancient Egypt to modern systems of electric clocks. Of special interest are the representations of a water clock from Karnak of about 1400 B.C. and an Egyptian shadow clock of the tenth to eighth centuries B.C., also the fourteenth century turret clock from Dover Castle. The second of John Harrison's four chronometers, the performance of the last of which obtained the award offered by the British Government for a method of determining longitude, is also shown here.

The third-floor galleries contain the collections illustrating chemistry and industrial chemistry, geography, geodesy and surveying, optical instruments and astronomy. A large gallery adjoining the reception hall, with an entrance direct to Exhibition Road, has been allotted for special temporary exhibitions such as those illustrating the results of current scientific research which have been contributed in the past by the various research associations and have proved of considerable interest. At present this gallery contains the King George III. collection of scientific instruments which was formed during the latter half of the eighteenth century and located in the King's Private Observatory at Richmond until 1841. This collection forms an interesting and valuable record of the state of instrument design and development at that period, and includes instruments intended for serious scientific research in astronomy, electricity, and mechanics, as well as apparatus devised purely for instructional purposes.

## Obituary.

### SIR AUBREY STRAHAN, K.B.E., F.R.S.

ON Mar. 4 Sir Aubrey Strahan died at the age of seventy-five at his house, Fairfield, Goring, Berks, which had been his residence since his retirement from the directorship of the Geological Survey of Great Britain and the Museum of Practical Geology in July 1920. He had been in fairly good health up to within a few days of his death, and took an active interest in local public affairs, and was a member of the Court of the University of Reading.

Sir Aubrey Strahan was the son of Mr. William Strahan of Blackmore Hall, Sidmouth, and was born on April 20, 1852. He was educated at Eton, where he went in 1865 to the Rev. Herbert Snow's house. In 1870 he entered St. John's College, Cambridge, and took his honours degree in natural science in 1874. His experience at Cambridge moulded the course of his future life, for he was associated with a group of students under Sedgwick, McKenny Hughes, and Bonney, destined to attain great distinction as geologists. Among his friends of those years may be mentioned Teall, Marr, Sollas, and Clough. In 1875 he joined the Geological Survey of Great Britain as an assistant geologist, and in that service he continued for the rest of his active life, ascending through every grade until he became director in 1914. His early work was done in the coalfields of North Wales and in the Isle of Wight, and his interests were principally in Secondary and Carboniferous rocks: all his work was done with painstaking thoroughness and has well stood the test of time.

Strahan was a geologist of sound judgment, little disposed to speculation or hypothesis. His great merits as an authority on coalfield geology received recognition in 1903, when he was appointed a member of the Royal Commission on Coal Supplies. He was one of the most valuable members of that Commission, which produced a report of the greatest permanent value, such as no other country than Great Britain possesses. Since 1897 Strahan had been in charge of the revision of the maps of the South Wales coalfield, which were old and unsatisfactory. This work occupied his attention for nearly twenty years and resulted in the production of a complete series of memoirs, one-inch and six-inch maps of that coalfield, which are recognised as being of a very high standard. With Dr. William Pollard he also produced a memoir on the coals of South Wales, discussing the causes of anthracitisation, which has attracted much attention.

In January 1914, on the retirement of Sir Jethro Teall, Strahan was appointed director of the Geological Survey. Very soon thereafter the country became involved in the War, and the whole of his energies were absorbed in the task of supplying geological information for civil and military purposes. He prepared and issued maps of the Belgian war zone, and undertook a great variety of tasks, both personally and through his staff, in connexion with active operations on all the fronts. In addition to this, the demands for home sources of minerals for industry became very urgent. The staff was greatly depleted by the departure of geologists on active service, but Strahan organised a bureau of information which gradually increased its activities until it took in every part of the field of British economic geology and extended also to many of the Dominions and allied countries. The result of this work afterwards appeared in a series of special reports on the mineral resources of Great Britain, which now comprises thirty volumes and contains accurate descriptions of practically every useful source of economic minerals in Great Britain.

During and after the War, Strahan served on many departmental committees and was much consulted in reference to problems of reconstruction and the development of research in connexion with industry. He aided in the reorganisation of the Geological Survey which resulted from its transference to the Department of Scientific and Industrial Research in 1919, and placed the institution on a much more satisfactory basis.

The maps and memoirs which Strahan prepared in collaboration with his colleagues are far too numerous to mention individually. Among the more important may be cited the memoirs on Chester, Rhyl, Flint, Isle of Purbeck and Weymouth, and the series on the South Wales Coalfield. He was very specially interested in the problem of buried or concealed coalfields in the south-east of England. Several important papers from his pen have appeared in the *Quarterly Journal of the Geological Society of London*.

Among the honours conferred on Strahan were the fellowship of the Royal Society (1903), president of the geological section of the British Association (1904), vice-president of the International Geological Congress (1913), president of the Geological Society of London (1913–14), and the Wollaston medal (1919). He took the degree of Sc.D. at Cambridge in 1907 and was created K.B.E. in 1919.

The distinguishing characteristics of Strahan's personality were his thoroughness and his trustworthiness. His opinions on all questions of geology were given with caution and were very highly valued. The conclusions he arrived at were always founded on very elaborate investigation. Although he did not shun speculation, he was averse to brilliant and elusive hypotheses. He had great charm of manner, and his friendship was much prized. In addition to this he had a shrewd judgment of men and excellent business capacity; these qualities made him a Civil Servant of outstanding distinction, and coupled with an intense love of geological work and a wide knowledge of British geology, they raised him to the highest position in the Geological Survey.

J. S. F.

## News and Views.

DR. JEANS'S recent lecture before the Royal Society of Arts, which forms our Supplement this week, affords one more example of its author's remarkable power of presenting the results of the most recondite astronomical research in intelligible and exceedingly interesting language. No one has contributed more conspicuously to the impressive story which it unfolds than Dr. Jeans himself, and the secret of his success, both in investigation and exposition, can be traced in no small measure to the fact that he never loses sight of the universe while examining the stars. He has learnt, as every astronomer and physicist must ultimately do, to think cosmically. It is an awe-inspiring tale he tells, and one which tends to escape critical appreciation by the reason, by virtue of its overpowering effect on the imagination, unless one is careful to repeat to oneself over and over again the warning that "our three-days-old infant cannot be very confident of any interpretation it puts on a universe which it only discovered a minute or two ago." This necessary corrective to our enthusiasm might well receive greater emphasis without risk of chasing the impassioned expression from the countenance of the most poetical of the sciences. There is a danger that the charm and artistic completeness of Dr. Jeans's exposition should cause readers to invest his remarks with a finality which his own intellectual control would not allow him to claim for them. It must be borne in mind that the 'immortal moment' to which he refers is not necessarily the moment of glimpsing immortal truth. A child has two immortal moments—one when he first beholds the sea, and another when he reads "Treasure Island." It is perhaps an open question which is the more worthy of comparison with the present outlook in cosmogony.

SIR OLIVER LODGE, on the occasion of Dr. Jeans's lecture, directed attention to the most striking deficiency of our present views, in asking what becomes of the radiation which the stars are continually pouring into space. In the last few ticks of the clock we have learnt where the radiation may come from, but no one has yet been able to hazard even a plausible guess as to where it goes, or is destined to go, in a possibly finite space. Our ignorance on this point may well make us doubtful whether we have yet begun to understand the universe. Can we really say we have begun to understand geography if we have learnt where a river may rise, but remain unaware of the existence of the sea? Dr. Jeans's figures lead to the conclusion that the mass-equivalent of the radiation already discharged must far exceed the total mass of matter now existing as stars and nebulæ. We therefore know nothing of the greater part of the substance of the physical universe. If we have cause for congratulation, it is that we can now realise more clearly than before how inadequately our present conceptions represent reality. That is a great advance—perhaps an essential part of every advance the human mind is capable of making—and the considerations which Dr. Jeans has brought before us contribute substantially to intellectual progress when judged by this standard.

IN January 1927 the Australian Development and Migration Commission submitted to the British Government a scheme for a geophysical survey of certain parts of Australia. This scheme was referred by Mr. Amery to the Empire Marketing Board, which invited the Committee of Civil Research to set up a sub-committee to investigate the proposal. Appointed in April last, the sub-committee presented a report which was approved by the Committee of Civil Research in July; the Empire Marketing Board then arranged with the Australian Government to finance the scheme jointly, by equal contributions up to £16,000 each, spread over two years. Already by November last the leader of the survey party had been chosen, namely, Mr. A. Broughton Edge. The report of the sub-committee has recently been issued, under date November 1927, though for press purposes it was 'released' only in February 1928. The report is a valuable and important document, and in the short space of 15 pages indicates where and to what extent geophysical methods of surveying have been employed for economic purposes, what are the principal methods that have been successfully used, with their range of usefulness, and what recent advances in method have been made.

GEOPHYSICAL surveying methods depend on properties which can be detected without direct access; the chief of these are gravity, electrical conductivity, intensity of magnetisation, and elasticity. They may be used directly to ascertain the presence of bodies of ore which themselves produce measurable effects at the surface, or indirectly in cases where such effects, though not caused by the bodies sought for, are produced by other underground substances usually associated with those bodies. The indirect method has an important application to the location of oil deposits, which appear to be associated with salt-domes, the location of which can be determined directly by geophysical means. The development of such methods has occurred mainly since the War, stimulated by the increasing possibility of working deep deposits, and by the cost and difficulty of borings and shafts for the direct location of deposits. The report indicates in outline how far it is of value to use different methods in conjunction with one another. The specific recommendation is in favour of an experimental survey of a restricted area, say 20 miles square, in Australia; the choice of the area, among the large number which the committee considers are likely to be suitable prima facie, being left for decision by the leaders of the party in consultation with the leading Federal and State geologists, regard being had to the desirability of developing new regions for expansion of population. Detailed recommendations are made as to the personnel, cost, duration,

(*Continued on p.* 471.)

*Supplement to* NATURE

No. 3047 MARCH 24, 1928

## The Wider Aspects of Cosmogony.[1]

By J. H. JEANS, Sec. R.S.

INTEREST in scientific cosmogony is a recent, and still a very tender growth. Anthropologists and geologists tell us that man has existed on earth for something like 300,000 years ; we must go this far back to meet our ape-like ancestry. Between them and us some 10,000 generations of men have walked the earth, most of whom have probably given some thought, in varying degrees, to the significance of their existence and the plan of the universe.

Of these 10,000 generations of men, the first 9990 unhesitatingly regarded the earth as the centre, and terrestrial life as the central fact, of the universe. As was suited to its majesty and dignity as the abode of man, the earth stood still while the celestial sphere spun round it, covering in the earth much as a telescope-dome covers in the telescope ; and this dome was spangled with stars, which had been thoughtfully added so as not to leave the central earth unillumined at night. Ten generations at most have been able to consider the problem of their existence in anything like its proper astronomical perspective.

### THE POSITION OF MAN IN THE UNIVERSE.

The total age of the earth far exceeds the 300,000 years or so of man's existence. The evidence of geology, and of radio-activity in rocks in particular, shows that it must be something like 2000 million years, which is several thousand times the age of the human race. Old Mother Earth must regard man as a very recent apparition indeed ; he has just appeared to burrow into her, burn her forests, put her waterfalls into pipes, and generally mar the beauty of her features. If he has done so much in the first few moments of his existence, she may well wonder what is in store for her in the long future ages in which he is destined to labour on her surface. For in all probability the life in front of the human race must enormously exceed the short life behind it. A million million years hence, so far as we can foresee, the sun will probably still be much as now, and the earth will be revolving round it much as now. The year will be a little longer, and the climate quite a lot colder, while the rich accumulated stores of coal, oil, and forest will have long been burnt up ; but there is no reason why our descendants should not still people the earth. Perhaps it may be unable to support so large a population as now, and perhaps fewer will desire to live on it. On the other hand, mankind, being three million times as old as now, may—if the conjecture does not distress our pessimists too much—be three million times as wise.

Looked at on the astronomical time-scale, humanity is at the very beginning of its existence—a new-born babe, with all the unexplored potentialities of babyhood ; and until the last few moments its interest has been centred, absolutely and exclusively, on its cradle and feeding-bottle. It has just become conscious of the vast world existing outside itself and its cradle ; it is learning to focus its eyes on distant objects, and its awakening brain is beginning to wonder, in a vague, dreamy way, what they are and what purpose they serve. Its interest in this external world is not much developed yet, so that the main part of its faculties is still engrossed with the cradle and feeding-bottle, but a little corner of its brain is beginning to wonder.

Taking a very gloomy view of the future of the human race, let us suppose that it can only expect to survive for two thousand million years longer, a period about equal to the past age of the earth. Then, regarded as a being destined to live for three-score years and ten, humanity, although it has been born in a house seventy years old, is itself only three days old. But only in the last few minutes has it become conscious that the whole world does not centre round its cradle and its trappings, and only in the last few ticks of the clock has any adequate conception of the size of the external world dawned upon it. For our clock does not tick seconds, but years ; its minutes are the lives of men. A minute and a half ago the distance of a star was first measured and provided a measuring-rod for the universe. Ten seconds ago Shapley showed how the peculiar stars known as Cepheid variables

[1] The Trueman Wood Lecture delivered before the Royal Society of Arts on Wednesday, Mar. 7.

provide a longer measuring-rod, and taught us to think in distances so great that light takes hundreds of thousands of years to traverse them. With the very last tick of the clock, Hubble, using the same measuring-rod, has found that the most remote objects visible in the biggest telescope on earth are so distant that light, travelling 186,000 miles a second, takes about 140 million years to come from them to us.

Not only is our vision of the universe continually expanding, but also it is expanding at an ever-increasing rate. Is this expansion destined to go on for ever? So far as we can at present see, no; for a general guiding principle, that of generalised relativity, fixes a limit, which we are fast approaching. According to this theory, space cannot extend for ever; it has no limit, but is nevertheless finite like the surface of the earth. Without exploring and surveying the whole of the earth's surface, we can make a fair estimate of its total area by measuring its radius, which we can do by measuring its curvature at any one point. In the same way the total volume of space is fixed by a quantity, the curvature of space, which can be determined by measuring the density of distribution of matter in space. Space which contained no matter would go on for ever, but the parts of space we can survey with our telescopes contain enough matter to show that we already see an appreciable fraction of the whole of space. It is as though our baby, watching ships coming from over the horizon, concluded that the earth's surface was curved, and formed a general rough conception of its size by imagining the observed curvature continuing until the earth's surface rounded back on itself.

Exact figures are impossible, but Hubble has calculated that space is not likely to extend to more than about a thousand times as far as the farthest nebula visible in the biggest telescope. Nothing prevents our going on and on in space beyond this distance, but, if we do, we merely come back to ourselves. The possessor of a sufficiently sensitive wireless apparatus may emit signals and pick them up a seventh of a second later after they have travelled round the world. In the same way a not inconceivable increase in the size of our telescopes would take us round the whole of space, and we should see the stars surrounding our sun by light which had travelled round the universe, not of course as they now are, but as they were 100,000 million years ago.

Such considerations make it improbable that the expansion of the universe can continue at its present rate for much longer. Having grasped that the world is round, the infant speedily forms a fair idea of its size. Our particular infant, mankind, has made the great discovery of the existence of the outer world, has formed some conception of its size, and adjusted his ideas, not by a process of slow revelation, but by a brain-flash of the last few seconds. In his mature years and his staid old age he is no doubt destined to make many sensational discoveries, but he can never again live through the immortal moment at which he first grasped the immensity of the outer world. We only live through a few ticks of his clock, and fate might have ordained that they should be anywhere in the three days that the child has already lived, or in the seventy long, and possibly tedious, years yet to come. The wonderful thing is that she has selected for us what is, perhaps, in some ways the most sensational moment of all in the life of our race.

The child sets its newly awakened mind to work to adjust and co-ordinate a new array of facts. If the world was not made to surround its cradle, what purpose can it serve? If the lights of the great ships in the harbour were not designed to light its nursery at night, what can they possibly be for? And, most interesting problem of all, if the world is such a big affair, can there be other cradles and other babies?

These remarks will have served their purpose if they suggest that what I am rashly trying to set forth here should not be judged as a finished science or the solution of a problem; it is rather the first confused gropings of the infant mind trying to understand the world outside its cradle. And if the impression produced by its first inexperienced glance at the outer world had to be described in a single word, it would probably select the word 'immensity.'

### The Immensity of Space.

The immensity of space is measured by the figures already mentioned. Light and wireless signals travel at the same rate because, of course, they are essentially the same thing; and this thing takes a seventh of a second to travel round the world, and probably something like 100,000 million years to travel round the universe. The ratio of these times ($2 \times 10^{19}$) measures the dimensions of the universe in terms of the familiar dimensions of the world; incidentally, it also measures the expansion of our spatial ideas since Copernicus. The disparity of size is too great to be easily visualised. Suppose the size of our earth represented by a single atom. Then the range of vision of the biggest telescope is about represented by the whole earth, and the size of the whole universe, according to the theory

of relativity, is represented by a stack of a thousand million earths.

Scarcely less bewildering than the immense extent of space is the immense amount and variety of matter it contains. The sun, which is a million times as big as the earth and 300,000 times as massive, proves to be something less than a grain of sand on the seashore. It forms one of a family whose number must certainly be counted in thousands of millions; Seares has estimated it at thirty thousand millions. This is not the only family of stars in space. Each of the great spiral and other extra-galactic nebulæ, such as are shown in Figs. 1, 2, and 3, is either a family of stars, or consists of stars in the making, or of matter which is destined ultimately to form stars. We can estimate the masses of these great nebulæ by gravitational means, and each is found to contain enough matter to make a thousand million suns. This of itself will give some conception of the vast size of these nebulæ, but to tell the whole story, it must be added that their colossal masses are so tenuous that each millionth part of an ounce is, on the average, as big as the Matterhorn. Think of a body which is bigger than the Matterhorn by as much as a thousand million suns is heavier than a millionth part of an ounce, and we have the size of any one of these great nebulæ. Any one of the three photographs here reproduced would have to be enlarged so as to cover the whole of Asia before a body of the size of the earth became visible in it at all, even under the most powerful of microscopes.

Hubble estimates that about two million such nebulæ are visible in the great 100-inch telescope at Mount Wilson, and that the whole universe has about a thousand million times the volume of that part of space visible in this telescope. Let us now multiply 1000 million by 2 million, and the product by 1000 million. The answer ($2 \times 10^{24}$) gives some indication of the probable number of stars in the universe; the same number of grains of sand spread over England would make a layer hundreds of yards in depth. Let us reflect that our earth is one millionth part of one such grain of sand, and our mundane affairs, our troubles and our achievements, begin to appear in their correct proportion to the universe as a whole.

While the stars may fairly be compared to grains of sand in number, they differ too much *inter se* for the comparison to be carried further. There is an enormous variety of big and little stars, of bright and faint stars, of red and blue stars, and of hot, hotter, and still hotter stars. The faintest of known stars (Wolf 359) emits only a fifty thousandth part of the light of the sun, while the brightest (S. Doradus) emits 300,000 times as much light as the sun. The smallest known star (Van Maanen's star) is about the size of the earth; a million such stars could be packed inside the sun and leave room to spare. The largest known star (Betelgeuse) is so large that 25 million suns could be packed inside it. Their ranges are greater than those between a searchlight and a glowworm, or between balloons and bird-shot.

Yet the stars are essentially similar structures. A normal atom consists of a central nucleus round which a number of electrons revolve like planets round the sun—a miniature solar system, in fact, in which the vacant space far exceeds that occupied by matter. With great heat the electrons begin to break loose and fly off at a tangent. The central temperatures of the stars can be calculated with fair precision, and prove to be so high that most of the electrons must have already broken loose from their atoms. Of recent years, a great deal of labour has been devoted to testing the hypothesis that practically all the electrons have so broken loose, the stripped atoms and electrons flying about in a general hurly-burly like the molecules of a gas. But the hypothesis has proved disappointing, and a much more probable hypothesis is, I think, that the atoms are not stripped quite bare, but that in most stars they retain a few rings of electrons which give the atoms so much size that they jostle one another about like the molecules of a liquid. This hypothesis explains beautifully the otherwise puzzling fact that stars of large mass fall into distinct groups, of what may almost be described as 'standardised' sizes. On the 'liquid star' hypothesis, these different sizes correspond to the different sizes possible for the stellar atoms, which

FIG. 1.—Regular shaped nebula (N.G.C. 4594) with ring of dark matter surrounding equator.

may have 0, 1, 2, or 3 rings of electrons left, but cannot have fractional numbers. The largest stars of all, such as Betelgeuse, have three rings left, while minute stars, such as Van Maanen's star, consist of atoms most of which are stripped quite bare, so that there is almost no limit to the closeness with which they can be packed together. An average handful of the matter of which this star is composed would contain about ten tons.

Thus the observed sizes of the stars proclaim the secret of the structure of the atom. The sizes of the stars are discontinuous because the sizes of atoms broken down to different stages are discontinuous. These discontinuities can be traced in turn to the discontinuities which form the central feature of the new quantum dynamics. Thus the distinguishing characteristic of the laws which govern the most minute processes in Nature is transmitted directly into the large scale phenomena of astronomy and governs the distribution of the huge masses of the stars. The infinitely great is never very far from the infinitely small in science, but it would be hard to find a more sensational illustration of the unity of science than that I have just given.

On this hypothesis, not only do the observed sizes of the stars disclose the general structure of the atom, which is old knowledge, but they also reveal the detailed structure of the particular atoms of which the stars are composed, and this is new knowledge. To be precise, the observed sizes of the stars disclose the atomic weights of the stellar atoms; they indicate that the stellar atoms are probably rather heavier than the heaviest atom, uranium, known on earth. The atoms which reveal their presence in stellar spectra are, of course, atoms of the ordinary terrestrial elements—hydrogen, iron, calcium, and the like. These, being the lightest atoms in the star, must naturally float up to its surface, and, as the earth was originally formed out of the surface of the sun, the earth is necessarily composed of them. But it now appears likely that down in the depths of the stars are other unknown and heavier atoms. We may almost say that it must be so, for no terrestrial atoms, not even radium or uranium, can produce anything like the amount of energy which these stellar atoms are observed to produce.

### The Immensity of Time.

The immensity of space is paralleled by that of time. We can estimate the ages of stars from the impression that time has made upon them, just as we estimate the age of a tree from the number of subdivisions of its stem, or of rings in its cross section. There are three principal methods of doing this. The orbits of binary stars, which are circular at birth, are gradually knocked out of shape by the forces from passing stars. As we can calculate the rate at which this process occurs, the shape of stars' orbits can be made to reveal their ages. The moving clusters provide a second method. Groups of bright stars such as the Great Bear, the Pleiades, Orion's Belt, are often found to consist of exceptionally massive stars which move in regular orderly formation through a jumble of slighter stars, like a flight of swans through a confused crowd of rooks and starlings. Swans, however, are conscious beings, and continually adjust their flight so as to preserve their formation. The swan-like stars cannot do this, so that their orderly formation must in time be broken by the gravitational pull of other stars. When this happens, the lighter stars are naturally knocked out of formation first, while the most massive stars retain their formation longest. This agrees with what is observed, and as we can calculate the time necessary to knock out the lighter stars, we can at once deduce the ages of those which are left in. A third method of investigation rests upon a rather abstruse dynamical theorem, which shows that after a sufficient time the energies of motion of the different types of stars must tend to equality, the little stars making up for the smallness of their mass by the rapidity of their motion. Seares has shown that the stars near the sun have nearly attained to this ideal state, and as we can calculate the time needed to establish it, we can again deduce the ages of the stars.

It is gratifying and significant that all three lines of investigation lead to the same result: the stars are found to be some millions of millions of years old, perhaps from five to ten millions of millions. We cannot state their age with much precision, but it is the general order of magnitude, not the exact figure, that is important.

### Stellar Radiation.

Year after year, century after century, for millions of millions of years, the sun radiates enough energy from each square inch of its surface to keep a 50 h.p. engine continually in action; still hotter stars may radiate as much as 30,000 h.p. per square inch. If this energy were produced by the combustion of coal, the stars would all be completely burnt out in a few hundreds or thousands of years. Where, then, shall we find a source of energy to last millions of millions of years?

More than twenty years ago I directed attention to the enormous store of energy made available by the annihilation of matter, by positive and negative electrons falling into and annihilating one another, thus setting free the whole of their intrinsic energy as radiation. On this scheme neither energy nor matter had a permanent existence, but only a sort of sum of the two; each was, theoretically at least, convertible into the other. Whether energy is ever transformed into matter we do not know; probably not. But the falling together of electrons and protons forms the obvious mechanism for the transformation of matter into energy, and it now seems practically certain that this is the actual source of the radiation of the stars. A beam of radiation exerts pressure on any surface it falls upon, just as a jet of water does or a blast of air. The reason is that radiation carries mass about with it, and electromagnetic theory tells us the amount of this mass. For example, we can calculate that a searchlight which is radiating 50 horse-power of energy is discharging mass into space with the radiation at the rate of a gramme and a quarter a century; with sufficiently delicate adjustments it might even be possible to observe the recoil of the searchlight. Indeed, the pressure of radiation has actually been measured, although not in this particular way. New mass is of course being continually fed into the searchlight by the electric current.

Each square inch of the sun's surface is in effect a searchlight discharging radiation into space at the rate of 50 horse-power, and so is discharging mass at the rate of a gramme and a quarter a century, and the sun's surface is so large that the sun as a whole is discharging mass into space at the rate of 250 million tons a minute. Now the sun has no source of replenishment. It must have weighed 360,000 million tons more yesterday than to-day, and by to-morrow will weigh 360,000 million tons less. These are not mere speculative statements; they rest on observation, and on generally accepted principles which are directly confirmed by observation.

Allowing for the fact that a more massive star emits more radiation than a less massive one, we can calculate that five or ten million million years ago the sun must have been several times as massive as it is to-day, so that it has already lost most of the mass it had at birth. Of each ton it had at birth only a few hundredweights at most remain to-day. The loss of mass which accompanies radiation is, then, no mere academic hair-splitting. It is a real astronomical phenomenon, and young stars must be many times as massive as old stars.

There is a certain amount of direct evidence of this change of mass. The radiation of the stars imposes an endlessly recurring capital levy upon their masses, which, as observation shows, is graduated and increases very steeply indeed for the richest stars. The levy makes all the stars poorer, but it also tends to equalise what wealth remains; the older the stars get, the more nearly equal their impoverished masses become. This is a large part of the reason why the stars are nearly equal in mass. The process is most clearly marked in the binary systems, which have been formed by a single star breaking into two. The two component stars of such a system are necessarily of the same age, and it is a matter of observation that the small stars of old systems are nearer to equality of mass than the massive stars of young systems.

Thus observation and theory agree in indicating that the universe is melting away into radiation. Our position is that of polar bears on an iceberg that has broken loose from the icepack surrounding the pole, and is inexorably melting away as the iceberg drifts to warmer latitudes and ultimate extinction.

Five million million years ago the sun had stored up within itself the energy which was destined to provide its light and heat until to-day, and the mass of this energy was many times the present mass of the sun. No means is known by which so much mass could be stored except in the form of electrons and protons. Thus we must suppose that the radiation of the sun through these millions of millions of years has been produced by the annihilation of electrons and protons which existed in it originally, but no longer exist now. These electrons and protons are pure bottled energy; the continuous breakage of these bottles in the sun sets free the radiation which warms and lights our earth, and enough unbroken bottles remain to provide light and heat for millions of millions of years to come.

The amount of energy made available in this way is amazing. The annihilation of a pound of coal a week would produce as much energy as the combustion of the five million tons a week which are mined in the British Isles; an ounce of coal a month would provide locomotive power for all the British railways, while a single drop of oil would take the *Mauretania* across the Atlantic. When we speak of the efficiency of a steam engine as 5 per cent. or so, we regard complete use of the thermal energy of combustion as 100 per cent. efficiency. If we measure the work done against the total intrinsic energy of the fuel, as made

available by its complete annihilation, the efficiency is more like 0·00000001 per cent. On this scale the efficiency of the sun and stars is exactly 100·00 per cent.

Modern physical theory shows that the annihilation of an electron must produce a single flash of radiation of wave-length far shorter than any we can produce on earth. As this radiation threads its way through a star, its wave-length is continually increased, or, to use the technical term, the radiation is continually softened. In time it becomes $\gamma$-radiation, then hard X-radiation, then soft X-radiation, and finally it emerges from the surface of the star as ordinary light and heat. Consider, however, an electron which is annihilated not inside a star but outside in free space, or in one of the almost transparent nebulæ. The short wave-length radiation now undergoes no softening, but travels on until it meets something capable of checking it. Thus all astronomical bodies, including the surface of the earth, ought to be under continual bombardment by radiation of shorter wave-length, and consequently of greater penetrating powers, than any we can produce on earth.

Many years ago such radiation was detected in the earth's atmosphere by McLennan, Rutherford, and other observers; it has recently been studied in detail by Millikan and others. There is no reason to doubt that it originates just where it ought to, namely, in the great nebulæ, and its amount is about what it ought to be, if it is evidence of the whole universe melting away into radiation. The wave-length of the radiation might be expected to reveal the physical process by which it is generated, but the evidence is a bit puzzling. The hardest terrestrial radiation penetrates inches of lead and corresponds to a voltage of hundreds of thousands of volts. The cosmic radiation penetrates about five yards of lead, and the hardest rays are now found to correspond to about 60 million volts. Millikan was at one time inclined to attribute the rays to the combination of four atoms of hydrogen to form an atom of helium, but rays so produced would only be of the hardness corresponding to 30 million volts. There are many ways known to physics of softening radiation, but none of hardening it. Thus we must look for some source more energetic than the synthesis of hydrogen into helium, and I can see no possible stopping-place short of the annihilation of matter. Again, we are not dealing with a minute phenomenon of mere academic interest. In a sense this radiation is the most fundamental physical phenomenon of the whole universe, most regions of space containing more of it than of visible light or heat. Our bodies are traversed by it night and day. Short of going down into a mine or in a submarine we cannot escape it, and it is so intense that it breaks up several million atoms in each of our bodies every second. It may be essential to life or it may be killing us.

### The Lives of the Stars.

The stars are almost certainly born in nebulæ of the type of the great extra-galactic nebulæ, such as are shown in Figs. 1, 2, and 3. These nebulæ show a great variety of shapes, but a single thread connects them all; they are the shapes of huge masses of gas endowed with different amounts of rotation. So definitely is this the case that when Hubble recently tried to classify the shapes of these nebulæ, deliberately and avowedly shutting his eyes to all theoretical considerations, he found that purely observational considerations compelled him to classify them in precisely the sequence I had predicted on theoretical grounds some ten years earlier.

A huge mass of gas which was entirely devoid of rotation would of course assume a strictly spherical shape; rotation would flatten this shape out, just as the earth is flattened by its rotation, until ultimately most of the matter was spread out in a thin disc. We see the process beginning in Fig. 1, and it is well advanced in Fig. 2. Fig. 3 shows a nebula which is probably physically similar to that shown in Fig. 2, but viewed from another angle. Now mathematical theory shows that the thin disc-like structure could not remain a mere featureless mass of gas. Just as the cooling of a cloud of steam causes it to condense into drops of water, so the cooling of a cloud of gas causes it to condense into detached masses. We see the phenomenon in progress in nebular photographs; it is a necessary theoretical consequence of the laws of gases and the law of gravitation.

Now the same theory which predicts that the phenomenon must happen, predicts the scale on which it will happen. We can calculate how much matter will go to the formation of each 'drop,' and the calculated masses of the drops come out to be just about the same as the masses of the stars. Indeed these drops are stars, and the process just described is that of the birth of stars. Unmistakable stars have been observed in the outer regions of many of the spiral nebulæ. It is naturally not possible to identify every observed spot of light with a star, but some of them show precisely the same peculiar fluctuations of light as characterise a certain

class of variable star, the Cepheid variables already mentioned, and these put the identity of these particular spots of light beyond all reasonable doubt.

In these nebulæ, then, we are watching the birth of stars, the transformation of an inchoate mass of

FIG. 2.—Spiral nebula (N.G.C. 891) seen edge on.

gas into an 'island universe' of stars. Indeed Hubble found it necessary to end up his classification of nebulæ with clouds of stars. At one end of his continuous sequence is a nebula, shaped like a mass of rotating gas, in which not a single star is visible: at the other end a star-cloud in which nothing but stars are visible. Our galactic system of stars is probably the final product of just such a transformation, the Milky Way still recording the position of the equatorial plane of the original nebula.

Stars born in this way may meet with a variety of accidents and these result in different observed astronomical formations. A star may rotate too fast for safety, just as a flywheel may; when this happens it breaks into two, and the two stars so formed revolve endlessly about one another as a binary system. Two stars may run into one another, although this is very rare. A more common occurrence is for two stars to escape running into one another by a narrow shave. When this happens, huge tides are raised on the two stars involved, and these may take the form of long streamers of gas, which ultimately condense into 'drops' just as did the gas in the outlying regions of the spiral nebulæ. It seems reasonably certain that the planets were formed in this way.

The birth of the solar system, then, resulted from the close approach of two stars; if a second star had not happened to come close to our sun, there would have been no solar system. It may be thought that with a life of millions of millions of years behind it, one star or another would have been certain to come near enough at some time to tear planets out of the body of our sun. Calculation shows the reverse; even after their long lives of millions of millions of years, only about one star in 100,000 can be surrounded by planets born in this way. A quite unusual accident is necessary to produce planets, and our sun with its family of attendant planets is rather of the nature of an astronomical freak.

In the thousand million stars surrounding our sun there are, at a moderate computation, not more than ten thousand planetary systems, because there has not been time for more than this number to be born. They are of course still coming into existence; calculation suggests a birth-rate of about

FIG 3.—Spiral nebula in Ursa Major (M. 81).

one per thousand million years. Thus we should have to visit thousands of millions of stars before finding a planetary system of as recent creation as our own, and we should have to visit millions of millions of stars before finding a planet on which civilisation, and interest in the outer universe, were

as recent a growth as are our own. We are standing at the first flush of the dawn of civilisation, and are terribly inexperienced beings.

It may be suggested that the creation of planetary systems is also only beginning, and that in time every star will be surrounded, like our sun, by a family of planets. But no; the stars will have dissolved into radiation or disappeared into darkness before there is time for this to happen. So far as we can judge, our part of the universe has lived the more eventful part of its life already; what we are witnessing is less the rising of the curtain before the play than the burning out of candle-ends on an empty stage on which the drama is already over. There is not time for many more planets to be born.

### Life and the Universe.

The planets are the only places we know where life can exist. The stars are too hot; even their atoms are broken up by the intense heat. Nebulæ are in every way unsuitable; even if cool solid bodies exist in them, they would probably be so drenched with highly penetrating radiation as to render life impossible. Life demands a special type of matter, such as does not produce intense light and heat by transforming itself into radiation. We find it only in the surfaces of the stars, which are too hot for life, and in the planets which have been pulled out of these surfaces.

On any scheme of cosmogony, life must be limited to an exceedingly small corner of the universe. To our baby's wonderings whether other cradles and other babies exist, the answer appears to be that there can at best be very few cradles, and there is no conceivable means of knowing whether they are tenanted by babies or not. We look out and see a universe consisting primarily of matter which is transforming itself into radiation, and producing so much heat, light, and highly penetrating radiation as to make life impossible. In rare instances, special accidents may produce bodies such as our earth, formed of a special cool ash which no longer produces radiation, and here life may be possible. But it does not at present look as though Nature had designed the universe primarily for life; the normal star and the normal nebula have nothing to do with life except making it impossible. Life is the end of a chain of by-products; it seems to be the accident, and torrential deluges of life-destroying radiation the essential.

There is a temptation to base wide-reaching inferences on the fact that the universe as a whole is apparently antagonistic to life. Other quite different inferences might be based on the fact of our earth being singularly well-adapted to life. We shall, I think, do well to avoid both. Each oak in a forest produces many thousands of acorns, of which only one succeeds in germinating and becoming an oak. The successful acorn, contemplating myriads of acorns lying crushed, rotten, or dead on the ground, might argue that the forest must be inimical to the growth of oaks, or might reason that nothing but the intervention of a special providence could account for its own success in the face of so many failures. We must beware of both types of hasty inference.

In any case, our three-days-old infant cannot be very confident of any interpretation it puts on a universe which it only discovered a minute or two ago. We have said it has seventy years of life before it, but in truth its expectation of life would seem to be nearer to 70,000 years. It may be puzzled, distressed, and often irritated at the apparent meaninglessness and incomprehensibility of the world to which it has suddenly wakened up. But it is still very young; it might travel half the world over before finding another baby as young and inexperienced as itself. It has before it time enough and to spare in which it may understand everything. Sooner or later the pieces of the puzzle must begin to fit together, although it may reasonably be doubted whether the whole picture can ever be comprehensible to one small, and apparently quite insignificant, part of the picture. And ever the old question obtrudes itself as to whether the infant has any means of knowing that it is not dreaming all the time. The picture it sees may be merely a creation of its own mind, in which nothing really exists except itself; the universe which we study with such care may be a dream, and we brain-cells in the mind of the dreamer.

*Printed in Great Britain by* R. & R. Clark, Limited, *Edinburgh.*

and procedure of the survey. News of the actual work and results of this very interesting development in the application of research to Imperial problems will be awaited with keen interest.

THE freedom of the City of Stoke-on-Trent was conferred, on Mar. 14, on Sir Oliver Lodge, who was born at Stoke in 1851. Lady Lodge, who accompanied her husband, has local associations too, and Sir Richard Lodge, formerly professor of history at the University of Edinburgh, accompanied his brother. The visitors were heartily welcomed throughout their brief stay, and at Stoke Town Hall were received by the Mayor, Alderman T. C. Wild. Among others, the city electrical engineer, Mr. C. H. Yeaman, was introduced to Sir Oliver, under whom he studied at Liverpool. Sir Oliver and Lady Lodge were greeted enthusiastically by the aldermen, councillors, and citizens assembled in the Council Chamber. The Mayor, in moving the resolution to admit Sir Oliver as an honorary freeman, referred to his attainments and his important contributions to the striking progress made in modern times, concluding by offering, on behalf of the Council and the inhabitants of his native city, "a very hearty and sincere welcome home." The Deputy-Mayor seconded, and the motion was carried with great applause, the Mayor then handing to Sir Oliver the freeman's scroll. Sir Oliver Lodge, responding, recalled that thirty years ago, when he received the Rumford Medal of the Royal Society, he regarded it as the highest honour of his life. Now he doubted it, for few people receive the freedom of their native city, especially after more than fifty years' absence. Continuing in reminiscent mood, Sir Oliver mentioned, *inter alia*, that he left school at fourteen years of age, then for seven years was his father's book-keeper, devoted all spare time to such pursuits as mathematics, physics, and experiments, attended local science classes, and eventually got to University College, London, for further study.

THE Bodleian Library, Oxford, contains at present about 1,500,000 volumes, besides more than 40,000 manuscripts. To this collection between 20,000 and 25,000 volumes are added each year. At the present rate of growth the existing accommodation will not last more than another eight or nine years. To meet the need which will soon become pressing, various measures have been suggested, the most important of which are the following: (*a*) To build an extension of the Bodleian Library on the north side of Broad Street, and to acquire sufficient land in the neighbourhood of Oxford to provide accommodation for little-wanted books and periodicals. It is estimated that this plan would give the necessary space for at least 100 years. (*b*) To build an entirely new library in a central place, keeping Duke Humfrey's fifteenth century Library with the Arts and Selden ends as a library of early printed books, and the Radcliffe Camera as a reading-room for undergraduates. The cost of a new building such as is contemplated would be about £500,000. It is obvious that the expense of either plan could only be met by a great benefaction. Advocates of the second plan consider that it would remedy certain admitted inconveniences in the present administration of the Library. In particular, they allege the unavoidable slowness in book-service, the restricted hours of opening, the limitation of access to the shelves by readers. It is, however, not admitted by the supporters of the former plan that these drawbacks could not be remedied under the alternative scheme, if sufficient funds were forthcoming. In either event, a revision of the catalogue, estimated to cost £100,000, is considered to be highly desirable. It is not proposed that under either scheme the Radcliffe Scientific Library, now a department of the Bodleian, should be moved from the Museum.

IN order to commemorate the work of that great educationist, the late Dr. A. H. Fison, Guy's Hospital Medical School and the Gilchrist Trustees founded the Fison Memorial Lectureship four years ago. The first lecture on "The Structure of Light" was given by Sir J. J. Thomson, and the second by the Very Reverend Dr. W. R. Inge on "Science and Ultimate Truth." The third lecture was delivered by Sir William Bragg on Mar. 13, at Guy's Hospital Medical School, under the chairmanship of Sir William Pope. In his introduction, Sir William Bragg described "The Structure of an Organic Crystal" as a "borderline subject in that it draws from physics the explanation of the new methods by which the structure is found; it relies on chemistry for valuable comparisons between its own determinations and the picture of the organic molecule which the older science is able to supply; and it looks forward to a fruitful connexion with the biological sciences in which the organic molecule plays so great a part."

SIR WILLIAM BRAGG'S lecture was both a record of achievement and a statement of unsolved problems. X-ray analysis, which has shown on one hand that the structural formulæ of organic compounds are plans rather than diagrams, and has enabled the lattice constants of crystals to be measured with high accuracy, has still advanced insufficiently to permit of full interpretation of the diffraction pattern of such a relatively simple substance as naphthalene. It has shown that there is a definite structure in the normal aliphatic carbon chain, but cannot explain satisfactorily why even numbered chains occur more frequently in Nature than the odd members, and although it has proved that many bodies which were supposed at one time to be amorphous are really essentially crystalline, it still leaves as a curious fact that complicated molecules often produce a simple unit of pattern in the aggregate. A point stressed by Sir William in his concluding remarks was that, interesting and significant as the new results are in relation to molecular structure, biologically they are literally of vital importance. The lecture has been published by Messrs. Longmans, Green and Co., Ltd. (1/6 net).

IN his Friday evening discourse at the Royal Institution on Mar. 16, Prof. E. T. Whittaker discussed "The Quantum and Relativity Theories of Light." He stated that the classical theory of light,

created by Fresnol in 1816–23, and transformed into an electromagnetic theory by Maxwell in 1861–62, was believed at the end of the nineteenth century to be capable of accounting for all optical phenomena. Since then, a number of facts have been observed which appear to be irreconcilable with it, for example, the photo-electric effect; and a great and successful theory—the quantum theory of spectra—has been developed, which presents a picture of radiation quite different from that given by the electromagnetic theory of light. Dealing first with the last-named difficulty, Prof. Whittaker showed that it has been almost completely removed by the new wave-mechanics. In place of the 'stationary states' of the old quantum theory, which were interpreted as the description of particular orbits by electrons, we now have normal solutions of the wave-equation. In a normal solution, the electric moment of the atom does not vary with the time, and there is therefore no reason why, in the electromagnetic theory, radiation should be emitted. On the other hand, when the state of the atom is represented by a superposition of two normal solutions, the electric moment does vary with the time, and radiation is emitted until the atom arrives at a state represented by a single normal solution. Prof. Whittaker then discussed the difficulties raised by the photo-electric effect, and showed that the classical theory is not in contradiction with the capture by a single atom of a whole quantum of radiation, or the preservation of the identity of the quantum as it travels over great distances. The latter part of the lecture was devoted to the new theory of the five-dimensional universe and to the behaviour of light rays in a gravitational field according to the theory of general relativity. It is found that a light ray may be captured permanently by the gravitational field of a point-mass.

ON Monday, Mar. 19, at the Æolian Hall, a paper entitled "From the White Nile to Ruanda" was read before the Royal Geographical Society by Mrs. Patrick Ness, describing part of a journey through Africa from Cairo to Cape Town, planned and carried out by her in the winter of 1926–27, with impressions gained at different times before 1914, when accompanying her late husband on big-game shooting expeditions. The regions principally dealt with were the little known lands in the extreme south-west of Uganda; the volcano lands of the Mufumbiro Mountains in the heart of Africa; Lake Kivu and the interesting kingdom of Ruanda, which with Urundi is now mandated territory administered by Belgium under the League of Nations. The paper gave a picture not only of these beautiful equatorial uplands, but also of the various tribes met with, often curiously different though inhabiting the same localities, and again in some cases resembling each other in many ways though found hundreds of miles apart. To-day, when Africa is so opened up that motors can be driven from end to end, there still remain parts into which no car has penetrated, and on the route described from Uganda to the Belgian Congo, which climbs to more than 8000 feet, all loads are still carried on men's heads.

WE learn from a recent *Daily News Bulletin*, issued by Science Service of Washington, that the General Electric Company of America has made a vacuum tube which, when connected to a copper bar about ten feet long through a coupling system, acts as a tuned aerial circuit. The tube is five inches in diameter and is two feet long. The power taken is 15 kilowatts and the great bulk of this is radiated into space with a frequency of 50,000 kilocycles, that is, the radio waves have a length of only six metres. With such short waves, many curious phenomena are noticed in the neighbourhood of the copper bar. If one terminal of an ordinary electric lamp be put in contact with the copper bar, it lights up brilliantly. When a piece of copper lying on the floor is picked up, the fingers may be blistered although it appears cold. Doubtless the induced currents at this high frequency are all confined to a very thin outside layer of the metal. Cooking can be carried on inside a glass tube near the aerial. The waves also affect everyone who approaches too close to the copper bar; a warm glow all over is first felt, and then pains ensue in the limbs and joints. It is stated that after standing close to the aerial for fifteen minutes the body temperature is raised to 100° F., and thus an artificial fever has been induced. Dr. Whitney, the director of the G.E.C. Research Laboratory, says that if we had a perfectly harmless method of warming the blood, it might be of value to the medical profession. An apple placed on the end of a wire at some distance from the aerial was thoroughly baked in a few minutes. When the end of the aerial was touched with a metal tipped rod, a greenish-white arc arose at the point of contact to a height of about a foot. As many as three of these standing arcs, each without any visible return circuit, could be established simultaneously, each flame spluttering and sending out molten copper in all directions until it was blown out.

SIR JOHN RUSSELL, Director of the Rothamsted Experimental Station, will shortly leave England to visit Australia, where he is going at the invitation of the Australian universities to lecture on the applications of science to agriculture, especially to crop production, showing what science has done and is doing to assist the farmer. While there he will, at the invitation of the Commonwealth Council of Scientific and Industrial Research, visit some of the more important developments and soil reclamation schemes in progress, and discuss the problems with the Australian experts on the spot. He will also visit the chief centres of agricultural investigation, and among other things will discuss the possibility of exchange of information and rendering of mutual assistance between the British and the Australian agricultural investigators.

THE first dynamo test in the world was made in the winter and spring of 1878, in the hall of the Franklin Institute of Philadelphia, by Dr. Elihu Thomson and Prof. E. J. Houston. The tests were carried out on various types of dynamos in order to determine which was the most efficient. As a result of these tests, a Brush arc light generator was recommended

for purchase by the Franklin Institute. A celebration of the semi-centennial of these tests will be held in the Franklin Institute on the afternoon of Wednesday, April 18, in the hall of the Institute, when papers will be presented by Dr. Elihu Thomson, the survivor of the two who made the tests, and by Dr. Charles F. Brush, who invented the type of dynamo finally recommended. It is expected that representatives of the great electrical companies of the United States and Canada, as well as many scientific workers of these two countries, will be present to participate in this celebration. All scientific workers and members of scientific organisations of Europe who may be in the United States at that time will be heartily welcomed by the Franklin Institute.

ON Mar. 14 the Frank N. Meyer Medal for distinguished service in plant introduction was presented to Mr. H. N. Ridley, in recognition of the important part he played in establishing plantations of the Para rubber tree in the Oriental tropics. The presentation was made by the American Consul General on behalf of Mr. David Fairchild, president of the American Genetic Association, to whom the award is entrusted by the staff of the Office of Foreign Plant Introduction, United States Department of Agriculture. Mr. H. L. Washington, in presenting the medal, referred briefly to the pioneer work carried out by Mr. Ridley whilst Director of the Botanic Gardens, Straits Settlements, in securing seed of the Para rubber tree from the trees growing at Singapore, in order to start the plantations in Malay; to his work in raising improved kinds of the tree by selection, and to his early experiments in tapping. Appreciative references were also made to the part played by the Royal Botanic Gardens, Kew, in the original introduction of this tree from South America to the Far East.

J. P. AULT, commander of the yacht *Carnegie*, has contributed an interesting review of magnetic ocean surveys to the February number of the *Scientific Monthly*. Columbus is credited with the discovery of the magnetic variations of the compass; when seven days out from the Canaries, during his first voyage to America in 1492, he found that the compass needles had turned to the north-west of north, and on the following morning further to the north-west. Two hundred years later, substantial prizes were offered for improvements in navigational methods, and Edmund Halley, the astronomer, began his voyages in the *Paramour* "to improve the knowledge of the longitude and variations of the compass." As a result, he constructed and published the first magnetic chart of the oceans, his method of drawing lines through points of equal magnetic variation being still used on modern charts. During the two hundred years which have elapsed since Halley's voyages gross changes have taken place in the magnetic field. In London the compass needle pointed 11° east of north in 1580, in 1812 it was pointing 24° west of north, and it now points about 13° west of north. The causes of these changes are unknown; their explanation and the determination of the rates of change constitute one of the chief problems in terrestrial magnetism.

THE Carnegie Institution of Washington equipped and sent out the non-magnetic ship *Galilee* to the Pacific, to be followed by the yacht *Carnegie*, which has already sailed some 290,000 sea miles. It is proposed to sail on a seventh cruise in May next. Besides continuing the magnetic survey, it is proposed to carry out a series of determinations of the potential gradient of the atmosphere immediately above the sea, and to prosecute a carefully prepared programme of oceanographic research. By finding the density *in situ* of the water at various depths down to 2000 metres every hundred miles or so, it will be possible to arrive, by means of Bjerknes' circulation theory, at the components at right angles to the track of the voyage of the velocities of the various water layers, relative to each other. It is also proposed to make a survey of the phosphate content of the ocean waters, a matter of particular interest, since lack of this salt has been shown to limit plant life in the upper illuminated layers in the tropics and in temperate regions during the summer months, and upon such plant life—diatoms and peridinians—the rich animal life of the sea depends. Numerous other observations of biological and oceanographic interest are also to be made.

IN *Discovery* for March, Miss Moya Jowett describes the interesting but little known medieval town of Domme and its surrounding country in the valley of the Dordogne. Domme was at one time of considerable importance from the military and economic point of view, as the surrounding area was covered with dense forest, and the only safe method of trade and travel was by water. Near by is the castle of Simon de Montfort, here best known for his massacre of the Albigenses who then held the town. It was the outpost of English territory, and changed hands several times. Many interesting buildings of this period still stand and make the town well worth a visit: but an added attraction is its proximity to Les Eyziès, the centre and capital of the palæolithic cave district of the Dordogne. At the conclusion of her article, Miss Jowett informs her readers that arrangements are being made for a small party interested in archæology to visit Domme and Les Eyziès for a fortnight at Easter at a low cost. The party will stay for one week at Domme and for one week at Les Eyziès, and at the latter place will have the unusual privilege of being conducted over the caves by M. Peyrony. Particulars of the tour may be obtained through the Editor of *Discovery*.

ONE of the earliest uses of electricity was in connexion with lighthouse communication. Carbon arc lamps were employed, and both the lamps and the electric generators used needed constant supervision. A great step forward has recently been made by the use of gas-filled lamps for this purpose. We learn from the *Osram G.E.C. Bulletin* for February that the gas-filled lamps now in use are of very large size, some requiring four kilowatts to keep them in normal operation. The filaments operate at 80 volts, so the lead-in wires have to carry 50 amperes, and have a cross-sectional area of $\frac{1}{20}$ sq. in. The solution of the problem of making a vacuum tight seal between

glass and wire of this thickness required a year's research work. In the event of a lamp failing it is necessary that it be immediately replaced. This is done by having a reserve electric lamp, and in addition an emergency acetylene light. Such well-known lighthouses as those at Pendeen, Lizard, Hartland, Burnham, and Skerries have all been fitted with gas-filled lamps. In the case of the Lizard lighthouse, which originally contained an arc lamp working at 30 volts and having for a source of power one or two French alternators between forty and fifty years old, complete conversion of the plant was necessary. As the alternators were still sound, they were utilised and connected to the lamp by a transformer. The whole of the lighting equipment has been made automatic, and an automatic winding device has been added to the clockwork which rotates the lenses. These lamps have proved themselves trustworthy for lighthouse and lightship service and give economic results.

WE much regret to announce the death, on Mar. 19, at the age of eighty-five years, of Sir David Ferrier, F.R.S., emeritus professor of neuropathology, King's College, London.

A LARGE earthquake was recorded at Kew Observatory at 5 hr. 20 min. 51 sec. G.M.T. on Mar. 16. The epicentre is estimated to have been about 8400 miles away.

THE appointments made by the Secretary of State for the Colonies during the month of February, in addition to those for the East African Agricultural Research Institute, Tanganyika Territory, which were mentioned in NATURE of Mar. 17, include the following: Dr. H. Scott, entomologist, Iraq; Mr. J. L. Illingworth, curator and agricultural superintendent, Virgin Islands; Mr. C. B. C. Handley, assistant agricultural officer, Kenya; Mr. H. Marsland, cotton investigator, Agricultural Department, Tanganyika Territory; Mr. R. S. Kyle, veterinary officer, Tanganyika Territory.

AT the annual general meeting of the Optical Society, held on Mar. 8, the following officers and new members of council were elected for the session 1928–1929: *President*, Dr. R. S. Clay; *Vice-Presidents*, Mr. D. Baxendall, Mr. H. H. Emsley, Mr. J. Guild, Mr. F. C. Watts; *Hon. Treasurer*, Major E. O. Henrici; *Hon. Secretaries*, Prof. A. F. C. Pollard and Mr. W. B. Coutts; *Hon. Librarian*, Mr. J. H. Suttcliffe; *Editor of Transactions*, Dr. J. S. Anderson; *New Members of Council*, Mr. O. Aves, Mr. T. Chaundy, Dr. C. V. Drysdale, and Mr. A. Whitwell.

THE ninth International Congress of Psychology will be held at Yale University in New Haven, Connecticut, U.S.A., probably in August or September 1929. The officers of the Congress are as follows: President, J. McKeen Cattell, of New York; Vice-president, James R. Angell, of Yale University; Secretary, Edwin G. Boring, of Harvard University; Treasurer, R. S. Woodworth, of Columbia University; Foreign Secretary, Herbert S. Langfeld, of Princeton University; Executive Secretary, Walter S. Hunter, of Clark University; chairman of the Programme Committee, Raymond Dodge, of Yale University; chairman of the Committee on Arrangements, R. P. Angier, of Yale University. This is the first meeting of the Congress in America, and it is expected that it will be truly international in character. It is hoped in the United States that the appointment of some foreigners for lecturers and lectureships will be arranged near the time of the Congress, so that foreign attendance will be increased.

WE are informed by the Smithsonian Institution of Washington that large editions of two maps of the world, showing the 387 stations from which data were obtained for "World Weather Records" (Smithsonian Miscellaneous Collections, Publication No. 2913), are available. In one of these maps the world is represented as an ellipse, parallels of latitude being parallel straight lines and meridians of longitude arcs, and the other shows the northern and southern hemispheres on a zenithal projection. Each map is on a sheet of about 11 in. × 16 in., and copies can be obtained on application to the Smithsonian Institution at 5 cents a sheet, or 4 dollars a hundred sheets.

THE Kodak X-Ray Department will in future be known as the "Medical Department," as it includes in addition to the Radiography Section a Clinical Photography Section and a Medical and Surgical Cinematography Section. For work in the last section the 'Ciné-Kodak' is employed, and it has accessories which take pictures at four times the normal speed without increasing the rate of cranking, or one picture only at each revolution of the crank, thus allowing pictures to be taken at any desired slow rate. In conjunction with a microscope, this slow movement is specially useful in connexion with bacteriological and pathological work. Further details of these and of the Rheinberg colour filters for clinical microscopy, which in conjunction with the substage condenser, give differential colour illumination, are given in the December number of the *X-Ray News and Clinical Photography*, published bi-monthly by Kodak Limited.

THE Streatfeild Memorial Lecture for 1927 was delivered last November before the Institute of Chemistry and past students of Finsbury Technical College by Mr. O. F. Bloch, and is just issued in pamphlet form by the Institute. Mr. Bloch took as his subject "The Chemist in the Photographic Industry," and after a personal tribute to Mr. Streatfeild and some general remarks, passed to the problems of light sensitivity and the latent image. He gave twelve facts or questions which must be accounted for or answered by any theory before it can be generally accepted. He then passed in short review the work that has been done in late years and the suggestions that have been made towards the solution of these problems.

DR. JAMES F. NORRIS, Director of the Research Laboratory of Organic Chemistry of the Massachusetts Institute of Technology, has undertaken the consulting editorship of the International Chemical

Series, published by the McGraw-Hill Book Company. Dr. Norris succeeds the late Dr. H. P. Talbot, who was also at the Massachusetts Institute of Technology, where he and Dr. Talbot had been associated for considerable periods since 1895. Dr. Norris was president of the American Chemical Society in 1925 and 1926.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A curator of the Art Gallery of Kingston-upon-Hull—The Town Clerk, Guildhall, Hull (Mar. 30). An assistant in the Department of Scientific and Industrial Research, chiefly to make translations and abstracts of articles dealing with radio-telegraphy—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (April 4). A woman accountant and lecturer on book-keeping at the Swanley Horticultural College for Women—The Secretary, Horticultural College for Women, Swanley, Kent (April 7). A secretary to the Association of Special Libraries and Information Bureaux—The Chairman of Council, Association of Special Libraries and Information Bureaux, 38 Bloomsbury Square, W.C.1 (April 9). A Principal of the Dudley Technical College—The Clerk to the Governors, Education Offices, Dudley (April 13). A junior scientific officer on the Air Ministry Scientific Research Staff, primarily for duty at the Royal Aircraft Establishment for research in applied physics, chiefly in connexion with aeronautical instruments — The Chief Superintendent, R.A.E., South Farnborough, Hants (April 13—quoting A.265). An adviser in agricultural economics for the Western (Bristol) Province—The Registrar, University, Bristol (April 14). Professors of geography, medieval history, Egyptian and oriental history prior to Græco-Roman times, and of classics and Græco-Roman history respectively, in the Egyptian University, Cairo—The Director, Egyptian Educational Office, 39 Victoria Street, S.W.1 (April 30). A professor of geology in the Egyptian University, Cairo—The Dean of the Faculty of Science, Egyptian University, Cairo (April 30). A second and mathematical master at the City of London School—The Secretary, City of London School, Victoria Embankment, E.C.4. A clinical pathologist at the Crichton Royal Mental Hospital, Dumfries—The Physician-Superintendent, Crichton Royal Mental Hospital, Dumfries.

## Our Astronomical Column.

SKJELLERUP'S COMET.—News has been received from the Observatories of the Cape and Johannesburg, that this comet, which was so brilliant in December, has now been photographed in a dark sky on its emergence from the sun's neighbourhood ; its photographic magnitude was 8·9, and Mr. Wood notes that he hopes to be able to follow it for a long time. Since most of the observations in December were somewhat wanting in precision, owing to the absence of comparison stars, these new observations will be of great value for improving the orbit elements. Out of the list of observed positions the following nearly simultaneous observations at the two observatories are selected ; Cape, Feb. 11·11875 U.T., R.A. $18^h\ 58^m\ 32^s{\cdot}77$, S. Decl. 27° 0′ 43·7″ ; Johannesburg, Feb. 11·08398, $18^h\ 58^m\ 31^s{\cdot}01$, S. 27° 0′ 13·3″.

Dr. A. C. D. Crommelin has computed the following orbit :

| | | | |
|---|---|---|---|
| T | 1927 Dec. 18·1671 U.T. | | |
| $\omega$ | 47 | 8·82 | } 1927·0 |
| $\Omega$ | 77 | 14·90 | |
| $i$ | 85 | 12·81 | |
| log $q$ | 9·24579 | | |

The comet remains in high south declination until it is out of sight ; but it should be visible for some months. The observations up to February give no indication of appreciable deviation from a parabola.

PREPARATIONS FOR THE NEAR APPROACH OF EROS IN 1931.—In less than three years, this little planet will approach the earth within some 16 million miles, which is not much more than half its distance early in 1901, when it made its nearest approach since its discovery in 1898. An extensive parallax campaign is already planned ; the first essential is to obtain accurate positions of a large number of stars lying near the track of the planet ; this work is being undertaken at many observatories, including Greenwich and Mount Hamilton. A *Daily News Bulletin*, issued by Science Service, Washington, reports that Dr. R. H. Tucker has determined the positions of 821 stars in the first series, and of 402 stars in the second series ; the latter were observed in 77 working nights "during the best observing season at Lick Observatory in 30 years." British observers would give a somewhat less flattering report of last year's weather.

Eros is in opposition next September, in north declination 5° ; but its magnitude will then be only 11, whereas it will rise to 7 in January 1931.

UNIVERSITY OBSERVATORY, OXFORD.—The *Annual Report* of the Visitors of the University Observatory, presented to Congregation on Feb. 28, directs attention to the progress of the catalogue of stars to the eleventh magnitude, for which the co-operation of eighteen observatories was secured at Paris in 1887. The Oxford Observatory was the first to complete its share in manuscript, though circumstances caused some delay to its production in type. After its completion it was found possible to render material assistance to the Vatican Observatory, the publication of the contribution of which is now in sight. The Director has undertaken the chairmanship of the international Committee charged with this work, the completion of which is now showing signs of possible attainment.

The connexion of the seismological work initiated by Milne, undertaken provisionally by Oxford in 1913, has become gradually established with the University Observatory. Fresh accommodation for the seismographs is being provided in the basement of the library, now in course of extension.

Dr. Fotheringham has detected numerical errors in the determined mass of Venus which have a bearing on terms in the sun's longitude. His work on the secular accelerations of the moon has been recently confirmed by the identification of the eclipse of Ur, 2283 B.C.

Weather conditions interfered materially with the joint eclipse expedition to Southport from the Radcliffe and University Observatories. Photographs, however, were taken, and the programme of work was successfully carried through.

## Research Items.

HAWAIIAN SOMATOLOGY.—The late Louis R. Sullivan, while in Honolulu in 1920–21, made a number of measurements of Hawaiians which it was his intention to study comparatively in relation to other Polynesian material collected under the auspices of the Bernice P. Bishop Museum and the American Museum of Natural History. This material has now been edited and arranged by Dr. Clark Wissler for publication as *Memoir 9, No. 4, of the Bernice P. Bishop Museum*. Dr. Clark Wissler has added comparative notes based upon the Polynesian material from Samoa, Tonga, and the Marquesas. In stature the Hawaiians are the shortest, next in order being the Marquesans and the Maoris. In cephalic, fronto-parietal, zygomatico-frontal, and zygomatico-gonial index, the Hawaiians lead, as they do in head width, minimum frontal, and begonial width. From this it appears that the Hawaiian face and head is relatively wide, whereas in transverse and vertical diameter the head and face are short. The nose is intermediate. Considering all measured characters as of equal weight, the Hawaiians resemble more closely the Tongans and the Marquesans than they do the Samoans. Hawaiians show more straight hair and more brown hair. They exceed in flatness of nose, the order of the transverse axis being Hawaiians, Marquesans, Samoans, Tongans.

ZOOLOGY IN INDIA.—In his presidential address to the section of Zoology of the fourteenth Indian Science Congress held at Lahore in 1927, recently published by the Asiatic Society of Bengal, Major R. B. Seymour Sewell remarked that in India zoology is still in the stage in which taxonomy must be the first line of research, but he emphasised the paramount importance to the country of the study of ecology and bionomics and hence of more field researches. He pointed out the advantages of team-work in the field by zoologists, botanists, and chemists, so that not only the fauna, but also the associated flora and the chemical composition of the soil and water might be investigated. Failing such collaboration, there is much that a zoologist should be able to do for himself; for example, the estimation of hydrogen ion concentration, the amount of dissolved gases, and the salinity of sea-water, for the operations involved have been simplified and standardised provided the necessary apparatus is available. He also referred to the importance of a study of meteorological conditions in relation to investigations of the fauna of Indian seas, and stated that there is evidence of long period oscillations, of the nature of 'seiches,' which bring up from considerable depths masses of water that have a higher salinity than the normal surface water, and hence exert a profound effect on the fauna. Superimposed on these long period oscillations of salinity is a double diurnal oscillation brought about by an upwelling from a depth of probably 50 to 100 fathoms, and there is evidence that this is accompanied by changes in the plankton. He referred to the vertical migrations of plankton recorded in European waters and expressed his doubts as to whether the small organisms could make their way in the time available from and to the levels to which they are said to migrate, in some instances 200 fathoms. He considers it highly probable that in Indian waters the 'migration' of the plankton is really largely a 'translation.'

ECTODERMAL PLACODES IN THE HEAD REGION OF A SPARROW EMBRYO.—Mr. Frank Goldby (*Jour. Anat.*, vol. 62, 135-138; 1928) describes a remarkable series of ectodermal placodes which were found in a sparrow embryo. These placodes, six in number, were found on the right side only of the embryo, in series with the auditory placode, two posterior and four anterior to it. The asymmetry of the series, their irregularity in size, and the fact that they correspond to no adult structure, suggest that they are vestigial in character. Their position and their obvious arrangement in series with the auditory placode suggest that they represent traces of the acoustico-lateral system of anamniota. The occurrence of placodes of this kind in an amniote is unique.

EMBRYOLOGY AND MUSCULATURE OF INSECTS.—The greater part of the December issue of the *Quarterly Journal of Microscopical Science* is devoted to two papers on common insects. In the first of these, L. Eastham records his observations on the embryology of *Pieris rapæ*, rightly believing that an account of the developmental stages so readily obtainable will be helpful to teachers and advanced students. Cleavage begins within the first hour after oviposition, in sixteen hours the blastoderm is complete, at twenty hours the embryonic rudiment is distinguishable, gastrulation begins at twenty hours, and is completed from forty-eight to sixty hours after fertilisation. Of the nuclei resulting from cleavage, those destined to form blastoderm move peripherally to the cortical layer; the remainder are left in the yolk as vitellophags. The movement peripherally of the nuclei is attributed partly to a streaming of the cytoplasm which carries the nuclei. The development and changes in form of the embryonic rudiment are described. Gastrulation is effected by overgrowth of the middle plate by two lateral plates and the endoderm is formed as proliferations in the position of the future mouth and anus. In the second paper, Guy D. Morrison gives a detailed account of the muscles—including their histology and function—of the adult honey-bee. The musculature of all three castes is described, the histology and physiology of the nervous system, and the mechanics of respiratory movements are carefully considered.

FISSION IN STARFISHES.—In notes on New Zealand starfishes (*Records, Canterbury Mus.*, **3**, December 1927), E. W. Bennett supports the view that in those species in which the number of rays is more than five, this is due to reproduction by transverse fission. Out of 153 specimens of *Allostichaster insignis*, 132 were six-rayed or potentially so, and he states that fission undoubtedly occurs, this being indicated not only by the size and disposition of the rays, but also by the presence of a groove across the disc. It is equally certain that after fission the new arms are grown almost invariably in threes, which would account for the preponderance of six-rayed individuals. In *A. polyplax*, four new rays are produced after fission, and the characteristic number of arms in this species is eight. Autotomy has long been believed to occur in *Coscinasterias calamaria*, and the author states he has verified this from a specimen in an aquarium.

A MERISTIC VARIATION IN A FEMALE NEMATODE.—Mr. G. Henderson Cassidy, Hawaiian Sugar Planters' Experiment Station, Honolulu T. H., writes stating that in material collected by Mr. C. E. Pemberton in Menado, Celebes, and examined in Honolulu in November 1926 by Mr. Cassidy, were several specimens of the genus Dorylaimus, one adult female specimen of which, 1·05 mm. long, presented an unusual variation. It showed two vulvæ identical in formation,

presenting no abnormality of structure and both situated on the median line of the ventral surface 0·062 mm. apart. There were two reflexed ovarian tubes, the anterior arising from the anterior vulva and the posterior from the posterior vulva.

CHROMOSOME MUTATIONS IN GARDEN STOCKS.—In a combined study of the genetics and cytology of stocks (Matthiola) by Dr. Howard B. Frost and Mrs. Mann Lesley (*Jour. of Heredity*, vol. 18, No. 11), a series of trisomic mutations (with an extra chromosome) have been obtained, similar to those already known in Œnothera and Datura. The stocks have seven pairs of chromosomes. Four of the trisomic forms, called Smooth, Crenate, Narrow, and Dark, are of common occurrence, and apparently each contains a complete extra chromosome. In at least three others (Large, Slender, and Small) the extra chromosome is a fragment only. Among the progeny of Slender plants an occasional Narrow Slender mutant appears. This has, in addition to seven pairs of chromosomes, a large and a small unpaired extra. Resemblances between Small and Smooth suggest that the very small extra chromosome of Small is a fragment of the extra one found in Smooth. These mutants differ in earliness, flower-size, and to some extent in leaf-shape. Their offspring include tetrasomics (14 + 2) in which the peculiarities are more extremely expressed. Slender × Crenate gave one plant, the leaves of which combined the narrowness of Slender and the dentation of Crenate. It is said to have one extra chromosome, short like that of Slender, and another long, as in Crenate. These forms all show much sterility, and in the descendants of Crenate a form also with 15 chromosomes appears, called Crenatoid. This seems to bear the same relation to Crenate that *Œnothera semilata* does to *Œ. lata*.

PRECARBONIFEROUS PLANTS FROM AUSTRALIA.—Prof. W. H. Lang and Miss Isabel Cookson have just published a report on some very early Palæozoic plants from Victoria, Australia (*Memoirs of Manchester Lit. and Phil. Soc.*, vol. 71, No. 5). These plants have been collected from rocks generally regarded as of Yeringian (Upper Silurian) age. The most definite types of plants so far found are: (1) Large shoots with long linear leaves which cannot be closely compared with any known plant, and are of uncertain systematic position; (2) small-leaved shoots that have been closely compared with Thursophyton and more generally with Arthrostigma and *Psilophyton princeps*; (3) smooth-branched axes of various sizes, sometimes with axillary 'bud-like' structures, which have been closely compared with the various remains classed as Hostimella sp. It is considered that such an assemblage of plant remains, looked at in the absence of any information as to their position and locality, would suggest the Early Devonian flora, and perhaps the Middle rather than the Lower Devonian. The authors suggest that the so far scanty plant evidence should be used sparingly in determining stratigraphical successions, which should be delimited by the fauna when, as in this case, it is well represented. The history of the plants could then be related to this geological succession so determined.

INDIRECT EXCITATION OF SPECTRA.—The important observation of Prof. Paschen that Al II lines appear in the negative glow of a discharge from an aluminium cathode in pure helium, has been extended to a number of analogous cases by R. Frerichs (*Annalen der Physik*, vol. 85, p. 364). The ions of some metals the spark spectra of which had already been analysed, were produced by the process of 'sputtering,' and were then further excited by a transfer of energy from metastable atoms of helium, neon, or argon. It was found that the degree of excitation possible depended almost entirely on the energy of the inert gas, fewer spark lines appearing with argon than with either of the others. The principle so established was then applied to the still incompletely known spectrum of ionised copper, and should be capable of very considerable extension. A point of more general interest that is raised by this work is that the law governing the transfer of energy in a collision of the second kind is apparently more like that found to hold for ionisation by electron impact than that governing an inelastic collision at a resonance potential.

THE COSMIC RAYS.—Full details of their 1926 expedition to Bolivia have been published by Prof. R. A. Millikan and Dr. G. H. Cameron in the February number of the *Physical Review*. An outstanding feature of their report is the remarkable consistency which they have now succeeded in obtaining between measurements made with different electroscopes at various places, which is so good that the new results and the earlier Californian readings can all be represented by a single smoothed absorption curve. The progressive hardening of the rays in their passage through the air, which is shown by this graph, seems now to be definitely established, and corresponds to a spectral range of approximately an octave near $4 \times 10^{-4}$ A. Their conclusion regarding the suggested influence of the Milky Way is that if it has any effect upon the cosmic radiation, the rays coming from it cannot be 6 per cent. greater or less than those coming from the portion of the heavens at right angles. A terrestrial origin in the shape of thunderstorms is even more unequivocally dismissed after their experiments in a sheltered valley in the High Andes, and in the midst of heavy storms at sea. The value now found for the ionisation at sea-level is 1·4 ions per c.c. per second, and is, so far as the investigations go, independent of the shape, wall-material, and volume of the three electroscopes employed.

MAGNETIC THEORY.—The *Proceedings* of the fourteenth Indian Science Congress held at Lahore in 1927, and recently published by the Royal Asiatic Society of Bengal, contains the presidential address to the Section of Mathematics and Physics on some recent magnetic theories, delivered by Prof. D. M. Bose. It deals in the first instance with the application of electron theory to magnetism, and the disagreement which exists between the magneto-mechanical effect as predicted by the theory and the measured effect. It is possible that this discrepancy may be due to the magnetic field produced by the spin of the electron about its own axis, a field which was postulated by Sir J. J. Thomson in his Silvanus Thompson Lecture to the Röntgen Society in June last. There is still disagreement between observers as to whether the susceptibility of a diamagnetic gas is proportional to the pressure, and the introduction by Weiss of $T - T_0$ in place of the absolute temperature $T$ in the Curie law for paramagnetic substances has not been supported by observations. These show that $T_0$ may be negative although the theory makes it positive, and that for compounds of the same kind in which one atom is replaced by a more susceptible one, $T_0$ is decreased while theory predicts an increase. The magneton and the recent theories which predict the magnetons in a compound from its chemical formula are also dealt with.

AUTOMATIC SUBSTATIONS IN RAILWAY ELECTRIFICATION.—The electrification of the main line railways

in Great Britain has brought to the front the problem of the design and maintenance of automatic substations for the supply of electric energy to the trains. Experience has shown that with the usual automatic substations, frequent and lengthy visits by the maintenance staff have not infrequently been a feature of normal operation. The designer's aim, therefore, is to reduce the frequency and duration of these visits, and this necessitates departures from designs which have given every satisfaction in substations which have attendants. This problem is discussed in a paper read to the Institution of Electrical Engineers on Feb. 2 by H. B. Poynder. The chief problem is in connexion with the rotary convertors which have to convert the alternating supply into direct current. As the voltage required is 1500, they are connected two in series. In the early days of the working of an electric traction railway, short circuits on the track have to be regarded as normal operating occurrences. To guard against possible damage to the machines, apparatus for rapidly breaking the circuit has to be installed. To prevent overheating, some 10,000 cubic feet of air per minute has to be passed through each machine. The effect of forced ventilation is to carry with it a large amount of dust, especially in countries where sandstorms occur. As the deposition of dust is very deleterious when the substations are rarely visited, efficient air filters have to be provided. Wet air filters seem to be the best, as there is no fire risk and the air is cooled before it gets to the machine. As substations are usually in out-of-the-way positions, an alarm of fire is rarely given even when black smoke has been issuing for some time. A suggestion is made that a carbon dioxide plant should be installed for the protection of the substation which would operate when small quantities of smoke are present. Photo-electric cells balanced normally would distinguish between the light passed through two long tubes and so automatically release the valve of the carbon dioxide bottle when there was smoke in the sub-station tube.

NEW ELECTRIC LOCOMOTIVES.—On the electrified main lines of the German State Railways the permissible load on a pair of driving wheels has been increased to 20 tons and the maximum speed has been increased to 68 miles an hour. In order to take advantage of this change it is necessary to have a large motor output per axle. The driving of the axles by individual motors, or better by 'twin motors,' has been found to be the most economical. Two years ago the A.E.G. company supplied the State railways with a new type of electric locomotive having high tractive power and individual axle drive. It has given satisfaction in practice, and 33 locomotives of this type are now being constructed. The aggregate output of the motors on a locomotive on an hourly basis is 3700 horse-power, the weight of the locomotive being only about 110 lb. per rated horse-power. It is claimed in *A.E.G. Progress* for January that it is the lightest single-phase locomotive that has yet been built. Up to a third of full speed, the tractive effort measured at the circumference of the driving wheels is 49,000 lb. It moves easily up an incline of 1 in 8 and round a curve of 600 feet radius. The body of the locomotive is divided into three compartments. The central compartment contains the main motors and transformers, whilst the two end compartments form driving cabins with control gear. The roof of the machine cabin is divided into five parts so that the various parts of the electrical equipment can be dismantled from above. The ventilating ducts can be closed during heavy snow falls.

BUSCH MICROSCOPES.—A catalogue recently issued by Emil Busch, A. G., Rathenow, gives full particulars of an increased number of types of microscopes now being manufactured by the firm. These include several simple robust models suitable for students' use, as well as more elaborate outfits for biological and petrological routine or research work, and microscopes with body tube of extra large diameter suitable for photomicrography and projection. An interesting feature of the larger models is the fine focussing adjustment, which is effected by means of a spindle supported at both ends. A spiral thread cut on the spindle engages with a wedge-shaped nut. Rotation of the milled head on the spindle produces a lateral motion of the wedge and thereby raises or lowers the body tube through a pillar supported on the wedge by a steel roller. The catalogue also contains lists of objectives and eyepieces, illuminating appliances and various types of mechanical stages. A separate leaflet gives a description of a small portable microscope, the stand, stage, and tube carrier of which are cast in one piece. This instrument may be used for projection purposes, the base of the microscope being threaded and thus capable of being screwed on to the flange of the projection apparatus. Another pamphlet issued by the firm gives directions for the use of microscopes and accessories in the examination of opaque objects by reflected light, and also a description of various types of photomicrographic apparatus. Amongst these is a camera which can be easily attached to the upper end of the body tube of a microscope. The camera is provided with an observation tube which facilitates the focussing of the image and permits of its examination while the exposure is being made. The London agents for these instruments are Messrs. Emil Busch Optical Co., Ltd., 37 Hatton Garden, E.C.1.

INSULATING OILS.—Engineers are using at present a great many oils for insulating purposes. For example, the coils of high tension transformers are as a rule immersed in oil. Hitherto the work of oil refiners has been confined mainly to the production of a good lubricant. Up to the present the problem of producing an oil which will act satisfactorily as an electrical insulator has not been solved, although good progress has been made. Especially is this the case for the oils which are used to impregnate the insulating coverings of paper-insulated cables. For cable work it is most essential to keep the dielectric losses as low as possible, while for transformer and switchgear work this is not so important. In a paper read to the Institution of Electrical Engineers on Feb. 23 by T. N. Riley and T. R. Scott, the requirements for high voltage cables are briefly outlined. Experimental results are then quoted showing the bearing of the physical and electrical characteristics on the finished cable. It is necessary that the paper layers slide smoothly over one another when the cable is handled. It must therefore have the properties of a lubricant. The thermal conductivity of the oil must be high in order that the cable remain cool when working. Although the thermal resistivity of the paper fibre itself is usually less than that of the oil, yet the resistivity of paper contacts between layers of dried paper is of the order of five or six times that of the oil. Imperfect impregnation therefore greatly raises the thermal resistivity. The authors conclude that the elimination of gas 'pockets' in the dielectric is necessary. These spaces not only cause brush discharges and so produce burning and oil oxidation, but they also increase the thermal resistivity. Sensitive methods of measuring the electrical characteristics of the oils are given.

## Diseases of the Douglas Fir in Britain.

AS is often the case with exotics, there have been one or two scares on the subject of diseases in connexion with the Douglas fir plantations in Britain. A fungus attack reported in a young plantation, when investigated, proved to be caused by an undescribed species of Phomopsis (*P. Pseudotsugæ* Wilson). Then a species of Chermes (*Chermes Cooleyi*) appeared in several parts of the country. A recent leaflet (No. 18) issued by the Forestry Commission, deals with a disease new to Britain, the Douglas fir leaf-cast disease (*Rhabdocline Pseudotsugæ* Syd). The disease is common on the Douglas in the United States, but until within the last few years it had not apparently been noticed on the east of the Atlantic. It has been found on the blue form of the Douglas fir (*Pseudotsuga glauca*) and on the interior dry belt or Fraser River form (*P. Douglasii* var. *cæsia*). Recently it has been also observed on the green Douglas (*P. Douglasii*). This fungus occurs on all forms of the Douglas in the United States, and occasionally becomes epidemic for a season or so. It usually only infests young trees, but attacks larger trees growing on poor quality soils.

Infested needles develop blotches on the under surface during the winter, and at a later date tissues of the leaf on the upper surface, directly above, turn a yellowish brown. By early spring these areas turn a purplish brown, which, contrasted with the green unattacked part of the needle, give the infested foliage a mottled appearance not unlike the resultant mottling produced by *Chermes Cooleyi*. In the latter, however, the presence of the small secretions of white wool on the under surface of the needles serve to distinguish this attack. In the case of the fungus, the mycelium is developed in the leaf and does not pass back into the shoot. About March the hyphæ become numerous on the lower surface of the leaf just beneath the two bands of stomata in the discoloured spots, and it is here that the fructifications are formed. In May the epidermis ruptures, disclosing an orange-coloured layer which bears the spores. Spores are liberated at the time the buds are opening, and infection takes place shortly afterwards on the young needles. Infected needles fall at all seasons of the year. Trees attacked for several years by this fungus may be almost entirely defoliated and may die.

The green Douglas appears to be the least subject to this fungus. So far, the disease has been reported from Peebleshire and from several counties in the south of England. At present it is deemed impossible to suggest any definite remedy, but, in the case of an attack appearing on a few young trees only, the advice is tendered that they should be removed and burnt. In the nursery, spraying with a solution of soap and Bordeaux mixture as practised in the United States is recommended.

In the case of infestations, such as those here mentioned on the Douglas, the real solution would appear to rest on sylvicultural considerations. The planting of pure blocks of rapidly growing exotics is, in many parts of the world, to court disaster in the long run, in one form or another; more especially when the behaviour of the exotic from the sylvicultural point of view, in its new environment, is by no means well understood.

## Building Research.[1]

THE poet Cowper wrote the well-known couplet, "Knowledge is proud that he has learned so much; Wisdom is humble that he knows no more," and it was Tennyson who said, "Knowledge comes, but Wisdom lingers." These statements are indeed true of building science. The past centuries have witnessed an ever-increasing store of knowledge, wherein precedent, with the natural improvements added for the day current, shows the accretion of knowledge, though not necessarily an accretion of wisdom.

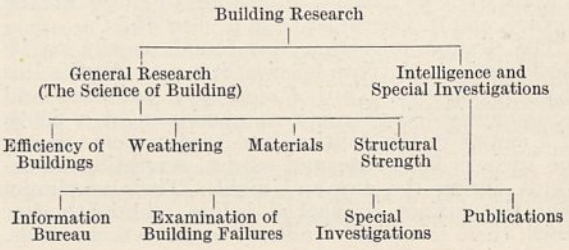
The work of the Middle Ages was largely empirical in nature, though we of to-day would hesitate to deny the wisdom of the ancients of Assyria, Egypt, Greece, and Rome in their palmy days of building activity. Forgetting for the moment the simpler constructive science involved in trabeate architecture, how else than by superior wisdom can we account for the survival of the magnificent relics to the present time—a survival that would have been far less mere relics had it not been for the fortuitous effects of bombardments and the criminal vandalism shown in using some of these buildings as mere quarries?

Though the monks may be credited as having been in the possession of a large amount of useful scientific knowledge in regard to building, as their stately cathedrals show us to this day, yet this knowledge lacked that admixture of wisdom which would have secured to their creations the same defiance of time as appertained to the earlier art. They could calculate to a certain degree the structural basis of the vaulting and groining, so as to promote the attainment of their aim, but the inadequacy of the results is made too painfully evident in these latter days. The poor quality of the stone, the inefficient counterforts and sundry other defects, entail the vast expenditure so frequently witnessed. Even after making allowances for altered conditions consequent upon tunnelling beneath the surface for railways and sewers and the deep excavations for commercial purposes, as well as allowing for the pollution of the atmosphere by reason of industrial processes, yet the charge of inadequate wisdom is justified in its entirety.

A welcome is therefore to be accorded to the present (if somewhat overdue) activity on the part of the Government, whereby scientific research into the capacity and quality of building materials is being undertaken; twofold in its nature, namely, curative research for the purpose of remedying accrued defects, and prophylactic research, which is wisdom in the highest degree, whereby preventive measures may be adopted in time.

The first Report of the Building Research Board, appointed by the Department of Scientific and Industrial Research, has recently been issued; brief as is the period during which the Board has been in existence, there is ample evidence of its utility.

The Board divides its operations into two main sections, (*a*) general research and (*b*) intelligence and special investigations; a reproduction of its 'labour tree' will best conduce to an appreciation of the method pursued:




[1] "Report of the Building Research Board for the Period ended 31st December, 1926." (London: H.M. Stationery Office, 1928.) 2*s*.

The subject of weathering has been considered from the various aspects of chemical attack (including solvent action of rain); biological attack, bacteria, lichens, etc.; movements due to temperature and moisture changes; and frost.

It is somewhat on the lines of the bismuth meal, when we note how investigators employ the method of impregnation of stones with coloured resins as a means of tracing the porosity channels of the various stones. Sections of decayed samples upon examination thus enable the formation of sulphates to be studied. In research upon the transmission of chemical solutions as preservatives, it has been demonstrated that the crystallisation induced by evaporation from the face of a wall so impregnated is often a cause of decay; when perished mortar joints have been made sound, evaporation will, in following the line of least resistance, issue from the stone itself, and hence the decay.

Further, it was found that aerobic bacteria rarely penetrate more than an inch below the surface; research into anaerobic bacterial activity has yet to be undertaken. The Board considers, after investigation, that there is no reason to believe that beetles cause decay in stonework; they use the already decayed stone merely as a home, not as a nidus.

Cement and concrete have claimed the Board's attention, and it is shown that the rapid-hardening Portland and high alumina cements are far more impermeable than the ordinary Portland cement. It is shown, too, why the cracking in the cement should be prevented; for if water cannot penetrate the material, then soluble salts cannot be washed out, nor can the steel embedded in reinforced concrete be attacked.

The Board expresses its belief that the deleterious action of frost is not so noticeable in Great Britain as it may be elsewhere. A series of freezing tests upon stone, brick, and tiles indicated general agreement with those of Kreüger in Sweden, where, however, frost is often very disintegrative in its action.

The behaviour of stone preservatives in a town atmosphere is being tested with a series of stone piers, treated and untreated, some with 'dished' tops, others with weathered tops; they are set upon the roof of a Government building in London. Also an illuminating set of experiments has been conducted upon the relation between the wet and dry strengths of bricks and stones.

Most of the Board's work is carried out at its station at Watford, but some investigations are undertaken elsewhere, including the National Physical Laboratory, where an interesting test is being conducted regarding vibration in buildings and fatigue in materials, and also the effect of wind pressure on roofs. The subject of wind pressure upon bridges is also being investigated.

Table 4 is illuminating regarding the diminution of tensile strength which so frequently takes place in neat cement with increasing age; whereas the compressive strengths, shown in Table 5, indicate fairly steady increase. Incidentally, it may be remarked that, later on in the Report, there is some confusion in numbering the tables.

A very valuable branch of research deals with acoustics, hitherto so largely a matter of empiricism in practice. Architects and engineers may now, with some assurance of satisfaction, seek the advice of the Board in this respect; a notable case in point is the series of acoustical experiments undertaken for the Government of India for the new buildings at Delhi.

Limits of space preclude adequate justice being done here to the many or to any of the activities of the Board. We must rest content with a mere brief schedule of such matters as condensation, waterproofing, repairs to old painted ceilings, etc.; the use of wood-cements, wall boards, plaster substitutes, and asphalte; investigation into dry rot, etc. The survey is all too brief regarding an undertaking of which the ramifications are numerous and the labour is indefatigable.

PERCY L. MARKS.

## Plankton Migrations.

DR. KENZO KIKUCHI, in a paper entitled "Notes on the Diurnal Migration of Plankton in Kizaki Lake" (*Journal of the College of Agriculture*, Imperial University of Tokyo, vol. 9, No. 3, Aug. 1927), recounts some interesting results arrived at by studying certain species in the plankton of Kizaki Lake in the Nagano Prefecture. The pump method was employed, about fifty litres of water being pumped from different depths at periodic intervals and strained through a plankton net. The number of each species was then counted and recorded. These included Cladocera, rotifers, rhizopods, and dinoflagellates, the Cladocera and copepods being specially studied. The lake lies at an altitude of 764 metres, the greatest length being three kilometres, the greatest breadth one kilometre. It is bordered by mountains and plains, and its greatest depth is 29 metres. The temperature ranges in August from 6°·2 near the bottom to 26°·6 at the surface, and in December from 5°·6 to 8°·2 C.

The diurnal migration was found usually to be most distinct in those species living at depths less than 10 metres. Thus *Polyphemus pediculus* and *Bosminopris deitersi* occur at maximum at a depth of 2 metres in the daytime and tend to come nearer the surface at sunrise and sunset, migrating downwards during the day and night. Their maximum near the surface is reached before midnight, after which there is a slight tendency to move downwards. *Daphnia longispina*, living at about 10 to 15 metres during the day, shows no tendency to migrate upwards in the summer, but may move downwards at night. In December, however, when it is spread out from the surface to near the bottom, it shows a slight movement upwards at night, the temperature in the upper layers being lower at that time.

Some interesting observations are made on the various stages from nauplius to adult of the copepod *Diaptomus denticornis*, which migrates upwards at night to attain its maximum at the surface before midnight. In August it was found that the younger the forms the nearer they are to the surface during the day and also the earlier do they reach the surface at night, whilst in the morning they leave the surface later than the older stages. Thus the young stages stay for a longer period near the surface than the older stages. In December there was no diurnal movement in the young forms which had a vertical range from the surface to 10 metres, although the adults still migrated towards the surface at night.

The dinoflagellate *Ceratium hirundinella* was found to range from 2 to 10 metres and to be especially abundant at 5 metres. It moves upwards at night and reaches a maximum at the surface shortly before sunrise.

Most of these migrations show better in August, the number of specimens falling considerably in December.

## University and Educational Intelligence.

CAMBRIDGE.—Dr. L. Brecher, of Vienna, has been elected to the Yarrow research fellowship in science at Girton College.

Smith's Prizes have been awarded to W. L. Edge, Trinity College, for an essay on "Ruled Surfaces of the Fourth, Fifth and Sixth Orders," and to A. H. Wilson, Emmanuel College, for an essay on "The Two-Centre Problem in Wave Mechanics." Rayleigh Prizes have been awarded to J. A. Gaunt, Trinity College, for an essay on "The Foundations of the Debye-Hückel Ionisation Theory with Application to Gases," and to W. H. M'Crea, Trinity College, for an essay on "The Quantum Theory and the Specific Heats of Gases." The essays of H. P. Mulholland, Queen's College, on "Theorems on Power Series and Dirichlet Series," and of L. Roth, Clare College, on "Discriminant Varieties," are mentioned as being also of distinction.

Dr. Roughton's lectureship in the Department of Physiology has been entitled the lectureship in physico-chemical aspects of physiology.

The Council has reported to the University in favour of accepting for five years from the Committee of the Privy Council for Scientific and Industrial Research an increased offer of £2500 per annum for the maintenance of the magnetic research work now being carried on at the Cavendish Laboratory by Dr. Kapitza, Trinity College. The grant is to be administered by a committee consisting of the Cavendish professor, the University treasurer, Prof. C. T. R. Wilson, and a member appointed by the Committee of the Privy Council.

Further details of the will of the late J. E. Bles, already referred to in these columns, have now been published. The amount of the bequest, which is subject to the life interest of his widow, is likely to be above £30,000, in addition to instruments, books, and fittings and contents of Mr. Bles's private laboratory. The first object of the bequest is the foundation of a Charles Darwin professorship of animal embryology, to be studied and taught from a purely scientific aspect, as distinct from an economic, technical, or medical aspect. If when the money becomes available the University already possesses such a chair, properly endowed, the subject of the new chair shall be bio-physics, the application of physics to a study of living plants and animals. After every twenty-five years a consultative board is to decide on the subsequent application of the trust fund, provided that the income of the fund is devoted to the promotion of a branch of biology as a pure science and that none is devoted to the purposes of economic, technical, or medical biology.

DUBLIN.—The Senate of the University has approved the conferment, on the recommendation of the Board of Trinity College, of the honorary degree of Sc.D. on Dr. G. L. Streeter, Director of the Carnegie Institution of Washington, Baltimore, Maryland, and Prof. A. S. Eddington, Plumian professor of astronomy and experimental philosophy in the University of Cambridge.

LONDON.—Keddey Fletcher-Warr Studentships, each of the value of £200 a year for three years, have been awarded to Dr. G. F. J. Temple, for research on the application in integral equations to the study of vibrations and stability and to other problems of mechanics and mathematical physics, and to Mr. C. P. Snow, for the study of molecular spectra with special reference to molecular structure.

OXFORD.—A proposal has been started for the establishment of a Common Room or Club for the use of men who are members of the research or teaching staff of the Museum departments and similar institutions. The need for such a scheme is especially felt in the case of those workers who do not enjoy the usual privileges of fellows of Colleges. If sufficient support is forthcoming, it is intended to call a meeting of those concerned in order to elect a committee for the consideration of details.

The School of Geography and the Committee for Anthropology have published their respective programmes for the ensuing term. These include lectures and instruction on land forms of western Europe; chronological sequence in the Pleistocene period; methods of physical anthropology; human hybridisation; man and the Pleistocene epoch; primitive language in its relation to thought.

---

THE annual Congress of the National Union of Students, to be held at Oxford at the end of March, will be opened by Sir Michael Sadler, Master of University College, Oxford, with an address on "The Future of the Universities." Other speakers on the main theme of the Congress, "Quo Vadis?" will include Sir Oliver Lodge and Prof. Burstall, of the University of Birmingham. A discussion on "University Problems" will be opened by Prof. Patrick Geddes, of Montpellier. Mr. John Galsworthy has consented to speak on "Man and Beast" at a meeting of the University of London Animal Welfare Society to be held during the Congress.

As a result of a conference recently convened by the London School of Hygiene and Tropical Medicine, which was attended by representatives of the Colonial Office, the India Office, the Ministry of Agriculture, the Department of Overseas Trade, and many important business organisations with interests in the tropics, it has been decided to make arrangements at the School for courses of instruction in hygiene for men and women—especially employees of business firms and official bodies—proceeding to the tropics. Inquiries regarding the courses should be addressed to the Secretary, London School of Hygiene and Tropical Medicine, Malet Street, London, W.C.1.

SHORTLY after the death, on April 4 last, of Prof. D. A. Gilchrist, a fund was opened to establish a memorial commemorating his work while professor of agriculture at Armstrong College, Newcastle-on-Tyne. A sum of about £480 is now available for this purpose, and it is proposed to found prizes, one at the Newton Rigg Farm School and others at the School of Agriculture at Armstrong College. The latter will be available until the death of Mrs. Gilchrist, when a sum of £3000 comes to the College for two scholarships under Prof. Gilchrist's will; the memorial prizes will then cease, and the money be devoted to support a research exhibition tenable at the College.

THE Air Ministry announces that a number of openings are available for young men to be trained as pilots in the Air Force Reserve. Up to sixty candidates will be accepted. Applicants must be of good education and physique, but need not have had any previous flying experience. They must be more than eighteen and less than twenty-five years of age. Selected candidates, after passing an examination by a medical board, are nominated to commissions in the Reserve as pilot officers on probation. When undergoing training an officer receives, generally speaking, the same pay and allowances as an officer of the same rank on the active list. Further details can be obtained from the Secretary (S. 7. c.), Air Ministry, Adastral House, Kingsway, London, W.C.2.

## Calendar of Customs and Festivals.

**March 25.**

FIFTH SUNDAY AFTER LENT, the ancient Passion Sunday, also known as Care Sunday. The word "Care" here refers to a custom of the north of England and Scotland of giving away and eating grey peas which have been fried in butter after being soaked overnight. These are called "carlings." The Sunday on which they were eaten at an entertainment was also called "Carle" Sunday. This custom has no obvious connexion with any explanation of "Care" Sunday suggested by ecclesiastical writers. It is not unreasonable to conclude that the name of an older custom has been adapted to a Church festival. "Carle," it is suggested, is related to "ceorl," a country fellow or labourer, which would make it a rural festival. The "carling groat" is a Yorkshire custom that every labourer should repair to the village alehouse to have a drink of ale free. Anyone who did not comply would succeed in none of his undertakings in the coming year. Another name for the day found in the Isle of Ely, was "Whirlin Sunday," when each family made "Whirlin Cakes." The day is therefore clearly linked up with some form of rejoicing. In some of the observances of "Carrying out the Death," cited by Frazer in "The Golden Bough," peas are specially mentioned as part of the feast which takes place after the procession. Brand, who refers to the dole of soft beans mentioned in the Roman Calendar as given away at funerals, and the use of peas and beans in the Parentalia, the Roman festival connected with the souls of the dead, also quotes Plutarch as saying that pulse was of the highest efficacy for invoking the Manes.

LADY DAY. THE ANNUNCIATION OF ST. MARY.—A festival which was always carefully observed in England. The Synod of Worcester, A.D. 1240, forbade all servile work on this day. An exception was afterwards made in favour of agriculture. If it fell in Lent it was postponed, as was customary; but the church of Notre Dame de Puy had the privilege of making it override Good Friday when it occurred on that day, and great indulgences took place in the church.

It is not surprising that a date of such importance in Christian belief should have appealed to the minds of the early Christians as a time which by its very sanctity would be the necessary occasion of other events of importance in sacred history. It was also the date of the Crucifixion; and in a set of ancient verses it is noted as a day on which many miraculous events took place: Adam was created; Abel, the first martyr and the first man to die, was killed; Melchisedek made his offering; Isaac was offered up; John the Baptist was beheaded; the penitent thief was accepted by Christ, and so forth. Martyrologics add the crossing of the Red Sea and the wiping of the face of Christ by St. Veronica. It will be remembered that the features of the Christ were imprinted on the cloth with which this was done.

The idea which underlies the Annunciation is one which has been familiar to students of primitive thought since the researches of Spencer and Gillen among the Arunta of Central Australia. It is now known that these tribes are not alone among primitive peoples in failing to appreciate the physiological facts of paternity. Among the Arunta it is believed that conception takes place solely by the entry of a spirit into the body of the future mother. It is from this idea that beliefs in reincarnation arise, as can be shown by a comparison of the various forms which they take. Among certain South African tribes, for example, even though they have advanced beyond the more primitive ideas of the Arunta so far as the physiological facts go, it is nevertheless believed that the spirit of an ancestor enters the body of the mother to animate her child, and usually it is known with certainty which of them is thus reincarnated.

ST. SIMON, boy martyr, A.D. 1475: ST. WILLIAM, boy martyr, A.D. 1144—two of a number of child murders for which the Jews were held responsible.

ST. SIMON, aged 29 months, was killed on Tuesday in Holy Week at Trent: ST. WILLIAM at Norwich, at the age of 7 years. The point of the accusation against the Jews was that the abduction always took place in Holy Week, the alleged intention being to crucify the child in simulation of the crucifixion of Christ. The first mention of the crucifixion of a boy by the Jews is in the Church History written by Socrates, who states that it took place about A.D. 414 at a place called Immestar in Syria. In England there were a number of cases—one of a child in 1160; a boy, Robert, at Bury St. Edmunds in 1181; and Hugh of Lincoln, whose fate is celebrated in a popular ballad, in 1255. In 1240 a Christian boy at Norwich was circumcised, and was about to be crucified when rescued. Further cases in Germany, France, Bohemia, and Russia are numerous down to modern times, though not all were boys, girls sometimes being murdered. An alleged case in Russia, just before the War, attracted widespread attention.

In addition to the charge of murder by crucifixion, it was sometimes alleged that the motive was to obtain blood for ritual uses at the Passover. In the case of St. Simon, a bowl of blood was discovered in a cupboard in the Synagogue, and it is usually alleged that the death of the victim is effected in accordance with Jewish ritual. It may be noted that the same accusation was brought against the Christians in the early days of the Church by Roman writers. There is no doubt that the medieval populace was influenced against the Jews by primitive superstition about the efficacy of blood and its use in ritual.

**March 26.**

ST. LUDGER, BISHOP OF MUNSTER, A.D. 1809.—A native of Friesland whose legend embodies a record of pagan birth customs. When Liafburg, his mother, was born, her grandmother on the father's side, still a pagan, was enraged that her daughter-in-law had borne no sons. She sent officers to take the babe from its mother's arms before she had had an opportunity to feed it, for it was the custom to kill a child before it had tasted earthly food. It was snatched from the arms of the officer by a servant, who hurriedly placed some honey in the child's mouth, which it swallowed. It could not then be killed.

**March 30.**

ST. REGULUS, BISHOP OF ARLES AND SENLIS, 4th Century.—An incident in his life illustrates the supersession of pagan by Christian shrines. When passing through Louvres, near Paris, he overthrew an idol of Mercury, and built a chapel dedicated to the Virgin.

ST. JOHN CLIMACUS, A.D. 606.—An early reference to the Wandering Jew is contained in the record that when St. John was entertaining 600 pilgrims on Sinai, a stranger habited in linen, after the ancient Jewish fashion, appeared among the attendants and vanished after the feast was over. St. John concluded it must have been Moses, who had revisited Sinai for a brief moment. Numerous Hebrew legends of a similar character call the mysterious stranger Elijah. Among the Arabs a similar undying man is known as El Khoudir, friend and instructor of Moses.

## Societies and Academies.

LONDON.

**Royal Society**, Mar. 15.—**J. D. Cockcroft**: The design of coils for the production of strong magnetic fields. One of the most difficult problems in the production of magnetic fields of the order of half a million gauss is to construct a satisfactory coil. Even in the method developed by Kapitza, in which the field is only produced for a fraction of a second, the heating of the coil is a serious limitation, whilst the electromagnetic forces on the coil give rise to stresses in the copper of the order of 7000 kgm./sq. cm. beyond the elastic limit of ordinary copper. This paper develops methods for selecting dimensions of the coil which will produce the greatest field for given power input, and for fixed allowable temperature rise.

**D. Jack**: The band spectrum of water vapour. The band λ3428 has been analysed from new measurements. For this band the emitter has the same initial state as for band 3064, and same final state as for bands 3122 and 2875. Consequently, band 3428 corresponds to transition $0 \rightarrow 1$ of vibrational quantum number. The initial and final values of the moments of inertia for the vibrationless state are, $I_0' = 1 \cdot 633$, and $I_0'' = 1 \cdot 498$, in units $10^{-40}$ gm. cm.$^2$. Corresponding nuclear separations of an OH ion are, $r_0' = 1 \cdot 022 \times 10^{-8}$ cm., and $r_0'' = 0 \cdot 979 \times 10^{-8}$ cm.

**R. d'E. Atkinson**: Statistical experiments on the motion of electrons in gases. Various papers of Prof. Townsend and his assistants claiming results which are not reconcilable with the quantum theory are discussed. In particular, the presence of metastable states in the term-systems of the gases undermines, at two different points, a theory which has implicitly assumed their non-existence. The experimental methods employed are statistical, and introduce many unknown quantities, but within wide limits of obtainable accuracy no disagreement is found with the quantum theory.

**Lord Rayleigh**: The light of the night sky: its intensity variations when analysed by colour filter (3). The intensity of the light of the sky at night has been observed by collaborating workers at a number of stations scattered over the world. Colour filters were used to separate as nearly as may be the region of the green auroral from the red and blue regions of the spectrum on either side. The broad result is that the intensity in each component has the same general values and range of intensities (four or fivefold) previously found for England. Much of the variation is irregular, and has not been found to be correlated at the different stations. Five years' observation in England indicates a definite annual periodicity, which survives the process of averaging the same month (for example, February) for each year; amplitude of variation corresponds to intensity ratio of 1·6; maximum is in October. The scanty available evidence suggests a similar variation in the southern hemisphere, with opposite phase, maximum in April.

**W. Wilson**: Relativity and wave mechanics. The equations of motion of a charged particle can be derived from those of an uncharged (which represent a geodesic in space-time continuum) by substituting for the mechanical momentum an extended momentum. This suggests that we regard the world-line of the charged particle as a geodesic in 5-dimensional continuum. With this modified relativity theory as basis, a generalised form of Schrödinger's equation for a single particle is deduced.

**A. E. H. Love**: The bending of a centrally loaded plate supported at two opposite edges. The question is of some importance in connexion with the experimental determination of elastic constants, inasmuch as it has been proposed to determine such constants, especially of crystals, by measuring, by an interferential method, the central deflection of a rectangular plate, supported at two opposite edges, and bent by concentrated pressure applied at the centre of one of its faces. The object of the paper is to obtain such a formula in the case where the material is isotropic. The problem, a purely mathematical one, is solved completely, and calculated numerical values of central deflection are tabulated for various values of the ratio breadth to length, and for two values of Poisson's ratio for the material.

**M. Nottage**: Studies in adhesion (3). The adhesion–molecular composition curves of three sets of binary mixtures have been determined and compared with the corresponding melting-point–molecular composition curves. Transition points occur at corresponding points on the two sets of curves and are generally points of definite molecular composition.

**Optical Society**, Feb. 16.—**W. M. Hampton**: An investigation into the beam from a standard lighthouse lens. The distribution of light from a third order Fresnel panel was measured, using two different light sources, a standard petroleum vapour burner and a 3 kw. lighthouse cruciform lamp. A complete theoretical discussion of the factors affecting beam candle-powers is worked out and tables are provided for the calculation of the beam candle-power from any apparatus using any light source.—**R. Kingslake**: The 'absolute' Hartmann test. According to the ordinary methods of performing the Hartmann test, the assumption is made that all the rays cross the optical axis. As a matter of fact, this is very far from the truth, especially in the case of the large astronomical objectives and mirrors to which the Hartmann test is most generally applied. In the present paper a brief description is given of a modified test in which each 'ray' is treated on its own merits, and its absolute deviation from the ideal path is determined in both magnitude and direction. This method incidentally leads at once to the well-known criterion $T$ of Hartmann, which is now generally adopted in the comparison of large telescopes.—**R. S. Clay** and **Sir Richard Paget**: A portable stereoscopic kaleidoscope. No new optical principles are made use of in this instrument. It differs from the ordinary kaleidoscope mainly in the fact that the mirrors are of sufficient size to enable objects to be viewed by both eyes and thus to see them in stereoscopic relief. The mirrors are front silvered and are mounted at an angle of 30°, one mirror being vertical. The objects, consisting of coloured silks, artificial flowers, etc., are arranged on a black velvet background on a drum, which is rotated at the open end of the mirrors, and lighted from one side by an incandescent lamp. The stereoscopic relief greatly adds to the charm of the resulting pictures.

**Geological Society**, Feb. 22.—**C. A. Matley**: The pre-Cambrian complex and associated rocks of south-western Lleyn (Carnarvonshire). With a chapter on the petrology of the complex, by **E. Greenly**. The pre-Cambrian complex of Lleyn occupies the coastal strip from Nevin to Aberdaron and Bardsey Island, and is a detached 'region' (the Mainland region) of the Mona Complex of Anglesey. It is bounded on the east by a great thrust which has driven it over Ordovician strata and the Sarn granite. Its members are now correlated with those of Anglesey. The gneisses, several members of the bedded succession, the plutonic instrusions, and the 'Penmynydd zone of metamosphism' are all represented. The Holyhead group is absent. The gneisses are always found near

the boundary-thrust. Both their basic and their acid members are almost identical with those of Anglesey. Their crystallisation and foliation are older than the deposition of the bedded succession. Most of the region is occupied by the Gwna Group. Resting on the Gwna beds are some 300 feet of quartz-albite dust-rocks (Gwyddel beds). They may be a special facies of the Skerries group of Anglesey, with a representative of the Tyfry beds at their base. The gabbros are akin to those of Anglesey, and are regarded as plutonic intrusions belonging to the complex. The tectonics and foliation of the complex resemble in almost every detail those of the complex in Anglesey. Many basic dykes are exposed in the complex, of which the great majority are Palæozoic (post-Llandovery and probably post-Silurian), but earlier than the great thrusting movements after the close of Silurian time. Three Tertiary dykes have been found. The boundary-thrust is certainly a great rupture, which shows no sign of dying out at either end of the exposed part of the complex. The extent of its overdrive cannot be determined, but it should probably be measured in terms of miles, and may have been sufficient to sever the whole plexus of Palæozoic dykes in the complex from their roots.

**Physical Society**, Feb. 24.—**W. H. J. Childs**: Some methods of estimating the intensities of spectral lines. A critical account is given of methods of spectral photometry applied to the special case of the band spectrum of helium. With the method finally adopted, the line spectrum is photographed in the usual way, and the density of the line photographs is measured. For this purpose the plate is calibrated by illuminating the slit of the spectroscope in a special manner by a tungsten filament lamp, so that upon development the plate exhibits a number of images of continuous spectra of progressively increasing density. From these images may be ascertained (*a*) the relation between intensity of light and density of image, and (*b*) the relation between plate sensitivity and wavelength of the incident light. Density measurements are obtained by a simply constructed selenium cell microphotometer, with which the density contour of each line can be investigated.—**P. W. Burbidge** and **N. S. Alexander**: Electrical methods of hygrometry. Two methods are considered, depending on (1) the change in resistance of organic materials (cotton-wool and human hair) on exposure to water vapour; (2) the change in mobility of ions due to water vapour. In the first case the logarithm of resistance is proportional to the humidity, while in the second the effect produced is too small to permit accurate measurement. Neither method is suitable for general use.

**Linnean Society**, Mar. 1.—**A. M. Smith**: The Algæ of a bog: five years' observations. Observations were taken at approximately monthly intervals of the algæ of a small Sphagnum bog near Bradford between March 1923 and August 1927. Observations of the temperature and of the hydrogen ion concentration of the water were also made. Two main algæ associations were clearly distinguished: (1) the association of the Sphagnum pools and (2) the association of the mud pools and deeper ditches. After the drainage of the bog in 1923 the Sphagnum association decreased, and the long, slow choking of the bog channels which followed later was accompanied by the gradual extension of this characteristic association. The total quantity of alga in the bog varied with the quantity of water in the bog, and showed little evidence of any check due to low temperatures. The quantity of certain species, however, *e.g.* a sterile species of Mougeotia, showed signs of diminution due to low winter temperatures.—**C. Crossland**: Coral-reefs of Tahiti, Moorea, and Rarotonga. The reefs of Tahiti, in spite of their covering of coral and Lithothamnion, are not extending seaward. The sunk reefs are the eroded remnants of a surface barrier. The lagoons have been excavated in an originally continuous reef, and subsidence is not necessary for the formation of barrier reefs. The adjacent island of Moorea has tilted and drowned its southern coast, with no effect on the form of the reefs. Lagoons and passes probably had their first origins in earth-movements, radial and circumferential cracks opening in the reefs. In Moorea the reduced amount of alluvium brought down allows a more vigorous growth of coral in the lagoons, and the maritime flat is largely composed of coral and is not being washed away. Flats of elevated coral occur in Moorea, which afford another proof that there has been no recent seaward extension of the reef. Rarotonga is usually described as having a fringing reef only, but comparison with Moorea suggests that it once had a lagoon which is now filled in.—**E. Handschin**: Collembola from Mexico.—**W. O. Howarth**: The genus Festuca in New Zealand.

**Institute of Metals** (Annual General Meeting),[1] Mar. 8.—**G. L. Bailly**: The influence of dissolved gases on the soundness of 70 : 30 brass ingots. Treating the molten metal with nitrogen gave an ingot practically free from unsoundness due to gas. Comparative tests were made on samples of 70 : 30 brass treated with nitrogen, hydrogen, and sulphur dioxide, poured in a series of moulds giving different speeds of solidification, and again no evidence was obtained of unsoundness caused by gas evolution during solidification. It is concluded that if appreciable amounts of gases are soluble in liquid brass, the solubility in the solid state is sufficiently high to retain the gas in solution. The probability is, however, that the high vapour pressure of zinc in molten brass precludes the solution of gas by the alloy.—**A. L. Norbury**: The effect of quenching and tempering on the mechanical properties of standard silver. Standard silver (92·5 per cent. silver, 7·5 per cent. copper) as ordinarily annealed contains a considerable amount of copper (in which some silver is dissolved), distributed in the form of small particles throughout the silver solid solution matrix. By suitable heating (*e.g.* about half an hour at 770° C.) and quenching, these copper particles may be dissolved and retained in supersaturated solid solution in the silver. The alloy in the quenched condition is about 30 per cent. softer and 20 to 30 per cent. more ductile than it is in the ordinarily annealed condition. On suitable tempering the quenched alloy (*e.g.* about half an hour at 300° C.) its Brinell hardness increases by about 300 per cent., and its tensile strength by about 50 per cent., and its ductility falls by about 50 per cent., due to the decomposition of the supersaturated solid solution of copper in silver. The hardening on tempering is accompanied by a decrease in volume and is uniform. The alloy is more resistant to oxidation and tarnishing when in the quenched and tempered conditions than it is when in the annealed condition.—**J. Newton Friend** and **W. E. Thorneycroft**: An example of Roman copper 'soldering' and welding from Uriconium. A Roman iron ferrule from Uriconium appears to have been made by welding two small pieces of iron into a strip, bending it over, and joining the two ends with copper. This appears to be the first example of copper 'soldering' of Roman origin to be examined.—**J. Newton Friend**: The relative corrodi-

[1] Continued from p. 442.

bilities of ferrous and non-ferrous metals and alloys. Part I. The results of four years' exposure in the Bristol Channel. The metals examined included tin, lead, nickel, zinc, aluminium, and various coppers and brasses. Nickel, tin, and lead resisted corrosion remarkably well. Of the brasses, screw metal (1·37 per cent. lead) made the best showing. This was closely followed by the nickel-copper (1·75 per cent. nickel). A galvanised iron bar lost less in weight than either the iron or the zinc separately. The aluminium bar was very deeply pitted.—**T. E. Allibone** and **C. Sykes**: The alloys of zirconium. The structures of partial series of the alloy systems copper-zirconium to 35 per cent. zirconium, nickel-zirconium to 55 per cent. zirconium, and iron-zirconium to 30 per cent. zirconium, are given. In each case the system is eutectiferous, and intermetallic compounds are formed. In the copper-zirconium system the compound $Cu_3Zr$ is found; in the nickel-zirconium system two compounds, probably $Ni_3Zr$ and $Ni_4Zr$ are found in the range of alloys investigated. The solid solubility of zirconium in the pure metals copper, nickel, and iron is in each case very small (less than 0·5 per cent.)—**Tsutomu Matsuda**: On the quenching and tempering of brass, bronze, and aluminium-bronze. These copper alloys containing a proper amount of the second metals may be hardened by suitable heat-treatment. The nature of the temper-hardening was investigated by means of microscopic and dilatometric tests and electrical resistance measurements, and it was concluded that the hardening is accompanied by the separation of $\alpha$ from $\beta$ or $\gamma$, or the decomposition of $\beta$ or $\gamma$ into eutectoid, or both of these changes, and probably due to the straining of the space lattice produced by these structural changes.

DUBLIN.

**Royal Irish Academy**, Feb. 13.—**R. Ll. Praeger**: On some doubtful species of the African section of the Sempervivum group.—**R. Southern**: Salmon of the river Shannon, 1924, 1925, and 1926. This report deals with results obtained from the examination of scales from rod-caught salmon taken at Killaloe, on the river Shannon, during 1924, 1925, and 1926. The proportion of one-year-old smolts is 40·4 per cent., of two-year-old smolts 58·8 per cent., and of three-year-old smolts 0·8 per cent. The average length of the one-year-old smolts is 9·7 cm., of the two-year-old smolts 14·5 cm. The most important group in the 1924 catch was that of the large spring fish, constituting 52·4 per cent. of the catch in numbers; whilst in the 1925 and 1926 catches the small spring fish predominated to the extent of 46·2 per cent. and 51·5 per cent. respectively. The proportion of fish which had previously spawned was 5·5 per cent., 11 per cent., and 4·1 per cent. in the three seasons. Spring fish comprise 80-90 per cent. of the total catch; large spring fish average 26 lb., small spring fish 13 lb. The high average weight of the Shannon salmon is due to the high coefficient of condition (ratio of weight to length) and to the high proportion of the old fish in the catch.—**Miss A. L. Massy**: The Cephalopoda of the Irish coast. Descriptions and particulars were given of the occurrence of all the species of Cephalopoda which have been found in Irish waters. They comprise 31 species and a larval form (Rynchoteuthion).

EDINBURGH.

**Royal Society**, Feb. 6.—**W. H. Lang**: The flora of the Old Red Sandstone of Scotland: a general survey. The paper dealt with the following types of plant-remains that can be authenticated by specimens. It is evident that the main horizons of the Old Red Sandstone of Scotland have distinct assemblages of fossil plants. Upper Old Red Sandstone—*Archæopteris hibernica* (Berwickshire), ribbed stems (corduroy plant), woody incrustations, and specimens suggestive of Cyclostigma and Archæopteris (Shetland). Middle Old Red Sandstone—*Psygmophyllum Brownii*, Rhacophyllum-like fossil, ribbed stems, black woody stems, *Palæopitys milleri*, *Cauloopteris Peachii*, Hostimella sp. (*Psilophyton robustius*, Kidston non Dawson), *Milleria* (*Psilophyton*) *Thomsoni*, *Milleria pinnata*, *Hostimella globosa*, *Hostimella racemosa*, *Pseudosporochnus Krejčii*, *Protolepidodendron Karlsteinii*, *Thursophyton Milleri*, *Hicklingia edwardi*, fructification (Hugh Miller's 'fern'), sporetypes. Also from the Rhynie Outlier—*Rhynia Gwynne-Vaughani*, *R. major*, *Hornea Lignieri*, *Asteroxylon Mackiei*, Pachytheca, Nematophyton, casts of large trunks. Lower Old Red Sandstone—*Arthrostigma gracile*, *Psilophyton princeps*, Pachytheca (Strathmore Sandstones); Nematophyton, Pachytheca, *Parka decipiens*, *Zosterophyllum myretonianum* (Carmyllie Beds).—**Sir Thomas Muir**: The theory of Jacobians from 1885 to 1919.—**D. M. Y. Sommerville**: An analysis of preferential voting.

**Royal Physical Society**, Feb. 27.—**J. S. S. Blyth**: Some observations on the relation of gonadic structure to comb growth in the fowl. Changes in the histological appearance of the gonad coincident with the springing of the comb in the juvenile male of the domestic fowl are described. The increased comb growth and vascularity occurred at a time when the luteal tissue had begun to degenerate rapidly and the production of intra-tubular cells in the prophase of the first meiotic division was approaching its maximum. The latter appears to be the most probable source of the stimulus, but it cannot yet be decided whether the influence exerted on the comb by the gonad is inherent in the cells at this particular stage of maturation or whether it arises from the general increase in cell activity at this time.—**I. J. F. Williamson**: Furunculosis in the Salmonidæ. In recent years the salmon and trout in some British rivers have been attacked by an epizootic disease, known as Furunculosis; this disease has occurred on the Continent since the end of last century, and has also been recorded in America. The cause of the disease is a micro-organism, *Bacillus salmonicida*, which produces a general infection and is found in the blood of diseased fish. The bacillus does not produce disease in warm-blooded animals, but the flesh of affected fish is discoloured and softened and unfit for consumption.

SHEFFIELD.

**Society of Glass Technology**, Feb. 18.—**D. Starkie** and **W. E. S. Turner**: Note on the ultra-violet ray transmission of colourless bottle glass. Each of eight commercial soda-lime-silica glasses showed a maximum transmission in the green or yellow regions, the percentage of light transmitted then falling off gradually in the violet and near ultra-violet regions until a wave-length of about 3300 A. was reached, when the percentage of light fell off very rapidly to the limit of transmission. The glass containing 0·05 per cent. $Fe_2O_3$ transmitted down as far as wave-length 2960 A. Four others, each containing 0·07 per cent. $Fe_2O_3$, transmitted down to 2995 A., whilst the pale green glass with 0·18 per cent. $Fe_2O_3$ had its limit at wave-length 3175 A. All the glasses, with the exception of the green one, transmitted farther down into the ultra-violet than the average window glass, the limit for which is at about wave-length 3100 A. As further illustrating the relation between transmission in the ultra-violet and iron oxide content, some pure glasses, of approximate composition 75 per cent. $SiO_2$,

10 per cent. CaO, 15 per cent. $Na_2O$, containing small accounts of iron oxide, were tested. The iron oxide content and the limit of transmission were: 0·005 per cent. $Fe_2O_3$, transmission to 2600 A.; 0·008 per cent. $Fe_2O_3$, transmission to 2660 A.; 0·015 per cent. $Fe_2O_3$, transmission to 2740 A.—**W. Singleton** and **R. C. Chirnside**: The analysis of opal glasses. The constituents commonly occurring in commercial fluoride glasses were dealt with briefly, but more detailed consideration was given to the determination of boron, zirconium, tin, zinc, and arsenic. Zirconium was determined as pyrophosphate, according to the method described by W. F. Hillebrand. Arsenic was determined after decomposition of the glass by means of hydrofluoric acid. The solution of the glass was neutralised by ammonia, made acid with hydrochloric acid, then the arsenic was precipitated as sulphide. This was filtered, dissolved in caustic potash solution, and the arsenic finally determined volumetrically by titration against standard iodine solution. Fluorine was determined as calcium fluoride in the usual way.

## PARIS.

**Academy of Sciences**, Feb. 13.—**Laubeuf**: Safety apparatus in submarines. Detailed discussion and criticism of various forms of life-saving apparatus applicable to a submarine in cases of accident.—**d'Arsonval, Bordas**, and **Besson**: The climatological observatory of Mont-Revard. This observatory has been installed on one of the highest points of the Mont-Revard plateau (1522 metres), and is provided with maximum and minimum thermometers, temperature and humidity recorders, heliograph, rain gauge, anemometer and actinometer, readings being taken three times daily. The results of two years' observations are summarised.—**S. A. Janczewski**: Theorems of oscillation of regular homogeneous differential systems of the fourth order.—**J. Delsarte**: Functional linear transformations and non-Euclidean functional rotations.—**P. Fatou**: Certain systems of differential equations depending on a parameter.—**Maurice Janet**: A system of partial differential equations.—**L. Tumarkin**: The dimensional structure of closed ensembles.—**N. Bogoliouboff** and **N. Kryloff**: The method of finite differences for the approximate solution of the fundamental problems of mathematical physics.—**Frilley**: The spectrography of the $\gamma$-rays by crystalline diffraction.—**Francis Perrin** and **R. Delorme**: The measurement of the times of fluorescence of uranyl salts, solid and in solution. The luminescence of uranyl salts has all the characters of a simple fluorescence of long duration. The times measured are of the order of $1{\cdot}0\times10^{-4}$ to $6{\cdot}1\times10^{-4}$ sec.—**A. Piccard** and **E. Stahel**: The non-existence of the ether wind. A reply to some criticisms of Brylinski.—**P. Chevenard**: The electrical properties of ferro-nickels containing chromium. The allotropic transformation of iron-nickel alloys, rich in iron, is accompanied by an increase in the specific resistance on warming. The addition of chromium lowers the temperature of the allotropic transformation and the thermal hysteresis increases.—**Lucien Cavel**: Contribution to the study of activated sludge. Activated sludges lose their activity with increasing percentage of nitrogen: long aeration removes organic nitrogen and restores the activity. Activated sludges have not the same flexibility in use as bacterial beds, and are liable to be put out of action by changes in the composition of the sewage under purification.—**P. Carré**: The iodometric estimation of phosphoric acid, and the use of sodium bicarbonate in iodometry. In the presence of an excess of alkaline bicarbonate, the results are not exact, owing to the formation of iodate by the action of iodine on the bicarbonate.—**Paul Baud**: A method of manufacturing barium hydrate, starting with the carbonate. Barium carbonate and ferric oxide react at 1150°–1180° C., giving a product containing 56-58 per cent. BaO.—**R. Cornubert**: Orientation phenomena in α-methylcyclohexanone.—**D. Ivanoff**: The preparation of benzophenone by organo-magnesium compounds. The mechanism of the reaction between organo-magnesium compounds and their carbonated derivatives.—**C. and M. Schlumberger**: The discovery, near Hettenschlag, of a second salt dome in the plain of Alsace. This salt dome has been detected and its outline determined by an electrical method, based on measuring the mean electrical resistance of the soil on a thickness of the order of 100 metres.—**Daniel Chalonge**: Study of the ozone layer of the upper atmosphere during the night. The results, based on spectrometric data, show that the ozone layer is appreciably stronger during the night than during the day.—**H. Bellocq** and **Ch. Jacquet**: Magnetic measurements in the Basses-Pyrénées, Landes, and Gironde.—**Henri Labrouste**: Magnetic measurements in the north of France.—**Mlle. Eliane Basse**: Some Cretaceous fossil invertebrates from the south-west of Madagascar.—**Robert Lemesle**: Abnormal suberous formations in a Labiate (Hymenocrater).—**Mlle. M. L. Verrier**: The presence and structure of a retinal fovea in *Serranus cabrilla*.—**J. J. Thomasset**: Remarks on the canaliculæ of dental enamel.—**Charles Pérez**: The apparatus for attaching the abdomen to the thorax in decapods.—**F. Maignon** and **E. Knithakis**: The influence of watery diet on the urinary excretion of ketonic bodies in the dog.—**Léon Blum, P. Grabar**, and **Joseph Weill**: The influence of mineralisation on the osmotic pressure of the blood proteins.—**L. Ambard** and **F. Schmid**: Diuresis and osmotic pressure of the albumins.—**Louis Lewin**: An intoxicating substance, banisterine, extracted from *Banisteria Caapi*. The active principle has been obtained in crystals, of the composition $C_{13}H_{12}ON_2$. According to Merck, it is identical with harmine, extracted from *Peganum Harmola*, but its physiological effects are not identical with those of harmine. Banisterine may prove to have useful therapeutic applications.—**Ph. Joyet-Lavergne**: The oxido-reducing power of the chondriome.—**Lemoigne**: The formation of an orthodiphenol at the expense of glucides by certain soil bacteria.

## GENEVA.

**Society of Physics and Natural History**, Feb. 2.—**W. H. Schopfer**: Researches on biochemical sexual dimorphism. The author has made a study of carotine from *Mucor hiemalis*, which contains a material with crystalline structure. Its culture in a known nutritive medium (maltose and asparagine) shows that the most marked dimorphism takes place when the ratio of total carbon to organic nitrogen is a maximum.—**Sw. and Th. Posternak**: (1) Contribution to the study of the configuration of inositol. (2) A natural optically active inositotetraphosphoric ester. It results from this study that besides the hexaphosphate of inosite existing in all the seeds studied, the wheat embryo contains in preponderating quantity a lævorotatory tetraphosphate.—**L. Duparc** and **E. Molly**: (1) The presence of kenyite on the Abyssinian plateau. (2) Tokeite, a new Abyssinian rock. The authors have collected between Nekami and Addis-Abeka a rock very nearly identical with kenyite from Kenya, discovered by Gregory. They have given the name of tokeite to a rock of the basalt family, with 43·6 per cent. of silica: its texture is porphytic holocrystalline.—**Eug. Pittard**: A mummified head (*tsantsa*) of the Jibaros Indians. It represents one of the smallest described; its horizontal circumference is 200 mm.

## Official Publications Received.

BRITISH.

Journal of the Marine Biological Association of the United Kingdom. New Series, Vol. 15, No. 1, February. Pp. 364. (Plymouth.) 12*s.* 6*d.* net.

The Physical Society Proceedings. Vol. 40, Part 2, February 15. Pp. 37-70+3 plates. (London: The Fleetway Press, Ltd.) 7*s.* net.

The Junior Institution of Engineers. Journal and Record of Transactions. Vol. 38, Part 6, March. Pp. 261-316+x+iv. (London.) 2*s.*

Air Ministry. Aeronautical Research Committee: Reports and Memoranda. No. 1112 (Ae. 286): On the Influence of Supercharging on the Performance of Aeroplanes. By R. McKinnon Wood. (B.4. Engines 56, revd.—T. 2210, revd.) Pp. 14+5 plates. 9*d.* net. No. 1113 (E.26): Closed Vessel Explosions of Carbon Monoxide, Oxygen and Nitrogen Mixtures. By R. W. Fenning. Work performed for the Engineering Research Board of the Department of Scientific and Industrial Research. (I.C.E. 567.) Pp. 13+1 plate. 9*d.* net. (London: H.M. Stationery Office.)

Journal of the Chemical Society: containing Papers communicated to the Society. February. Pp. iv+253-528+x. (London: Gurney and Jackson.)

Journal of the Royal Statistical Society. New Series, Vol. 91, Part 1. Pp. 151+xii. (London.) 7*s.* 6*d.*

Ministry of Agriculture and Fisheries. The Practical Education of Women for Rural Life: being the Report of a Sub-Committee of the Inter-Departmental Committee of the Ministry of Agriculture and Fisheries and the Board of Education. Pp. 61. (London: H.M. Stationery Office.) 6*d.* net.

Quarterly Journal of the Royal Meteorological Society. Vol. 54, No. 225, January. Pp. 78. (London: Edward Stanford, Ltd.) 7*s.* 6*d.*

Agricultural Research Institute, Pusa. Bulletin No. 172: The Mechanical Analysis of Tropical Soils. By J. Charlton. Pp. 9. (Calcutta: Government of India Central Publication Branch.) 3 annas; 4*d.*

Memoirs of the Geological Survey of India. Palæontologia Indica. New Series, Vol. 9, Memoir No. 2: Revision of the Jurassic Cephalopod Fauna of Kachh, Part 2. By Dr. L. F. Spath. Pp. 73-161+plates 8-19. (Calcutta: Government of India Central Publication Branch.) 1.14 rupees; 13*s.* 3*d.*

Nigeria. Sixth Annual Bulletin of the Agricultural Department, 1st August 1927. Pp. 264. (Ibadan: Department of Agriculture.) 5*s.*

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 4: The Bionomics of *Smynthurus viridis* Linn., or the South Australian Lucerne Flea. By F. G. Holloway. Pp. 23. Pamphlet No. 5: Liver Fluke Disease in Australia; its Treatment and Prevention. By I. Clunies Ross. Pp. 23. (Melbourne: H. J. Green.)

Journal of the Indian Institute of Science. Vol. 10A, Part 9: Studies in Intensive Bacterial Oxidation. The Oxidation of Ammonia to Nitric Acid, Parts i-iv. By Gilbert J. Fowler, Y. N. Kotwal, Roland V. Norris, S. Ranganathan and M. B. Roy. Pp. 97-116. 1 rupee. Vol. 10A, Part 10: The Decomposition of Alkaline Earth Sulphates. By L. A. Bhatt and H. E. Watson. Pp. 117-129. 12 annas. (Bangalore.)

Indian Journal of Physics, Vol. 2, Part 2, and Proceedings of the Indian Association for the Cultivation of Science, Vol. 11, Part 2. Conducted by Prof. C. V. Raman. Pp. 135-266. (Calcutta.) 3 rupees; 4*s.*

University of Toronto Studies. Geological Series, No. 25: Albertosaurus arctunguis, a new Species of Therapodous Dinosaur from the Edmonton Formation of Alberta. By Prof. W. A. Parks. Pp. 42+1 plate. (Toronto.) 1 dollar.

Report of the Rugby School Natural History Society for the Year 1927. (Sixty-first Issue.) Pp. 45. (Rugby.)

University, Hyderabad. Publications of the Nizamiah Observatory. Astrographic Catalogue 1900-0, Hyderabad Section (Part 2), Dec. −20° to −24°, from Photographs taken and measured at the Nizamiah Observatory, Hyderabad, under the direction of T. P. Bhaskaran. Vol. 6: Measures of Rectangular Coordinates and Diameters of 81,821 Star-Imagesion Plates with Centres in Dec. −22°. Pp. xxxix+270. (Hyderabad.) 15 rupees; 20*s.* net.

Proceedings of the Society for Psychical Research. Appendix to Part 103, Vol. 36, January. Pp. v+577-633. (London: Francis Edwards, Ltd.) 2*s.* 6*d.*

Ministry of Agriculture and Fisheries: Board of Agriculture for Scotland. Report on Dr. Serge Voronoff's Experiments on the Improvement of Livestock. By Dr. F. H. A. Marshall, Dr. F. A. E. Crew, Dr. A. Walton and Wm. C. Miller. Pp. 24. (London: H.M. Stationery Office.) 9*d.* net.

Colonial Agricultural Service: Report of a Committee appointed by the Secretary of State for the Colonies. (Cmd. 3049.) Pp. 47. (London: H.M. Stationery Office.) 9*d.* net.

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 66, No. 375, March. Pp. 241-340+xxxii. (London: E. and F. N. Spon, Ltd.) 10*s.* 6*d.*

FOREIGN.

Department of Commerce: U.S. Coast and Geodetic Survey. Manual of First-Order Traverse. By Casper M. Durgin and Walter D. Sutcliffe. (Special Publication No. 137.) Pp. iv+133. (Washington, D.C.: Government Printing Office.) 30 cents.

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 37: Land-Grant Colleges, Year ended June 30, 1926. By Walter J. Greenleaf. Pp. vi+75. 15 cents. Bulletin, 1927, No. 38: Record of Current Educational Publications, comprising Publications received by the Bureau of Education during July-September 1927. Pp. ii+50. 10 cents. (Washington, D.C.: Government Printing Office.)

Researches of the Department of Terrestrial Magnetism. Vol. 6: Land Magnetic and Electric Observations, 1918–1926. Magnetic Results, 1921–1926, by H. W. Fisk; Magnetic, Atmospheric-Electric, and Auroral Results, Maud Expedition, 1918–1925, by H. U. Sverdrup. (Publication No. 175.) Pp. iv+524+13 plates. (Washington, D.C.: Carnegie Institution.)

A Photographic Atlas of Selected Regions of the Milky Way. By Prof. Edward Emerson Barnard. Edited by Edwin B. Frost and Mary R. Calvert. Part 1: Photographs and Descriptions. Pp. vi+134+53 plates. Part 2: Charts and Tables. Pp. iv+52+50 tables+50 charts. (Washington, D.C.: Carnegie Institution.)

State of Illinois. Department of Registration and Education: Division of the Natural History Survey. Bulletin, Vol. 17, Art. 1: Epidemic Diseases of Grain Crops in Illinois, 1922–1926. The Measurement of their Prevalence and Destructiveness, and an Interpretation of Weather Relations based on Wheat Leaf Rust Data. By L. R. Tehon. Pp. iii+96. Bulletin, Vol. 17, Art. 2: A Manual of Woodlot Management. By C. J. Telford. Pp. 97-104. Bulletin, Vol. 17, Art. 3: An Epidemic of Leeches on Fishes in Rock River. By David H. Thompson. Pp. 193-201. Bulletin, Vol. 17, Art. 4: The Plankton of Lake Michigan. By Samuel Eddy. Pp. 203-232. (Urbana, Ill.)

Smithsonian Institution: United States National Museum. Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1927. Pp. ix+221. (Washington, D.C.: Government Printing Office.) 25 cents.

Theophrastus: De Causis Plantarum. Book 1: Text, Critical Apparatus, Translation and Commentary. By Robert Ewing Dengler. A Thesis in Greek presented to the Faculty of the Graduate School of the University of Philadelphia in partial fulfilment of the Requirements for the Degree of Doctor of Philosophy. Pp. 143. (Philadelphia, Pa.: University of Philadelphia.)

Bulletin of the Experiment Station of the Hawaiian Sugar Planters' Association. Entomological Series, Bulletin No. 19: Studies in Tropical Wasps—their Hosts and Associates (with Descriptions of New Species). By Francis X. Williams. Pp. iv+179. Entomological Series, Bulletin No. 20: The Interrelationships of Insects and Round-worms. By R. H. Van Zwaluwenburg. Pp. 68. (Honolulu, Hawaii.)

University of California Publications. Bulletin of the Department of Geological Sciences, Vol. 17, No. 1: A Review of the Fossil Bird, *Parapavo californicus* (Miller), from the Pleistocene Asphalt Beds of Rancho La Brea. By Hildegarde Howard; with an Appendix, Statistical Identification as applied to *Parapavo*, by Frederick H. Frost. Pp. 62+13 plates. (Berkeley, Calif.: University of California Press.) 80 cents.

Proceedings of the United States National Museum. Vol. 72, Art. 5: A Bibliography of the Conodonts, with Descriptions of Early Mississippian Species. By Grace B. Holmes. (No. 2701.) Pp. 38+11 plates. (Washington, D.C.: Government Printing Office.)

University of Wisconsin Studies in Science. No. 4: The Optic and Microscopic Characters of Artificial Minerals. By Prof. Alexander Newton Winchell. With Determinative Tables for Identifying Artificial Minerals Microscopically chiefly by means of their Optic Properties. Pp. xv+215. (Madison, Wis.) 1.50 dollars.

State of Connecticut: State Geological and Natural History Survey. Bulletin No. 40: The Geology of the Shepaug Aqueduct Tunnel, Litchfield County, Connecticut. By Prof. William Macdonough Agar; with a Chapter by Robert A. Cairns. Pp. 38+8 plates+2 maps. 50 cents. Bulletin No. 41: Guide to the Geology of Middletown, Connecticut, and Vicinity. By Prof. William North Rice and Prof. Wilbur Garland Foye. Pp. 137+3 plates. 1 dollar. (Hartford, Conn.)

Smithsonian Miscellaneous Collections. Vol. 80, No. 4: Religion in Szechuan Province, China. By David Crockett Graham. (Publication 2921.) Pp. 83+25 plates. Vol. 80, No. 8: Fossil Footprints from the Grand Canyon, Third Contribution. By Charles W. Gilmore. (Publication 2956.) Pp. 16+5 plates. (Washington, D.C.: Smithsonian Institution.)

Publications of the United States Naval Observatory. Second Series, Vol. 11: Results of Observations with the Six-inch Transit Circle, 1909–1918, reduced under the direction of J. C. Hammond, discussed by J. C. Hammond and C. B. Watts; Catalogue of 215 Stars for 1910·0 from Observations in the Years 1909–1910; Catalogue of 2499 Stars for 1910·0 from Observations in the Years 1911–1918. Pp. iii+712+5 plates. (Washington, D.C.: Government Printing Office.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 75: The Perennial Cultivation of Cotton, with special reference to the Cultivation of Ratoons in Egypt. By Dr. James Templeton. Pp. ii+81+11 plates. (Cairo: Government Publications Office.) 5 P.T.

United States Department of Agriculture. Technical Bulletin No. 48: The Western Cedar Pole Borer or Powder Worm. By H. E. Burke. Pp. 16. (Washington, D.C.: Government Printing Office.) 5 cents.

## Diary of Societies.

*FRIDAY*, MARCH 23.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botany Department, Imperial College of Science), at 2.30.—R. S. Pearson: Forest Products Research: Research in Progress at the Laboratory at Princes Risborough.—J. F. Martley: The Work of the Oxford Branch.

PHYSICAL SOCIETY (Annual General Meeting) (at Imperial College of Science), at 5.—Ordinary Meeting:—W. D. Flower: The Terminal Velocity of Drops.—Satyandra Ray: On the Longitudinal Waves along a Rod.—J. J. Manley: On the Damping of Mercury Ripples.—Demonstration of *Die Rastermethode* (the Testing of Spherical Aberration by Means of Shadows in an Astigmatice Beam), by J. E. Calthrop.

*SATURDAY*, MARCH 24.

ROYAL SANITARY INSTITUTE (at Municipal Buildings, Taunton), at 10.30 A.M.—Discussion on Present Tendencies regarding Disinfection and on House Refuse Collection.

BRITISH MYCOLOGICAL SOCIETY (at University College), at 11 A.M.—Prof. E. S. Salmon and W. M. Ware: Two Downy Mildews of the Nettle.—Dr. E. J. Schwartz and Dr. W. R. Ivimey Cook.—Life History of a New Species of Olpidium.—Symposium on the Nomenclature of "Strains": Dr. W. B. Brierley, Dr. W. Brown, Dr. G. G. Hahn, Dr. H. Wormald.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Transformation of Matter (III.).
HULL ASSOCIATION OF ENGINEERS (at Technical College, Hull), at 7.15.—H. J. Young: The Uses of Metallurgy in Engineering.

*MONDAY*, MARCH 26.

INSTITUTE OF ACTUARIES, at 5.—T. F. Anderson and H. O'Brien: Notes upon Experiments with Actuarial Functions and Fourier's Series.
ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Prof. W. G. Fearnsides and W. H. Wilcockson: A Topographical Study of the Flood-swept Course of the Porth Llwyd above Dolgarrog.
INSTITUTE OF ACTUARIES, at 5.—T. F. Anderson and H. O'Brien: Notes upon Experiments with Actuarial Functions and Fourier's Series.
INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 6.30.—R. E. L. Maunsell: The Trend of Modern Steam-Locomotive Design (Annual Lecture).
INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—F. H. Rosencrants: Practice and Progress in Combustion of Coal as applied to Steam Generation.
ROYAL SOCIETY OF MEDICINE (Odontology and Electro-Therapeutics Sections), at 8.—Special Discussion on The Pulpless Tooth.—Speakers:—For Section of Odontology: F. Coleman, O. C. Morphy, A. T. Pitts, Dr. A. Livingston, St. J. Steadman, B. Mendleson, and A. F. MacCallan. For Section of Electro-Therapeutics: Dr. H. M. Worth, Dr. G. Murray Levick, Dr. M. Jones, Dr. J. F. Brailsford, N. Grellier, Dr. A. C. Jordan, and Dr. G. B. Batten.

*TUESDAY*, MARCH 27.

ROYAL DUBLIN SOCIETY (at Ball's Bridge, Dublin), at 4.15.—Prof. H. H. Dixon and T. A. Bennet-Clark: The Effect of Temperature on the Electrical Response of Plants.—W. D. Davidson: (*a*) The Rejuvenation of the Champion Potato; (*b*) A Review of the Literature dealing with the Degeneration of Potato Varieties.
ROYAL SOCIETY OF ARTS (Dominions and Colonies Meeting), at 4.30.
ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.—Prof. D. W. Calmalt-Jones: New Zealand Views on Goitre.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. J. Collier: Epilepsy (Lumleian Lectures) (II.).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: The Behaviour of Animals (VI.).
INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Annual General Meeting.
SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (jointly with Hull Chemical and Engineering Society) (at Photographic Society, Grey Street, Hull), at 6.45.—Discussion on Some Aspects of the Oil Cake and Feeding Stuffs Industry:—R. A. Bellwood: Fish Meal as a Food for Cattle, Swine, and Poultry.—H. Thompson: The Analytical Aspect of the Oil and Seed Crushing Industry.—G. Milne: Oil Seed Residues in Animal Nutrition.—T. Andrews: Some Aspects of the Fertilisers and Feeding Stuffs Act.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—M. Sargant-Florence: Colour Co-ordination.
INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.—R. B. Matthews: Electric Ploughing.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Sir Arthur Keith: Human Remains discovered by Sir Aurel Stein in Ancient Cemeteries of the Taklamakan Desert.
ILLUMINATING ENGINEERING SOCIETY.—Discussion: Various Aspects of Street-Lighting.

*WEDNESDAY*, MARCH 28.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts), at 11 A.M.—Presentation of Institution Premiums to H. J. R. Biles and W. C. S. Wigley.—Admiral of the Fleet Lord Wester Wemyss: Presidential Address.—Sir John H. Biles: The Present Position of the Question of Fuel for Ships.—At 3.—J. F. King: Bending and Loading of Ships.
ROYAL SOCIETY OF MEDICINE (Comparative Medicine Section), at 5.—T. Dalling, J. H. Mason, and W. S. Gordon: (*a*) Intradermic Tuberculin Testing in Cattle; (*b*) Transference of Maternal Immunity in Sheep.—J. W. Trevan: The Present State of Knowledge of Sex Hormones.—H. J. Parish: B.C.G. Experiments in Guinea-pigs.—C. C. Okell: Diphtheria Infections and Diphtheria Immunity in Horses.
INSTITUTION OF CIVIL ENGINEERS (Students' Informal Meeting), at 6.30.—R. F. Legget: The Limitation of Concrete as a Material in Construction.
INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—J. C. Stewart: Modern Mould Loft Practice.
SOCIETY OF CHEMICAL INDUSTRY (Newcastle Section) (at Armstrong College), at 7.30.—W. E. Billinghame: Emulsions, their Scope and Application.
MERSEYSIDE AQUARIUM SOCIETY (at 1 Falkland Road, Egremont), at 7.30.—A. G. Thüs and W. Mallinson: Demonstration of the Making of Tanks.
EUGENICS SOCIETY (at Linnean Society), at 8.—Dr. F. D. Turner, Lady Askwith, and others: Segregation and Sterilisation.
C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (in Grotrian Hall, Wigmore Street, W.1), at 8.30.—Debate. C. Pilley will maintain: That he agrees the Roman Catholics are right in opposing Dr. Marie Stopes. Dr. Marie Stopes will oppose.
BRITISH ASTRONOMICAL ASSOCIATION (at Sion College, Victoria Embankment).

*THURSDAY*, MARCH 29.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts), at 11 A.M.—Eng.-Capt. A. Turner: A Note on Experimental Diesel Engines.—At 12.—Presentation of Bust of the late Sir Philip Watts, by the Right Hon. Winston Churchill.—E. H. Mitchell: Design and Propulsion of Fast Double-ended Screw Vessels.—At 3.—E. L. Champness and F. McAlister: Further Notes on the Relative Strength of Fine and Full Cargo Vessels.—W. Sprague, and the Staff of the William Froude Tank: An Experimental Comparison of the Performance of Model Propellers working in Air and in Water.—At 8.—Prof. E. G. Coker: Stresses in the Hulls of Stranded Vessels.—G. H. Hoffmann: The Effective "I" of H.M.S. *Wolf*.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. J. Collier: Epilepsy (Lumleian Lectures) (III.).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15—Group-Capt. M. Flack: The Physiological Aspects of Flying (II.).
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—A. H. A. Gem: Physical Training in its Effect upon the Development of Children.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—F. Lydall: The Electrification of the Pietermaritzburg-Glencoe Section of the South African Railways.
INSTITUTION OF LOCOMOTIVE ENGINEERS (at 296 Vauxhall Bridge Road S.W.1), at 6.—J. Clayton: Engine Failures.
SOCIETY OF DYERS AND COLOURISTS (Midlands Section) (at University College, Nottingham), at 7.30.—Prof. F. M. Rowe: "Azoic Colours."
CHEMICAL SOCIETY, at 8.—A. H. Dickins, W. B. Hugh, and G. A. R. Kon: The Chemistry of the Three-carbon System. Part XVII. α-cyclo-Hexylideneacetone and -methylethyl Ketone.—F. Challenger and A. T. Peters: The Nitration of Aromatic Thiocyanates and Selenocyanates.—F. Ashworth and G. H. Burkhardt: Effects induced by the Phenyl Group. Part I. The Addition of Polar Reagents to Styrene and the Behaviour of the Halogenated Ethylbenzenes.—E. B. R. Prideaux and C. B. Cox: On Selenium Tetrafluoride.
BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (jointly with Psychiatry Section of Royal Society of Medicine) (at 1 Wimpole Street, W.1), at 8.15.—Symposium on The Etiology of Alcoholism. Dr. B. Hart and Dr. E. Mapother for Psychiatry Section, Royal Society of Medicine; Dr. E. Glover and Dr. H. Crichton Miller for Medical Section, British Psychological Society.
INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch).—Capt. H. P. M. Beames: The Reorganisation of Crewe Locomotive Works.
INSTITUTION OF MECHANICAL ENGINEERS (Cardiff Branch).—J. McCarthy: Rubber, and its Uses in Engineering.

*FRIDAY*, MARCH 30

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts), at 11 A.M.—Lt.-Col. V. C. Richmond: Some Modern Developments in Rigid Airship Construction.—G. S. Baker and J. L. Kent: Experiments on the Propulsion of a Single-Screw Ship Model.—At 3.—W. G. A. Perring: The Vortex Theory of Propellers and its Application to the Wake Conditions existing behind a Ship.—J. Tutin: Cavitation.—J. L. Taylor: Statistical Analysis of Voyage Abstracts.
INSTITUTION OF LOCOMOTIVE ENGINEERS (Manchester Centre) (at College of Technology, Manchester), at 7.—W. G. Smith: Some Features of the Mechanical and Electrical Equipment of the Port of Manchester.
JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—C. F. Adams: Locomotive Maintenance.
GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—A. G. Davis: The Geology of the Clapham-Morden Railway Extension.—Miss Helen M. Muir-Wood: A New Brachiopod, *Discinisca ferroviæ*, from the Woolwich Beds.—E. M. Venables: The London Clay of Bognor.
INSTITUTE OF METALS (Sheffield Local Section) (in Non-Ferrous Section, Applied Science Department, Sheffield University), at 7.30.—Dr. W. H. Hatfield: Non-Ferrous Metals in relation to Ferrous Metallurgy.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Ernest Rutherford: Radioactive Atoms and their Structure.

*SATURDAY*, MARCH 31.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 3.—B. E. Houle: The Installation of a Booster Fan.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Transformation of Matter (IV.).

## PUBLIC LECTURES.

*SATURDAY*, MARCH 24.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. E. Marion Delf: Light and Life.

*MONDAY*, MARCH 26.

GRESHAM COLLEGE, at 6.—G. P. Bailey: Modern Science and Daily Life: High and Low Temperatures.

*THURSDAY*, MARCH 29.

UNIVERSITY OF LEEDS, at 8.—A. N. Shimmin: Economics in Everyday Life: The Cost of Corporate Life.

*FRIDAY*, MARCH 30.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.15.—Dr. R. E. Stradling: "Balbus built a Wall" (Bossom Gift Lecture).

## CONFERENCES.

MARCH 28 TO 31.

GERMAN BALNEOLOGICAL CONGRESS (at Baden, near Vienna).

MARCH 29, 30, AND 31.

TUBERCULOSIS SOCIETY AND SOCIETY OF SUPERINTENDENTS OF TUBERCULOSIS INSTITUTIONS (in Dunn Laboratory, Oxford).
*March* 29, at 2.—Discussion on Lupus and its Treatment.
*March* 30, at 10 A.M.—The Potentially Tuberculous Child.
At 2.—The Treatment of Hæmoptysis in Pulmonary Tuberculosis.
*March* 31.—Discussion on Intestinal Tuberculosis.