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Television.

THE lecture delivered by Mr. J. L. Baird on Jan. 6 at the Physical and Optical Society's annual exhibition was very largely attended, and had to be repeated the same evening in order to prevent widespread disappointment. The attendance was a tribute to the intrinsic interest of the subject and to the expectations aroused by what little has become known of the lecturer's apparatus and achievements.

Mr. Baird did not add to the general knowledge by what he said and did on that occasion. The situation appears to be that he has achieved a certain success in transmitting instantaneous images divided into some thirty vertical strips, each strip showing more or less correct gradation in a vertical direction. The picture composed by the strips is therefore very coarse-grained in one direction while sufficiently graded in a direction at right angles to it. The most important point about the transmission is that it uses diffusely reflected light, and not the light transmitted, say, by a lantern slide. To the latter transmission Mr. Baird will not consent to apply the term 'television' at all, and in this we consider he is justified. The eye itself normally sees objects by diffusely reflected light, and television, to be worthy of the name and to accord with popular expectation, must do the same.

Now this proviso is a very serious obstacle to overcome. For the 'candle-power' of a brightly illuminated face is approximately unity, whereas in kinematograph projection it amounts to thousands. True television, as defined by Mr. Baird, is therefore at least a thousand times more difficult than the transmission of shadows of moving objects such as has already been achieved by several inventors, among whom Ruhmer was the first in 1907.

Mr. Baird appears to have succeeded in transmitting images of objects artificially illuminated to an extent equivalent to bright sunlight, and to have overcome the difficulties of synchronisation in transmitting and receiving within the same building. He also claims to have accomplished similar transmissions by radio over about ten miles, and to have transmitted living faces showing considerable detail. While giving him all credit for his very direct attack on a difficult problem, and for what he has demonstrably achieved, we must guard against an underestimate of the remaining difficulties. These will affect such things as synchronism, illumination, and detail.

It is comparatively easy to keep two motors running at the same speed, even at a distance. But when a difference of phase of only one degree is capable of spoiling definition, the maintenance of the correct phase becomes a formidable task. Granted that Mr. Baird transmits the equivalent of 30,000 signals per second as against the 300,000 required for satisfactory television, it is easily seen that the problem of synchronism may become sufficiently acute to bar further progress. The figure of 300,000, on which most workers on this problem are agreed, is based upon the fact that a face alone, to be recognisable, requires some 3000 graded elements. Most press portraits comprise at least 10,000 such elements; and in order to produce the illusion of continuity or motion, there must be at least sixteen transmissions of the whole picture per second.

From the information available—and it must be remembered that Mr. Baird has not disclosed the essential details of his method—it appears highly probable that little further progress need be expected along the lines chosen by him. The illumination seems to have been driven to its farthest limit, and the recent claims to have transmitted 'outlines' by infra-red rays mark no advance towards television with diffusely reflected light. The subdivision of the image by a disc of spirally staggered lenses seems incapable of extension, and the suggestion thrown out in the course of the lecture, that several photo-electric cells (and several radio-frequencies) might be used simultaneously, only serves to emphasise difficulties already known to exist.

It is to be regretted that, possibly on account of patent considerations, Mr. Baird has hitherto been unable to submit to a proper authentication of his claims by a learned society. For aught his recent audience could say, the invention might be a mere plaything, with no more resemblance to television than a toy engine has to the real thing. That is not the way to convince a sympathetic audience of experts who are expected to judge of the merits and prospects of an invention.

There are at least three pioneers in the field who seem to be on the verge of a complete solution of the television problem. Belin in France, and Alexanderson and Jenkins in America, are all approaching the problem by way of the transmission of photographs, which they accomplish in great perfection. Dr. Alexanderson, chief engineer of the Radio Corporation of America, claims to be able to transmit a complete photograph in one second, and points out that if sixteen successive photographs could be transmitted in one second, the problem of television (or, at least, of telekinematography) would be solved. He adds, however, that the difficulties, especially of synchronism, increase as the square of the speed.

It is well to remember that the earlier solutions proposed after the discovery of the light-sensitive property of selenium did not require the synchronisation of moving parts at the sending and receiving stations. But a multiplicity of wires, one for each picture element, is out of the question, and so is a multiplicity of radio-frequencies. Unless, therefore, some device such as Dr. Fournier d'Albe's acoustic resonator system can be employed for the simultaneous reception of a medley of signals, the question of synchronism, effective both in speed and phase, will arise; and when we realise that the synchronism required is that of two 'pencils' which traverse the picture completely in a sixteenth of a second, and in doing so describe several hundred lines, the mechanical difficulties may well appal us. The speed with which the stimulus can be applied at the transmitting end is great enough nowadays, for the action of a photo-electric cell shows no appreciable lag, and the use of a Braun cathode ray tube at the receiving end, first suggested, we believe, by Mr. Campbell Swinton, will solve the speed problem there.

There remains the problem of sensitiveness to illumination at the receiving end. Mr. Baird does not tell us what he uses. His results suggest a potassium photo-electric cell for ultra-violet, and either selenium or bolometer for the infra-red. If he has discovered any reagent of greatly superior power, that discovery alone would entitle him to our gratitude, and would constitute a valid claim even though all his other devices had been anticipated by others. The policy of withholding publication of an essential item does not commend itself to modern inventors. It savours too much of medieval practice, and usually defeats its own object of securing to the inventor the fruits of his invention.

It would be a source of satisfaction to us if one of our countrymen were the first to provide a practical solution of a problem of this magnitude, a solution such as the civilised world has been expecting for some years. If the solution has been reached without the scientific, engineering, and financial resources at the disposal of rival inventors, it will appeal very powerfully to our sympathy and imagination. But for the present, and on the evidence supplied, the scientific world will probably prefer to reserve its judgment.

Is Darwinism Dead?

(1) *A Companion to Mr. Wells's "Outline of History."* By Hilaire Belloc. Pp. iv + 119. (London: Sheed and Ward, 1926.) 7*s.* 6*d.* net.

(2) *Mr. Belloc Objects to "The Outline of History."* By H. G. Wells. (The Forum Series.) Pp. vii + 55 + 2 plates. (London: Watts and Co., 1926.) 1*s.* net.

(3) *Mr. Belloc still Objects to Mr. Wells's "Outline of History."* By Hilaire Belloc. Pp. x + 43. (London: Sheed and Ward, 1926.) Paper, 7*d.*; cloth, 1*s.*

QUITE a dozen years ago statements began to appear in our public press announcing that "Darwinism was dead," and so often has this assertion been repeated in more recent days that there has arisen in the public mind a fear that some sort of fatality has overtaken the reputation of the great naturalist. If by Darwinism is implied the body of fact, inference, and doctrine contained between the covers of "The Origin of Species," then assuredly Darwinism is not dead, for the revolution which that book began to work in the minds of thoughtful men sixty-seven years ago still continues its forward and unchecked progress.

The essence of Darwin's teaching is to be found in the last paragraph of the introduction he wrote for the first edition of "The Origin," and is repeated in all the later editions. There Darwin states that "I can entertain no doubt, after the most deliberate study and dispassionate judgment of which I am capable, that the view which most naturalists until recently entertained, and which I formerly entertained—namely, that each species has been independently created—is erroneous." Through Darwin's influence 'special creationists' in all the leading nations of the world were transformed into 'evolutionists.' Thus in its widest sense Darwinism implies merely the acceptance of the belief that all living things have been evolved from other and older living things. There is no book which seems so certain of a place in the permanent literature of the world as Darwin's "Origin of Species."

That Mr. H. G. Wells, trained under Huxley, should be a Darwinist in this wider sense occasions no surprise; but it was scarcely to be expected that Mr. Belloc, a devout son of the Roman Catholic Church, should be of the number. Yet, like Darwin, Mr. Belloc rejects special creation and accepts evolution; he even reproves Mr. Wells for being ignorant of the fact that "the conception of the Old Testament as an exact text-book of history and science, not a word of which must be taken as allegory or generalisation, was mainly confined to England and to her colonies. The Catholic Church never held it or could of its nature hold it" ("A Companion," p. 32). Mr. Belloc assures his readers that the theory of evolution is old, and that "the ancients and fathers of the Church" were familiar with it.

Darwinism is confined by many people to cover merely the theory enunciated in the "Descent of Man." When used in this more limited sense Darwinism cannot be considered as dead, for I do not know of any living anthropologist or student of the human body who believes that man arose by a special act of creation. Anthropologists may differ as to the kind of ape from which humanity has been evolved, and as to the geological date at which its face was turned man-wards, but on the evidence now before them, which grows in volume and in trustworthiness every year, most of our authorities share Darwin's belief that the anthropoid apes and man have sprung from a common stem. In this narrower sense Mr. Wells is a Darwinist, but so adroitly does Mr. Belloc cover his verbal tracks with a smoke-screen that it is somewhat difficult for his readers to decide whether as regards man's origin he is a fundamentalist or a Darwinist. He quotes with approbation the belief held by "St. Thomas, the great teacher of the Middle Ages," to the effect that "the creation of man was not mediate but direct." St. Thomas must, on this evidence, be classed among the fundamentalists. Mr. Belloc, however, gives his verbal assent to this narrower form of Darwinism which the fundamentalists find so objectionable; he believes in evolution; he regards the process by which man reached his present estate as open to debate; he speaks of "the moment when a true man existed at all"; he directs Mr. Wells's attention to the fact that certain tests show a close blood affinity between man and anthropoid. With such evidence before us we cannot say that Darwinism—even in this narrow sense—is dead.

Yet in justice to Mr. Belloc it should be added here that he rejects two points in Darwin's theory of man's origin. Darwin believed that man's rise from apedom was a slow and gradual process, and he hoped that the evolutionary forces which had lifted him thus high might lift him still higher. Mr. Belloc, on the other hand, prefers to believe that man's emergence was of the nature of a leap, and that he is now and will ever remain a 'fixed type.' Our scanty knowledge of fossil ape and man, and our much fuller information regarding

their embryological histories, are altogether against Mr. Belloc's beliefs and in favour of Darwin's postulates, which have been rightly adopted by Mr. Wells.

There is a third and more restricted sense in which the term Darwinism is used. As an intrinsic part of the machinery which he regarded as being concerned in the evolution of living forms, Darwin introduced the principle or law of "Natural Selection," which he defined thus: "This *preservation* of favourable individual differences and variations, and the destruction of those which are injurious, I have called Natural Selection or the Survival of the Fittest" ("The Origin of Species," sixth edition, p. 63). There can be no doubt that Darwin claimed the recognition of this law and its application to the problems of evolution as his particular discovery. "Natural Selection," writes Mr. Belloc, "is the only thing that properly can be called Darwinism," and he reproves Mr. Wells for being unaware that Darwinism in this sense has been "riddled for a generation"; that it is "done for"; that it is "shaky"; that it is "nonsense"; that it is "old and exploded"; that it is "moribund"; and also that it is "quite dead."

Mr. Belloc devotes many pages to the exposition of Darwin's law of selection, and so little is the resemblance of the exposition to the original that one is forced to the conclusion that he has never read even the first chapter of "The Origin of Species." Darwinism as expounded by Mr. Belloc is certainly dead; indeed, it was never born. One does expect a historian, especially one who is ever accusing his antagonist—very unjustly—of being ignorant of recent events in the history of Darwinism, to be familiar with some of the chief happenings which followed the publication of "The Origin of Species." Mr. Belloc apparently does not know that Mr. St. George Mivart ("On the Genesis of Species," 1871), a convert to the Catholic Church, and one of the ablest anatomists of his time, formulated all the arguments which he now brings against Darwinism, and based them on an expert and first-hand knowledge of living things, such as Mr. Belloc can lay no claim to. Nor is he aware that Darwin, patient with even unscrupulous and prejudiced opponents, devoted twenty-eight pages of the sixth edition of "The Origin of Species" (1872) (pp. 176-204) to answering Mivart's criticisms. From first page to last of this sixth edition, Darwin protests against those early critics who supposed that the variations utilised by natural selection occurred 'singly' and 'accidentally'; he admits time after time that although he does not know the 'efficient cause' which brings variations into existence, yet he is certain that their appearance is regulated by many laws, "some few of which can be dimly seen," one of these being the law of 'correlated growth' whereby a whole series of structures may be modified together so as to serve more advantageously some functional purpose.

Mr. Belloc resuscitates this ancient misrepresentation of 'accidental' and 'single' variations and is thereby enabled, sitting in his armchair, unoppressed by any sense of modesty or burden of knowledge, to enumerate a dozen arguments, each ticked off after another with a triumphant emphasis, all of them demonstrating that the author of natural selection was an uncommonly stupid man and his modern critic a very clever fellow. One who presumes to criticise Darwin's "Origin of Species," especially from a mathematical point of view, should have known that Prof. Fleeming Jenkin ("The Origin of Species," sixth edition, 1872, p. 71), in 1867, had demonstrated the impossibility of a new breed or variety arising by natural selection if it had only 'accidental' variations to work upon, and that Darwin had shown this erudite professor wherein his error lay. Mr. Belloc knows nothing of this. Nor does he seem to be in touch with what is happening all around him now. It is difficult to believe that any one who sees the unceasing struggle which goes on everywhere and every year for the possession of the continents of the world and has been waged since the dawn of history, a struggle which is attended by the spread and domination of a few favoured races and the retrocession and obliteration of many less favoured races, can doubt the potency of Darwin's law of selection as a factor in the process of evolution. We may not like the way in which evolution works out its effects, but I do not think man, devise as he may, can escape from them. Certainly animals and plants in a state of Nature cannot.

In the five and fifty years which have elapsed since the sixth and last edition of "The Origin of Species" was published, we have learned much concerning how evolutionary processes work in the world of living things, much that was unknown to Darwin. We know now something of the complex laws of heredity, and of the physiological means whereby the growth of the body is regulated, so that its several parts are modified together and made to serve a functional purpose. An example mentioned by Mr. Belloc ("The Companion," p. 22) will serve to illustrate the direction in which

our knowledge has improved. After citing one of Darwin's early critics to prove that "chance-made variations" could never have provided functionally useful structures, he proceeds thus: "And another biologist has well said—What is the survival value of horns without the structure to support them and muscles to use them?" Having set down this question, Mr. Belloc proceeds to answer it. "The mathematical chances," he informs his readers, "are millions and millions to one" against "the possibility of such a thing. Grant Design moulding all nature—that is, God—and this process is explicable." The impious biologist of to-day does not find it necessary to call in any divine or supernatural power to explain the multitude of changes which accompany the growth of horns in a young bull or antlers in a stag; the deity Mr. Belloc appeals to lies in the testes of these animals! The biologist knows that if a certain substance or hormone formed in the testes is withheld, none of these changes take place; if they are permitted to enter the circulation, then as the horns grow the bones and muscles of the neck increase in size and strength, the lumina of blood-vessels expand, and, what is still more wonderful, the temperament of the animal is transformed. The discovery of hormones, if it renders a direct appeal to the Almighty no longer necessary, does not in any way invalidate or lessen the efficiency of Darwin's law of natural selection; the hormone theory simply helps us to explain how variations of an adaptative nature can and do arise.

What is here written will suffice to show that Darwinism, in whatever sense we construe it, is neither an exploded creed nor a dead doctrine, and that those who assert the contrary not only sin against the light of truth, but also commit a crime by poisoning the springs from which a trusting public drinks its information.

It would be unfair to the memory of St. George Mivart were I to conclude without indicating, however briefly, the remarkable manner in which he anticipated in 1871 ("The Genesis of Species") the arguments which Mr. Belloc has brought against Darwin in 1926. Mr. Mivart began by asserting that a belief in evolution "was perfectly consistent with the strictest and most orthodox Christian theology"; Mr. Belloc echoes this statement but substitutes 'Catholic' for 'Christian.' Mr. Mivart called the "Fathers and Ancients" as witnesses for the orthodoxy of the theory of evolution, singling out St. Thomas for special mention; so does Mr. Belloc. Mr. Mivart reproved Darwin for his total ignorance of the "philosophy and teaching of the Catholic Church"; Mr. Belloc scolds Mr. Wells for the same offence. Mr. Mivart believed that structural modifications of a really useful kind were wrought by a supernatural agency; so does Mr. Belloc. Mr. Mivart believed that by a miraculous intervention man became possessed of a soul only in the last stage of his evolutionary progress; this apparently is also Mr. Belloc's belief. Darwin, as I have already mentioned, took infinite pains to answer Mr. Mivart's scientific objections, and I thought every one knew that Huxley had answered his theological arguments in a famous essay ("Mr. Darwin's Critics," 1871, Huxley's "Collected Essays," vol. 2, p. 120), but it must have escaped Mr. Belloc's attention, for he never alludes to it. Yet it is an essay which he might read with advantage, as should every one who honestly tries to reconcile Catholic beliefs with the truth of science. Even Mr. Mivart, in the end, found a reconciliation impossible. His later books were placed on the *Index Librorum Prohibitorum*, and in January 1900, when his last illness was upon him, he was excommunicated by Cardinal Vaughan because he dared to assert what his investigations into science had taught him. Such was Mr. Mivart's fate, and one wonders what would have happened to the author of "The Origin of Species" if his life had fallen in Catholic places and had his beliefs been in the keeping of Rome.

ARTHUR KEITH.

New Quantum Theories.

Probleme der Atomdynamik. Erster Teil: *Die Struktur des Atoms*; Zweiter Teil: *Die Gittertheorie des festen Zustandes.* Dreissig Vorlesungen, gehalten im Wintersemester, 1925–26, am Massachusetts Institute of Technology. Von Prof. Max Born. Pp. xiii + 183. (Berlin: Julius Springer, 1926.) 10·50 gold marks.

CLASSICAL electrodynamic theory has had considerable success in explaining many of the phenomena of atomic physics, but there are other facts which seem to necessitate a radical departure from this theory. During the first quarter of the century many attempts were made to meet these difficulties by means of special assumptions and rules, which constituted the quantum theory. Although these methods have had remarkable success in the interpretation of a restricted region, it has long been felt that such a procedure, designedly adopted with a particular end in view, was not satisfactory and that a more general theory was required.

In 1925 Heisenberg put forward a new theory of quantum mechanics which seems likely to have far-reaching consequences, even if it does not lead to a complete solution of the problem. One of the fundamental ideas employed by Heisenberg is that only such things as are directly open to observation should enter into the mathematical formulation. He considered it advantageous to avoid every notion which cannot be connected with experiment, and so eliminated all ideas of motion within the atom. We are unable to assign to an electron a special position in space at a special instant of time, so that, so far as our observations are concerned, an electron orbit does not exist. In the mathematical statement of the new theory, developed in association with Born and Jordan, the continuous variables of the classical theory are replaced by systems of discrete quantities (matrices) which can be expressed by means of algebraic equations.

Although the theory of matrices is founded on the work of Cayley, Sylvester, and H. J. Smith, and is about seventy years old, some mathematicians and most physicists are unfamiliar with the ideas involved. As pointed out recently in these columns (NATURE, August 28, 1926, vol. 118, p. 295), the fundamental notion is by no means difficult to grasp. Cayley considered a square arrangement of numbers as constituting a matrix, realising the value of treating it as a single magnitude. Thus nine numbers put in square formation, three by three, are called a matrix of order three. For example:

$$\begin{bmatrix} 1, & 2, & 3 \\ 4, & 5, & 6 \\ 7, & 8, & 9 \end{bmatrix}$$

We may also deal with a rectangular matrix of mn numbers, arranged in m rows and n columns. The matrix is to be thought of as a *compound* unit, an assemblage of numbers arranged in order but constituting a single entity. A simple geometrical illustration is afforded by taking $[x, y]$ as specifying the position of a point in a plane. Unless $x=y$, the point $[x, y]$ is not the same as the point $[y, x]$. Such an entity, which may include a row of n numbers, is a special case of a matrix of rank one. The determinant of a matrix must be distinguished from the matrix itself, just as the area of a triangle must be distinguished from the triangle itself. Cayley gave rules for adding, subtracting, and multiplying matrices, and it is of importance in the present connexion that the product AB of two matrices A and B is not generally equal to the product BA.

The most interesting part of the volume under notice is undoubtedly that in which Prof. Max Born has described in some fifty pages the development of the new quantum mechanics. In the classical theory a particular co-ordinate may be represented by a Fourier series comprising the various components, but in the new theory the collection of all possible vibrations is to be regarded as a whole in a quadratic scheme forming an infinite matrix. If q denote such a co-ordinate matrix and p an impulse matrix, instead of assuming that the product qp is equal to the product pq, we must introduce a new postulate, namely,

$$pq - qp = h/(2\pi i),$$

where h is Planck's constant and i is the square root of -1.

P. A. M. Dirac of Cambridge has expressed the new theory in a different form by means of a specially devised quantum algebra in which the quantum variables satisfy all the ordinary laws of algebra, excluding the commutative law of multiplication. Instead a special quantum condition is postulated, involving Planck's constant and equivalent to that stated above.

Schrödinger starts from the idea suggested by de Broglie that an atomic system is not to be represented by a trajectory, that is, by a point moving through the co-ordinate space, but must be represented by a wave in this space. From this starting-point he develops a wave-theory of matter, and obtains from a variation principle a differential equation which the wave function must satisfy. This equation turns out to be closely connected with the Hamiltonian dynamical equation which specifies the system. When the general solution of this equation is known, matrices to represent the canonical variables may easily be obtained satisfying all the conditions that they have to satisfy according to Heisenberg's matrix mechanics. The mathematical equivalence of the theories is thus established, and it is shown that (in the words of Schrödinger) "the wave-mechanics and the matrix mechanics are mathematically identical." The concept of characteristic oscillations in the atom and Schrödinger's theory based upon it represent a most significant contribution to the development of the quantum theory. "From the formal mathematical point of view it includes the whole of the Heisenberg-Born-Dirac matrix theory, and gives, moreover, a simplified, practically convenient method of finding the matrices. Beyond this, it opens new avenues of thought and seems to afford our first glimpse of the true nature of the quanta" (Epstein).

The development of the new theory is taking place with great rapidity, and several applications have already proved successful; only a few of these can be mentioned here. Pauli has shown that the Balmer formula for the hydrogen spectrum can be accounted for quantitatively, as well as the influence of electric and magnetic fields on this spectrum. A theory of the Stark effect based on Schrödinger's ideas has been presented by Epstein, who considers the radiation from a hydrogen-like atom in an electric field. The calculated positions of the components of the spectral lines practically coincide with those obtained in Epstein's old theory, which gave excellent agreement with experiment. The main interest lies in the expressions for the intensities, which agree with the observed values better than those deduced by Kramers from the correspondence principle. Schrödinger himself has discussed the same problem. Brillouin has treated the subject of rotation spectra by the calculus of matrices and has found experimental verification for certain of the theoretical deductions. Dirac has discussed the extension of the theory to relativity mechanics, and in particular to the theory of Compton scattering, and obtained results which can be tested by experiment.

One test of a scientific theory is its comprehensiveness, and the wide sweep of the new quantum mechanics is shown not only in the various ways of formulating it in mathematical language, but also in the physical ideas that may be associated with it. It is probable that the views of the quantum suggested by E. T. Whittaker and by the present writer, in which its magnetic aspects are emphasised, may be simply related to the new theory. In a recent paper Whittaker has described a simple light quantum in which a disembodied magnetic molecule, travelling with the speed of light, forms a singularity on the wave front and confers upon it the desired quantum properties. It may be suggested that such a quantum is related to a quantum magnetic tube on one hand, and to Schrödinger's wave mechanics on the other.

In discussing the relation between the quantum theory and the classical laws, Dirac remarks that the new theory "suggests that it is not the equations of classical mechanics that are in any way at fault, but that the mathematical operations by which physical results are deduced from them require modification. *All* the information supplied by the classical theory can thus be made use of in the new theory." H. S. ALLEN.

Our Bookshelf.

A Text-Book of Organic Chemistry: Historical, Structural and Economic. By Prof. John Read. (Bell's Natural Science Series.) Pp. xii + 680. (London: G. Bell and Sons, Ltd., 1926.) 12*s.* 6*d.* net.

OWING to the fact that systematic organic chemistry is but rarely taught in our public and secondary schools, elementary text-books on the subject are far less numerous than books on the inorganic branch. We have, it is true, a few excellent introductions to organic chemistry, but there is still room for a few more, especially if, like the present work, they are written in an agreeable style, are accurate, do not intimidate the beginner with a vast mass of unrelated facts, and, above all, show traces of original treatment.

Prof. Read departs from precedent by prefacing the subject with a fifty-page sketch of the development of chemistry as a whole, and although one might urge that much of this matter is not strictly relevant, the innovation is nevertheless welcome, not only because it is well done, but also because this phase of chemistry needs more emphasis than it has been given in the past. Another useful feature of the book is the insertion of references to industry and economics, which, as the author states, undoubtedly stimulate and maintain the interest of students. In this connexion, however, it is important that the statements and figures should be as up-to-date as possible, and that the period of time to which they relate should be precisely stated.

In the book under notice one would expect to, but does not, find adequate references to such recent and important matters as the large-scale manufacture of urea, cellulose-nitrate varnishes, acetic acid from cellulose by anaerobic fermentation, insulin, and the 'berginisation' of coal. Further, wholesale prices are far more important than those charged by the retailer, and when we read (p. 314) that "commercial oxalic acid costs about 10*d.* per lb., and the purified substance about 1*s.* 6*d.* retail," we can but marvel at the patience of the small consumer, because for a long time past the market price of the 98-100 per cent. commodity has been less than 6*d.* a pound, and now it is less than 4*d.*

Prof. Read and his publishers deserve our thanks for producing a thoroughly sound and interesting work.

The Modern Soap and Detergent Industry, including Glycerol Manufacture. By Dr. Geoffrey Martin. In 3 vols. Vol. 3: *The Manufacture of Glycerol.* (Containing the Index to the Complete Work.) Pp. xi + 78 + 36 + 13 + 20 + 8 + 41 + 57. (London: Crosby Lockwood and Son, 1926.) 30*s.* net.

THE working up of the by-product, glycerol, of the soap and stearin candle industry is of such economic importance that the author has felt justified in allotting this entire volume to the subject of glycerol. In attempting to prepare a complete treatise (as the present volume claims to be) on any branch of chemical industry, great

difficulties confront the writer. Many books of such a type, while apparently satisfactory to the technological student, are often to the works' chemist of less value and perhaps incomplete. This is mainly due to the unwillingness of manufacturers (very often for good reasons) to divulge details of processes which may be of indirect help to rival firms.

In the work under review it may justly be claimed that the author has collected together a great many practical details of modern glycerol plants and processes, especially in the sections dealing with the working of evaporators and stills. In fact, in no similar single publication, at least in English, can such a mine of useful information be obtained. The author has been extremely fortunate in having secured the valuable aid of various industrial firms, including still-makers, in the compilation of his data. In addition, as in the previous two volumes of this series, references are given to practically all the important related patents, including even those at present of no industrial significance, on the subject of glycerol production and application. A useful section on polymerised glycerol and glycerol substitutes is also included. In the final section the commercial valuation and analysis of glycerol and the various specifications for products of different grades are treated in a very satisfactory manner.

An exhaustive index for the three volumes is also included in the present work, with cross references. The complete work forms an indispensable reference treatise on the technical literature of the soap and delegent industry.

J. REILLY.

Practical Ultra-Violet Light Therapy: a Handbook for the Use of Medical Practitioners. By T. Clyde McKenzie and A. A. King. Pp. 108+14 plates. (London: Ernest Benn, Ltd., 1926.) 6*s*. net.

THIS handbook is for the use of medical practitioners; it contains a foreword by Sir John Robertson, the Medical Officer of Health for Birmingham, who is keenly alive to the part which this form of therapy is playing and is likely to play in the near future.

Doctors have now to know something of the technique of the sources of ultra-violet radiation, of the effects to which the rays give rise, and of the diseases which are favourably influenced thereby. The book under notice, in a restricted sense, provides this information; the authors write practically only upon their own experiences, and these appear to be restricted to the use of the mercury vapour lamp. They give an excellent account of these lamps, of the way in which they should be used, and of the diseases for which their use is warranted. We can understand, however, that many medical practitioners will want to know something about the open arcs which are largely used in many of the big light clinics.

Dosage in this form of therapy is still rather primitive; the 'normal dose' according to the authors may be taken to be "that which will produce in the patients' most sensitive skin surface the faintest perceptible erythema."

No doubt in time there will be established a physical unit of ultra-violet radiation which will be of service in medicine, and it is to be hoped that the interval will not be so prolonged as has been the case in X-ray therapy.

The American Annual of Photography, 1927. Vol. 41. Edited by Frank R. Fraprie and E. J. Wall. Pp. 238+54. (Boston, Mass.: American Photographic Publishing Co.; London: B. T. Batsford, Ltd., 1926.) 1.50 dollars.

THIS well-known annual appears this year in a new form with a much larger page, which gives more scope for the considerable number of half-tone reproductions with which it is embellished. The text also is improved, for the articles are fewer, longer, and of more interest; and the developer formulæ are set out in a more businesslike and concise form than we have been accustomed to, a strictly comparative table for each type of developer being given on the basis of 1000 parts of water in every case. Mr. E. J. Wall gives a practical digest of the year's work in photography, which is fuller than such summaries generally are, including working formulæ in almost all cases, and with occasional valuable comments. Mr. Wall also contributes a historical article on the desensitising of plates, written with his usual thoroughness. Among the other articles of special scientific value is one by Dr. Wightman on "Photographic Sensitivity and the Latent Image," and one by Messrs. J. I. Crabtree and J. F. Ross on "The Recovery of Silver from Exhausted Fixing Baths." All these contributions mentioned have full references to the original sources of information appended to them, forming valuable bibliographies of the subjects.

An Almanack for the Year of Our Lord 1927: containing an Account of the Astronomical and other Phenomena, and a Vast Amount of Information respecting the Government, Finances, Population, Commerce and General Statistics of the various Nations of the World. By Joseph Whitaker. Complete edition. Pp. lvi+896+lvii-clxxxiii. 6*s*. net. Abridged edition. Pp. xlviii+240+lvii-clxxxv. Paper, 1*s*. 6*d*. net. (London: J. Whitaker and Sons, Ltd., 1927.)

THE new edition of 'Whitaker' has undergone some rearrangement and contains several new features, but its familiar appearance and convenient form remain unchanged. Among the new features are fifty-seven short articles dealing with questions of the day so varied as betting, Kent coalfields, polar flights, and war debts; a summary of science and invention, art, music, and the drama during the year, and details of meteorological conditions in June, July, August, and September for half a century. The statistical information about all states of the world is given as usual. The 'abridged edition' now takes the place of the 'popular edition,' which is discontinued. It contains not a selection but an abridgment of the contents of the larger volume, and is a marvel of value at the price.

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 Beginning of Agriculture.

AT the present moment there is a widespread misunderstanding of the nature of the evidence that is now available to suggest how, when, and where the practice of tilling the soil began. It is not my intention to traverse the whole field so fully explored in 1921 by Prof. Thomas Cherry in his address on "The Discovery of Agriculture," delivered at a meeting of the Australian Association for the Advancement of Science; but new information is now available that confirms the accuracy of his statement, which should dispel the doubts and difficulties that have arisen.

I suppose most people would be prepared to admit that the invention of agriculture was the beginning of civilisation. It involved a really settled society and the assurance of a food supply. Hence it created the two conditions without which there could have been no real development of arts and crafts and the customs of an organised form of society. But for many years there has been a sharp conflict of opinion as to how and where this momentous event took place.

In 1901 it was my good fortune to become associated with Profs. George A. Reisner and Albert M. Lythgoe in the most thorough study of an early pre-dynastic site (Naga-ed-Der in Upper Egypt) that has ever been made. In the course of examining the well-preserved bodies found in this cemetery, I recovered from the alimentary canals of a large number of bodies the food which these people had consumed about sixty centuries ago. This material I sent for examination to Dr. Fritz Netolitzky, the professor of pharmacology in the University of Czernowitz, who is the leading authority on the subject. Prof. Netolitzky published an account of the results in the *Zeitschrift für Untersuchung der Nahrungs- und Genussmittel* (1911, Bd. 21, p. 607) and *Die Umschau* (1911, pp. 45 and 95). At the same time he sent me a letter summarising his results, which I quoted in the little book, "The Ancient Egyptians," I was then engaged in writing.

The statement that barley was the staple article of diet in Egypt from the earliest pre-dynastic period has passed without any notice whatever during the last fifteen years, excepting the use made of it by Prof. Thomas Cherry. In recent discussions that have been taking place at the meetings of the British Association, the Royal Anthropological Institute and elsewhere, as to the beginning of agriculture in Egypt, I am told that no reference of any sort has been made to these fundamental facts, the neglect of which must necessarily sterilise any real investigation of this most important issue.

Dr. M. Gompertz has directed my attention to a fact (which I had not realised until then) that in his memoirs published in 1911, Prof. Netolitzky has not made any unequivocal statement on the barley question. In fact, the only place in which the issue is explicitly mentioned is his memoir in *Die Umschau* (1911), which is almost identical with the private letter its author sent to me in the same year. But there is an important difference between the letter and the published statement. In the latter the statement is made that in almost every sample of the early pre-dynastic Egyptians' food, which I sent to Dr. Netolitzky, there is evidence of the husks of "the barley-wheat-type" (Gersten-Weizentypus), whereas in Dr. Netolitzky's private letter the corresponding sentence ran "in almost every sample there was evidence of the husks of barley." The difference between these two statements was so vital that I wrote to Prof. Netolitzky and asked him for further information. In a letter dated Nov. 25, 1926, he says:

"Barley is the chief cereal found in the Naga-ed-Der specimens. I am of the opinion that wheat was not eaten at that time, for we certainly should have found it if it was present in the specimens, because we can detect the much softer fragments of the husks of barley where the much harder and more characteristic husks of wheat are completely lacking. We can therefore assume that the Naga-ed-Der people did not use wheat; at any rate it is absent in the numerous specimens that you sent me. Some years ago the late Dr. Bruijning, of the Agricultural Experimental Station at Wageningen, wrote to me to say that he had come to the conclusion that wheat first came into Egypt at the beginning of the dynastic period. Schulz ('Die Geschichte der kultivierten Pflanzen,' 1, 1913) expresses the conclusion that barley was the first cereal used in the Nile Valley."

Prof. Netolitzky has also been kind enough to send me a paper by Frau Hedwig Gherasim ("Neue Kennzeichen der Getreidespeizen und Beiträge zur Bestimmung prähistorischer Pflanzenfunde," *Pharmaz. Monatsheften*, 1921) which contains the following statements. She says that while Prof. Netolitzky was convinced barley was the chief cereal used by the pre-dynastic Egyptians, at the time she began her research he had not definitely excluded the possibility—his letter to me in 1911 shows it to have been only a possibility—that wheat might also have been used, because in the material from Naga-ed-Der there was a number of husks of indefinite type (his barley-wheat-type). The solution of this problem he postponed for further investigation and then entrusted the task to Frau Gherasim, who says that she has now examined Prof. Netolitzky's material and has been unable to find a single case in which the diagnosis of wheat can be established, whereas there is ample evidence that barley was present in most of the specimens she examined. She says this discovery is of extraordinary interest and importance, for it definitely establishes the fact that the pre-dynastic people did not eat wheat. The number of specimens is so great that such an assertion can be made with complete confidence. The earliest example of *Triticum dicoccum* appears to be that found by Borchardt in the foundation at the west end of the offering-granary in the temple of King Sahure of the fifth dynasty. Dr. Cherry and others have pointed out, however, that it may have been in use in earlier dynastic times.

The question of the cultivation of barley in Egypt is not merely a matter of local interest, but also involves the much wider problem of the origin of civilisation itself. During recent years there have been repeated discussions as to the relative antiquity of Sumerian and Egyptian civilisation. Prof. Breasted now tells us that this question has been definitely settled once for all. In his book, "The Conquest of Civilisation," which was published a few weeks ago, he makes this statement (p. ix): "Perhaps the most far-reaching consequences among newly-discovered sources are the new cuneiform tablets with [Sumerian] dynastic

lists at last determining the maximum age of the earliest Babylonian written documents. They are at most a little earlier than 3000 B.C. Thus it is now a finally established fact that civilisation first arose in Egypt, followed a few centuries later by Babylonia." The opinion he expresses agrees with that of most of the experts of Great Britain, Europe and America who have first-hand knowledge of the material found within recent years in Mesopotamia.

It is now generally admitted that the first dynasty of Ur can be dated at 2900 B.C., and that the most remote age that can be assigned to it is 3100 B.C. Painted pottery has been found in Susa [Elam] which may be, and probably is, earlier than the first dynasty of Ur; but this has been equated with the pottery distinguished as Susa II. This follows Susa I., which it is generally estimated corresponds to the middle pre-dynastic period in Egypt. In other words, in Egypt the whole duration of the early pre-dynastic period is definitely anterior to any evidences of civilisation that have been found in Asia or in fact anywhere in the world. If, then, the early pre-dynastic evidence reveals the presence of cereals and suggests that agriculture was then being practised, we have positive evidence of the most significant kind that civilisation began in Egypt. We know also that people in Egypt at this time, many centuries before the metal copper was known, were using the copper ore malachite, which there is every reason for believing was obtained from the Wady Alaqi in Nubia. These and scores of other facts to which I have been constantly directing attention, in season and out of season, during the last fifteen years, establish on a firm foundation the certainty that civilisation, not merely agriculture and the working of metals, but also the invention of all the essential arts and crafts, customs and beliefs that go to the making of early civilisation, were first invented in the Nile Valley.

The fact that the alimentary canals of all those earliest Egyptians contained barley is surely certain evidence that barley was growing in Egypt at that time. Whether it was indigenous or not we have of course no direct evidence to prove, because every foot of land that can be cultivated in the Nile Valley has been turned over countless millions of times during the last sixty centuries by an unbroken series of *fellahin*. But the fact that wild barley is found in the north-east corner of Africa, both on the Mediterranean littoral and in the regions to the south and east of Egypt, suggests that it was also growing in the Nile Valley when men first made their way into that strip of land.

The only alternative is to assume that the earliest Egyptians brought barley into the country with them. I need scarcely say that this is a mere speculation, in support of which there is no evidence of any sort, not even a suggestion of its likelihood. The conclusion that is forced upon us is that the earliest settlers in the Nile Valley found barley growing there in a wild state and made use of this natural food supply. Living under such ideal conditions, the population, in course of time, increased to such an extent that the natural supply was inadequate to support them. Then it can be assumed men imitated the natural processes which they had watched year by year for unknown centuries, and by extending the area of irrigation instantly devised the art of irrigation and the invention of agriculture. This is the only reasonable interpretation of a vast mass of evidence.

G. ELLIOT SMITH.

University College, London,
Dec. 1.

Wireless Communication and Terrestrial Magnetism.

THE letters which have recently appeared in NATURE on the relationships of wireless reception and terrestrial magnetism suggest that a few remarks from the point of view of a magnetician may not be superfluous. First, on an historical point, it should be remembered that estimates of the altitude of a stratum of high electrical conductivity were made long before the times of wireless communication. Cavendish (*Scientific Papers*, vol. 2, p. 233) in 1790 obtained on strictly scientific grounds an estimate of from 84 to 114 km. for the altitude of an auroral arc. Prof. Störmer's methods of high precision have supplied numerous results for the lower level of aurora, which have long been well known. The levels he has found show variations with similar limits to those recently obtained by Appleton and Barnett (*Roy. Soc. Proc.*, A, vol. 113, p. 450). Auroral observations, of course, are not possible by day, and we may hope to learn much from wireless which it might be difficult or impossible to derive from auroral observations.

Again, the continual existence of high electrical conductivity in the upper atmosphere was first advanced as an hypothesis neither by Heaviside nor by Kennelly, but by Balfour Stewart. His statement will be found in §§ 121 and 134 of his article on "Terrestrial Magnetism" in the ninth edition (epoch *circa* 1882) of the "Encyclopædia Britannica." Störmer has shown that on special occasions aurora may extend to heights exceeding 600 km. Thus the term 'layer' applied to the space of high conductivity may not be a very appropriate one. But if any name is to be associated with a 'conducting layer' in the upper atmosphere, it should surely be neither Heaviside's nor Kennelly's, but Balfour Stewart's.

The arguments for the existence of the 'conducting layer' on the side of terrestrial magnetism, even leaving aurora out of account, are by no means wholly theoretical. The strongest argument, in the opinion of the writer, is derived from the observed large universal increase of the diurnal variation of the magnetic elements as we pass from sunspot minimum to sunspot maximum. No such universal relationship has been observed in any meteorological or other element at the earth's surface, or in the lower atmosphere, except in the case of electrical earth currents, and these are generally believed, through their association with aurora, to be a direct consequence of the electrical currents overhead.

It is this argument that has led practically all, if not all magneticians, to accept the upper atmosphere as the seat of electrical currents to which the regular diurnal variation of the magnetic elements is due. It is important to notice that it is the regular diurnal variation that has been observed to hold a parallel course to sunspot frequency. Speaking generally, years of few sunspots are less disturbed magnetically than years of many spots, but a year of many spots may not be a highly disturbed year. Thus 1893, though a year of sunspot maximum, was much quieter than either 1892 or 1894.

All the magnetic elements show largely increased diurnal ranges in years of many sunspots. In Britain the increase seems larger for H (horizontal force) than for D (declination). In H an increase of 100 in Wolf's sunspot frequency has corresponded to a rise of about 100 per cent. in the range of the mean diurnal inequality for the year. The effect varies with the season of the year, the percentage rise in the range at Kew being roughly twice as great at midwinter as at midsummer. With increasing sunspot frequency, the tendency seems to be for the increase of amplitude to be larger

in the 24-hour Fourier wave than in the waves of shorter period. This implies in the average day a reduction in the difference between day and night.

There is an important difference in Europe between quiet and disturbed days. On quiet days the magnetic changes are much larger in the day than in the night hours; but during large disturbance the night hours are the most active. Large disturbance in Europe is much more common between 4 P.M. and 4 A.M. than between 4 A.M. and 4 P.M.; it is rare near 10 A.M. This difference between night and day is not, however, universal all over the earth. In the Antarctic, from 1911 to 1913, disturbance was much more in evidence during the day than the night hours. The distribution of magnetic disturbance throughout the 24 hours in high northern latitudes still apparently awaits investigation.

Another result of interest is that the regular diurnal variation, whether in years of many or of few sunspots, tends to be larger on disturbed than on quiet days. This seems to imply that in addition to local irregularities in the conductivity of the 'conducting layer,' due presumably to the irregular distribution of the sources of ionisation, there is during magnetic disturbance a decided increase in the average conductivity. This phenomenon is comparatively trifling in southern England, but increases in prominence as we go north. If we may judge from what happened in the Antarctic in 1911 to 1913, it is exceedingly prominent in high magnetic latitudes, at least in years of few sunspots. At Cape Denison, the base station of the Australasian Antarctic Expedition, the range of the regular diurnal variation of H in the midwinter months for an average international magnetic character of 1·05—which implies only very moderate disturbance—was nearly six times the range from the international quiet days. Magnetic disturbance in these high latitudes is much larger and more persistent than in central Europe. This suggests that the natural place to study the relationships between wireless and magnetic phenomena is not the south of England but the north of Scotland, or still more northern regions. There are now magnetic observatories at Lerwick, Sodankylä (Finland), Matochkin Shar (Novaya Zemblya), Godhavn (Western Greenland), Meanook (Canada), and Sitka (Alaska). Wireless observations at two or more of these stations ought to provide in a short time a lot of interesting material.

C. CHREE.

75 Church Road, Richmond, Surrey.

The Symmetrical Top in Wave Mechanics.

IN a recent issue of NATURE (Dec. 4, 1926, p. 805) there appeared a letter of Messrs. R. de L. Kronig and I. I. Rabi, in which they gave, on the basis of the new wave mechanics of Schrödinger, an expression for the energy of a symmetrical rotator, *i.e.* a rigid polyatomic molecule having two equal moments of inertia.

A like result has also been obtained by F. Reiche (*Zeit. f. Phys.*, 39, 444, 1926) using the wave mechanics. Furthermore, under the assumption that the molecule possesses a permanent electric moment along the direction of its figure axis, Reiche derived to first order approximation the addition to the energy expression caused by placing the molecule in an external electric field. Independently of Reiche, also using the wave mechanics, we have carried the calculation to the second order of approximation and have thus been able to compute the dielectric constant. We find for the total energy $W^*_{j,m,n}$ of the molecule in the presence of an electric field of strength F

$$W^*_{j,m,n} = W_{j,n} - \mu F \frac{mn}{j(j+1)} + \frac{(\mu F)^2}{h^2/8\pi^2 A} 4(\Phi_{j,m,n} - \Phi_{j+1,m,n}),$$

where $W_{j,n}$ is the energy of the molecule without electric field, as already given by D. M. Dennison (*Phys. Rev.*, 28, 318, 1926) using the matrix mechanics. μ represents the permanent dipole-moment, A the moment of inertia about an axis perpendicular to the figure axis, and j, m, and n three quantum numbers. The first of these may take all positive integral values not including zero, while the others may take both positive and negative integral values including zero, subject to the restriction that the absolute value of each shall not exceed the value of j. The function $\Phi_{j,m,n}$ is a numerical factor depending only upon the quantum numbers:

$$\Phi_{j,m,n} = \frac{(j^2 - m^2)(j - n^2)}{(2j-1)(2j)^3(2j+1)},$$

$\Phi_{j+1,m,n}$ is the same expression, where only $j+1$ is substituted in place of j.

From the energy expression given above, the dielectric constant of a perfect gas is found to have the following value at high temperatures:

$$1 + \frac{4\pi}{3}\frac{N\mu^2}{KT},$$

where T is the absolute temperature, N the number of molecules per unit volume, and k the Boltzmann constant. This result is in complete agreement with the value of the dielectric constant of such molecules already found by Kronig (*Proc. U.S. Nat. Acad. Sci.*, 12, 608, 1926) using the matrix mechanics, and it means that at high temperatures the dielectric constant obeys the law of Langevin-Debye. We have found that at usual temperatures the departure from this law cannot exceed a few per cent.

It may be remarked that the second term in the energy expression given above predicts the existence of a Stark effect of the first order in the band spectra of symmetrical molecules, whereas for diatomic molecules an effect only of the second order is to be expected. The separation of the lines in the Stark effect of the first order for symmetrical molecules depends upon the magnitude of the dipole-moment and the field strength, but *not* upon the moments of inertia of the molecule. The intensity of the lines, on the other hand, is dependent upon the moments of inertia. The separation of the lines in the Stark effect of the band spectra of polyatomic molecules, which a simple calculation shows to be of a sufficient magnitude to be measured experimentally, thus provides a means of finding the dipole strength of such molecules. One finds $\Delta\lambda/\lambda = 22 \times 10^{-6}$ with $F = 50{,}000$ volts/cm. and $\mu = 1 \times 10^{-18}$ C.G.S. units.

A detailed paper covering the work outlined here will appear shortly by one of us in the *Physikalische Zeitschrift*.

P. DEBYE.
C. MANNEBACK.

Physikalisches Institut,
Eidgen. Technische Hochschule, Zürich,
Dec. 14.

The Homologues of the Adrenal or Suprarenal Bodies in Teleostean Fishes.

THE homologues of the adrenal or suprarenal bodies in teleostean fishes have long been the subject of discussion. In 1884, Weldon (*Quart. Jour. Micr. Sci.*, 1884, 24, 171-182) thought that the adrenals were frequently absent from this group, and that the lymphoid head-kidney took their place in these cases. This theory was refuted by one of us in 1896 (Swale Vincent, *Proc. Birm. Nat. Hist. and Phil. Soc.*, 10, Part 1, 1896). In the meantime it was commonly

assumed that the pale, spherical bodies, near the caudal end of the kidney, on its ventral or dorsal surface, were the homologues of the adrenal bodies in higher vertebrates (Swale Vincent, *Trans. Zool. Soc. Lond.*, 14, Part 3, 1897). The corpuscles of Stannius, as these bodies were named, appeared, in fact, to have roughly the structure of the inter-renal of the elasmobranch, and the cortex of the adrenal of higher vertebrates.

In 1908, E. Giacomini (*R. Acad. delle Scienze dell' Instituto di Bologna*, 24 maggio, 1908) put forward another claimant for the position of teleostean adrenal cortex, namely, groups of glandular-looking cells in the lymphoid head-kidney, and stretched out along the blood vessels in this region. Since that time it has been customary to refer to the anterior and posterior cortical adrenals in these fishes.

The work of Giacomini seemed to minimise the importance of extirpation experiments carried out upon the corpuscles of Stannius, in which experiments eels were found to live indefinitely after extirpation of these bodies (Swale Vincent, *Proc. Roy. Soc. Lond.*, 62, 1897).

We have recently had occasion to study the microscopic structure of the corpuscles of Stannius and the 'anterior adrenal bodies' of Giacomini. Using approved modern histological methods, we are satisfied that we have to deal not with two isolated portions of the same structure or organ, but with two totally separate and distinct glands, having in all probability different functions. This is indicated by a striking difference in the general appearance of the sections and is confirmed by measurements of the various elements. There are also obvious microchemical differences in the two structures.

In examining the detailed cytology, we have received much assistance from Dr. C. da Fano, of King's College, London, who has made for us preparations to show the Golgi apparatus. He agrees with us that the two structures bear very little resemblance to each other and that the Golgi apparatus has a different arrangement in the two cases.

We are inclined to believe that it is the anterior adrenal body in the head-kidney which ought to be considered the homologue of the adrenal cortex; and, if this is correct, this body should be styled simply the adrenal cortical body. If this is so, what are we to say of the corpuscles of Stannius? Here is a perfectly definite circumscribed organ for which we have to find a place, both morphological and physiological. One is tempted to place it, provisionally, in the group of epithelial organs, in which are included the anterior pituitary, corpus luteum, the parathyroids, islets of Langerhans, etc. It has occurred to us that it may, in fact, be an insulin-producing tissue, and if sufficient material can be collected, it is our intention to test this. We hope to publish a full account of this work at a later date.

SWALE VINCENT.
F. R. CURTIS.

Department of Physiology,
Middlesex Hospital Medical School,
London, W.1.

Scientific Achievement and Aptitude.

THE excellent editorial in NATURE of Nov. 13 suggests a few comments. Several years ago, Lady Gregory came to the University of Colorado and lectured on the Irish drama. She insisted on the importance of each country or region fostering its own dramatic art, and cultivating dramatic expression among its citizens. Under such conditions, she urged, not only is there a quickening of the general intelligence, but also genius finds its appropriate setting and chance for appreciation. Surely the same argument may be used with reference to science. It is not possible to determine the native ability of various nations from such statistics as are cited by Dr. Slosson. Very much depends on popular recognition, and even the discovery of new chemical elements is largely controlled by opportunity. Although the genius is an asset of incalculable value, he is only of value to communities intelligent enough to profit by his labours. In 1914, 105,681 infants under one year died in Great Britain. In 1924 the number was only 65,259. In the same period the deaths per thousand were cut down from 23·9 to 19·3. This was not done through the brilliant inspiration of some genius, but by the incessant labours of thousands of relatively or absolutely obscure persons using the knowledge communicated by scientific men of all grades of distinction.

My own interest in natural history was greatly stimulated by J. W. Taylor and W. D. Roebuck, who were preparing a "Monograph of the Land and Freshwater Molluscs of the British Isles." Their methods were in direct contrast to those of some monographers. We not rarely hear that so-and-so is monographing the ——. All specimens must be sent to him. No one else should have anything to say on the subject. By the time the great work appears, interest in its topic has so long been dead, that it is received with due reverence but little real joy. There are, of course, some fields of science which are necessarily cultivated in this manner. Only a few men of unusual training and powers, provided with unusual and costly apparatus, can do anything with them. The 'man in the street' is absolutely out of it, except as a possible contributor of funds. But in other fields this is not the case. Taylor and Roebuck, from the beginning, did everything to interest young conchologists in the possibilities of doing things, of making discoveries. The result was a great deal of enthusiasm and the accumulation of an enormous mass of data which eventually went into the monograph. It is lamentable to have to record that this beautifully illustrated and minutely detailed work has ceased publication, because the cost of printing is too high. As a contribution to national culture it would abundantly pay the country to continue the printing at the public expense.

The moral seems to be, that whether we desire material benefits or increased happiness, bread or song, it is of the utmost importance to cultivate scientific interest among the people at large. This interest should not simply take the form of open-mouthed astonishment at the works of the learned, but should be inspired by the hope and expectation of personal accomplishment, and the sense of having part in a great undertaking.

T. D. A. COCKERELL.

University of Colorado,
Nov. 24.

Behaviour of Silicic Acid Gel during the Drying-up Process.

IN the *Proceedings of the Indian Association for the Cultivation of Science* for June 1926, K. Krishnamurti in a short note describes the formation of fibres of potassium chloride when crystallised from silicic acid gel. This note was apparently written as the result of an observation made in May 1924.

On October 18, 1924, we communicated to the *Journal of Physical Chemistry* a paper, "Some

Observations on the Preparation and Properties of Silicic Acid Gel," which was published in March 1925. In this paper we describe the fibre-like crystals of sodium chloride obtained when crystallised from silicic acid gel. This publication seems to have perturbed Mr. Krishnamurti, since in his note of June 1926 he emphasises the fact that his *observation* was made prior to the date of the communication of our paper.

However, we decided to make no comment on Mr. Krishnamurti's remarks, knowing that our observations would receive such consideration from scientists as they deserved.

In a letter published in NATURE of December 11, 1926, Mr. Krishnamurti accuses us of having overlooked his contribution in our more recent publications. In particular, he refers to our paper published in *Proc. Roy. Soc.*, A, vol. 112, p. 468, 1926, on "Change of Crystal Structure of some Salts when Crystallised from Silicic Acid Gel: The Structure of Silicic Acid Gel." Mr. Krishnamurti's remarks are incorrect, even assuming that his note merited mention in our published work. If he will take the trouble to refer to our paper in the *Proc. Roy. Soc.*, he will find that the paper was communicated on May 17, 1926, hence it would be impossible for us to include in that paper a reference to a paper which was not published until June 1926.

Mr. Krishnamurti will also be interested to learn that we gave a summary of our last paper before the Chemistry Section of the British Association at Southampton in September 1925.

For Mr. Krishnamurti's information only we beg to state that our first observation of the formation of needle-like crystals of sodium chloride from silicic acid gel was in November 1923, but of course this was not publicly recorded until we had completed our investigation of the problem in hand.

J. B. FIRTH.
H. A. FELLS.

The Chemistry Department,
University College,
Nottingham, Dec. 13.

[DISCUSSIONS of priority of observation or publication are of limited interest and tend to become purely questions of personal differences of opinion. We much prefer, therefore, not to give further space to such matters as are referred to in the above letter.—ED. NATURE.]

A Source for Resonance Radiation.

WHILE engaged in some experiments on mercury resonance radiation at Johns Hopkins University last spring, I became convinced that a less erratic and, if possible, more intense source than the usual water-cooled quartz arc was almost a necessity for some kinds of work. A high-voltage discharge seemed likely to be much steadier than a low-voltage arc, and an obvious way of cutting down self-reversal due to normal mercury vapour was to use a gas for the discharge, with mercury present at a relatively low pressure, secondary processes keeping the mercury atoms largely in excited states. Experimental work was interrupted, however, and it was only recently that an opportunity arose for testing such a source in comparison with a regular quartz mercury arc.

A quartz tube 7 mm. in diameter and 20 cm. long, provided with tungsten electrodes and containing argon at a pressure of about 6 mm. and mercury vapour at a pressure corresponding to 50° C. was excited by a small wireless transformer. The voltage across the tube was 1500. Used as a source, this tube produced an intensity of resonance of λ2536 about half as great as that produced by a water-cooled quartz arc of the usual type. The arc was used without a magnetic field, but was cooled during the exposures at such a rate that it was extinguished in about a minute, thus producing the maximum intensity of resonance. The argon tube required no cooling or magnetic field and seemed perfectly steady and capable of indefinite operation without attention. I am grateful to Messrs. Foote and Mohler for apparatus used in these tests.

It is probable that the intensity of the 'gas-discharge' source can be greatly increased. The pressures given above are approximately optimum values for the particular tube and excitation used, but the possibilities of obtaining greater intensity by using greater power input (the tube was comparatively cool), end-on illumination, other gases, perhaps an arc instead of a high-voltage discharge, etc., have not been tested. The device recommends itself as it stands, however, by its great convenience of operation and the ease with which it can be constructed in the laboratory. It appears likely that this source would be advantageous for resonance measurements when using a photo-electric cell instead of photographic plates.

It is quite possible that such a gas-discharge tube has been used elsewhere as a source for mercury resonance. Dorgelo has used a similar discharge, although for a different purpose. The tube is also quite similar to those used by Wood and others for sodium, but its advantages over the much-used water-cooled mercury arc have seemed worthy of this notice.

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Nov. 23.

Collisions of the Second Kind between Ions and Atoms or Molecules.

SOME experiments dealing with collisions of the second kind between ions and atoms or molecules have been performed independently and simultaneously in two different laboratories—one at Princeton University and one at the University of California. Through correspondence the different investigators have learned of each other's results and have decided to present jointly, in this letter, a preliminary report of this phenomenon, which heretofore has been unknown. In both researches, the apparatus used are essentially those described in the positive ray experiments by Smyth (*Proc. Roy. Soc.* and *Phys. Rev.*) and by Hogness and Lunn (*Phys. Rev.*). One set of experiments is the preliminary stage of a complete study of the whole phenomenon; the other is incidental to work on the positive ray analysis of nitric oxide.

Mixtures of two gases, in equal amounts, have been ionised by electron impact, the impact electrons having velocities well above the ionisation potential of either of the gases. In each case the relative amounts of the two ions formed were determined as a function of the pressure of the gas mixture in the apparatus, and it was found that the relative amount of that ion corresponding to the higher ionisation potential decreased regularly with increase of pressure. The phenomenon can be explained only by collisions between ions and atoms or molecules, in which the ions rob the colliding atoms or molecules of one of their electrons, the process taking place with evolution of energy.

The results thus far obtained are given by the following equations:

$$He^+ + Ne = Ne^+ + He,$$
$$Ne^+ + A = A^+ + Ne,$$
$$A^+ + NO = NO^+ + A,$$
$$He^+ + NO = NO^+ + He.$$

The ionisation potentials of He, Ne, A, and NO are 24·5, 21·5, 15·4, and 9 volts respectively.

With diminishing pressure the above reactions take place to smaller extent and, in each case, the ratio of the relative amounts of the two ions, extrapolated to zero pressure, is that due only to electron impact ionisation. This extrapolated ratio gives the relative probabilities of ionisation of the different ions. The results thus obtained are in agreement with those of K. T. Compton and C. C. Van Voorhis (*Phys. Rev.*, 27, 730, 1926).

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Photo-electric Polarimetry.

WITH reference to the letter from Dr. J. Kenyon published in NATURE of February 27, 1926 (vol. 117, p. 304), which I have only just happened to see, I should like to add the following.

H. von Halban and K. Siedentopf in July 1922 applied for a German patent for methods of photo-electric polarimetry. The patent was granted as No. 386,537 and taken up by the optical works of R. Winkel, Göttingen.

The processes described in their specification were critically examined by K. Mayrhofer. This investigation was finished by July 1924 and the results were embodied in a Würzburg dissertation in 1924.

The best results were obtained with an arrangement in which the variations of luminosity of the source (mercury lamp) were compensated by using two cells.[1]

The light emerging from a monochromator was split up by a quartz plate. The transmitted ray passed through a polarimeter specially built by Messrs. Winkel on a potassium photo-electric cell with argon filling, while the reflected ray fell direct on a similar cell. The voltages on the two cells were so distributed that the photo-electric currents balanced, as shown by a single-fibre electrometer. Thereupon similar vessels with the solution to be tested were introduced into the two beams. This cancelled the loss of light by absorption and left only the change due to polarisation, which was then compensated by rotation of the nicol.

With this method measurements were made on the mercury lines down to 2536 Å.U. The readings could be reproduced with an accuracy of 0·01° in the strong ultra-violet lines, and rather less accurately in the feeble lines.

The same method can of course also be used for absorption measurements, and results were obtained for potassium chromate which agree well with those obtained by other methods.[2]

If, however, only absorption measurements are required, it will be found better to use the two-cell method of von Halban and Siedentopf (*ibid.*), since the polarimeter, with its many reflecting surfaces, introduces much loss of light.

A detailed publication of Mayrhofer's measurements will appear shortly in the *Zeitshrift für physikalische Chemie*.

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[1] E. Meyer u. H. Rosenberg, *Vierteljahrsschrift d. astronom. Ges.*, **48**, 3, 210 (1913). H. v. Halban u. H. Geigel, *Z. f. phys. Chemie*, **96**, 214 (1920). H. v. Halban u. K. Siedentopf, *Z. f. phys. Chemie*, **100**, 208 (1922). H. Rosenberg, *Z. f. Physik*, **7**, 18 (1921).

[2] H. v. Halban u. K. Siedentopf, *Z. f. phys. Chemie*, **100**, 208 (1922).

The Double Normal State of the Arc Spectrum of Fluorine.

IN NATURE of December 4, p. 804, Mr. de Bruin suggests that Millikan's complex hot spark lines of fluorine, at λλ607,657, are to be attributed to FI. The components of these lines exhibit intervals which, within the rather wide range of experimental error in this difficult region, are equal to the intervals Δ^4P_{12}, $\Delta^2P'_{12}$, and Δ^2P_{12} occurring among the red lines of FI, but it does not appear possible to form the groups into complete multiplets in such a way as to give the equalities undoubted significance. The assignment of these groups to FI is very hazardous, in view of the fact that they have been produced only under the extreme conditions of the hot spark. It may be recalled that Millikan at first assigned them to FVII.

In a recent paper (*Proc. Roy. Soc.*, A, 113, p. 323) I have given evidence that the ionisation potential of the neutral fluorine atom is approximately 17 volts. The ultra-violet groups in question correspond to excitation potentials of about 20 volts and 19 volts respectively. It would appear, therefore, that if Mr. de Bruin's assignment is correct, the groups must require the simultaneous excitation of two or more electrons for their production. This is unlikely, in view of the satisfactory correlation of the terms involved with those predicted by the Heisenberg-Hund theory on the supposition that only one 2_2 electron is excited. It therefore seems probable that the extreme ultra-violet lines are emitted by a fluorine atom which has been ionised one or more times.

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Rate of Work done by Athletes.

IN an article by Dr. J. S. Haldane and Dr. Y. Henderson in NATURE of August 28, p. 309, are references to the rate at which a man in good physical training can do work. For example, in a mile and a quarter rowing race the rate was 0·57 horse-power; and again, Douglas and Haldane, for short bursts of climbing, reached a rate of 0·9 horse-power.

It occurred to us that these rates might be exceeded by a runner raising his own weight against gravity when dashing up a flight of stairs with a running start. These experiments were easily carried out with a stop watch, and the rates obtained by a young man aged twenty-five years were, for a height of stairs mounting to 7½ feet, 13 feet, and 125 feet vertically, 1·87, 1·70, and 0·87 horse-power. The last experiment is a severe tax on the heart, and is not one to be recommended.

An interesting question is the efficiency per pound weight of the athlete. This resolves itself into the simple question of the vertical velocity, and in such experiments a man would probably have to take second place to a dog, a cat, or a sparrow. What is the most efficient living creature?

A. S. EVE.
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Nov. 27.

Total Solar Eclipses in the British Isles.

By Dr. W. J. S. LOCKYER.

ON June 29 of this year the sun will be totally eclipsed over a belt of northern England. Unfortunately, this event takes place very early in the morning, the total phase beginning at about $5^h\ 24^m$ G.M.T. or $6^h\ 24^m$ B.S.T., so that the sun will be only about 12° above the north-eastern horizon. Nevertheless, even under these rather unfavourable conditions, every one who has never seen the sun totally covered by the moon should make an effort on June 29 to be somewhere on that belt of country from which to see the striking spectacle of a total solar eclipse.

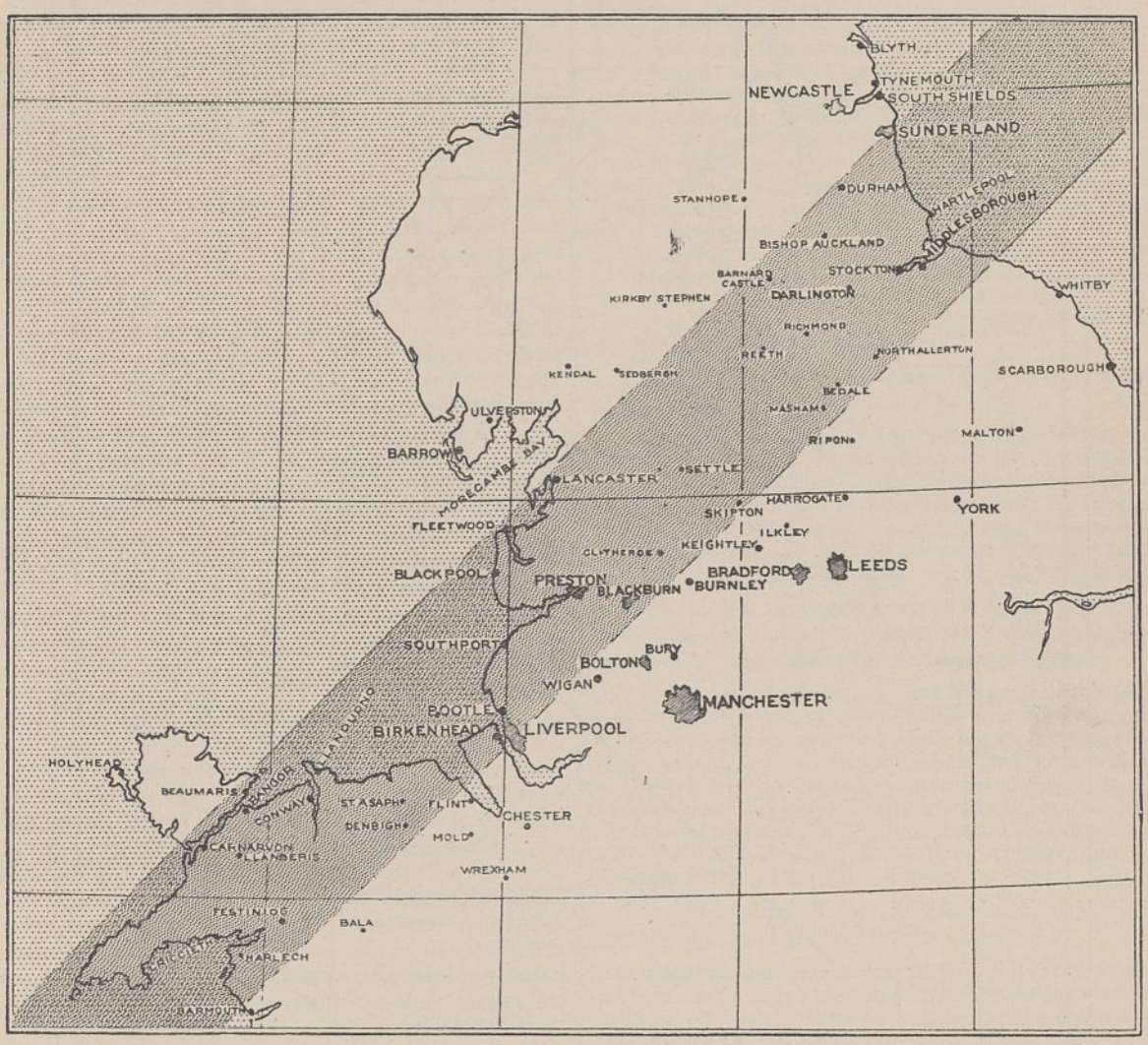

FIG. 1.—Track of the total solar eclipse across England on June 29, 1927.

An approximate position of the path of the moon's shadow is indicated on the portion of a map of England illustrated in Fig. 1. The breadth of the belt is about 30 miles, and the nearer the observer is to the centre of this belt the longer is the duration of totality. The central line of totality strikes the west coast of Britain near Criccieth, in Carnarvon, passes over Southport and nearly over Preston. It then sweeps over the north part of Yorkshire, and passes over Settle and Richmond, finally leaving the coast in the southern portion of the county of Durham, and passing over Darlington and Hartlepool and a little to the north of Stockton. The duration of totality is about 24 seconds, but is a little shorter than this on the west coast and a little longer on the east coast. Large towns just inside the border line of this belt are Carnarvon, Liverpool, Burnley, Skipton, Lancaster, and Durham.

So far, reference has been only made to that part of the track of the moon's shadow which first crosses England after commencing in the eastern Atlantic. Its later course is north-easterly, extending over Norway, Sweden, Lapland, and skirting the west coast of Novaya Zemblya. It then strikes easterly over the Arctic Ocean and north-westerly over north-eastern Siberia, terminating its course in the north-western portion of the Pacific Ocean.

The most satisfactory places for large, well-equipped

expeditions will undoubtedly be in Sweden and northern Norway, for there the sun will be well up in the sky and the eclipse of longer duration.

Formerly there were many problems that could be investigated only during a total eclipse of the sun. The rapid advancement of solar physics during the last half-century has so considerably reduced these in number that the importance of observing eclipses from this point of view is much reduced. Thus, it is now known that the corona is a solar and not a lunar appendage; that the prominences can be seen whenever the sun is visible without having to wait for an eclipse to observe them; the study of the spectrum of the chromosphere in the photographic region is not now so important as it was; Einstein's theory of the bending of light by solar influence has been proved and requires no further repetition.

The main problems still to be studied are the exact times of the four contacts for the problem of the moon's motion; the red end of the chromospheric spectrum; the spectrum of the corona, best studied when the sun is in its greatest state of activity; and, finally, the form of the corona. Even the last mentioned is nearing solution, because it is now ascertained that coronal matter is closely associated with prominence matter, and that the positions of the prominences as regards solar latitude are intimately tied up to the positions of the coronal streamers. Thus it is well known that the

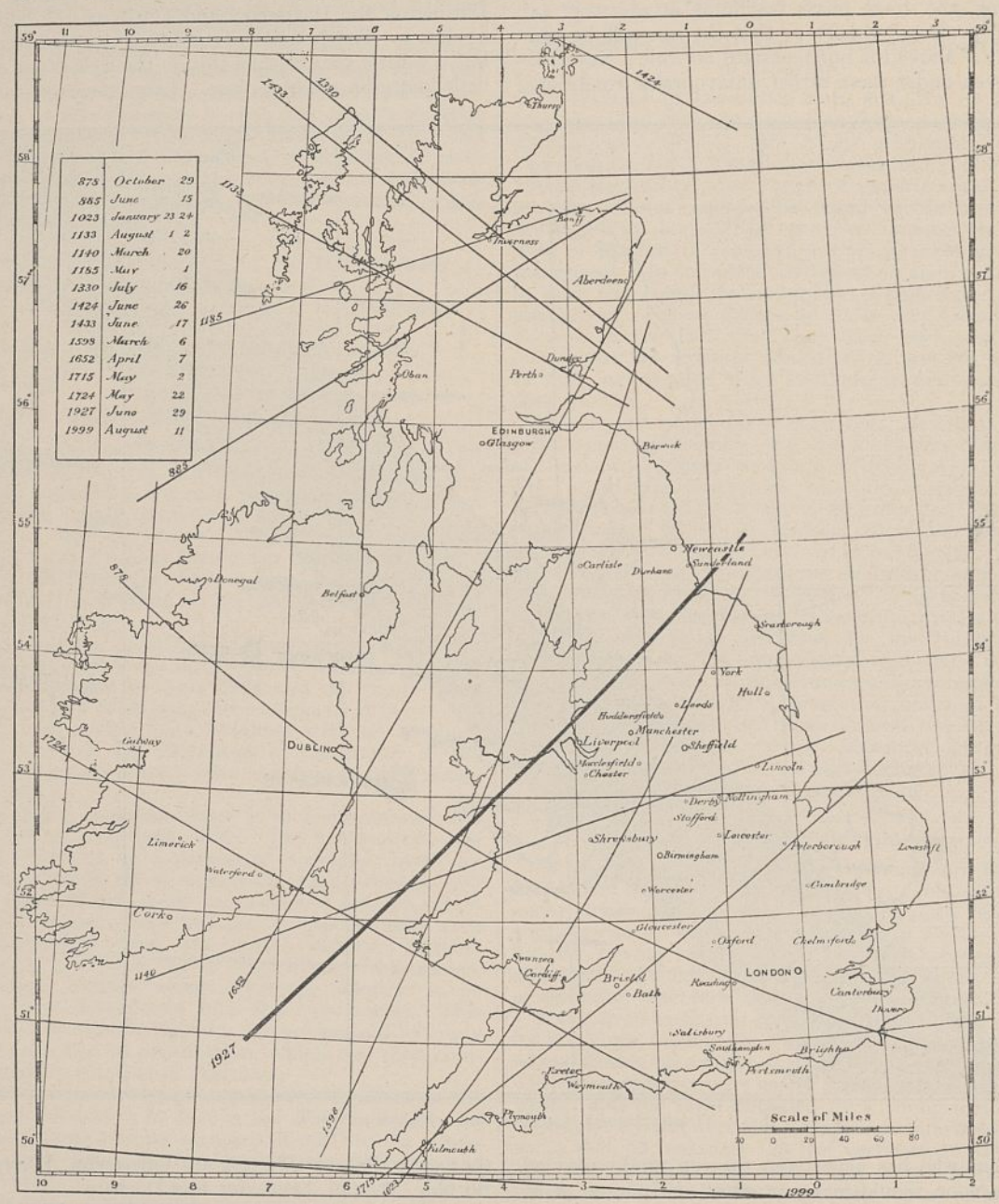

FIG. 2.—Map of total solar eclipses visible in Great Britain and Ireland from 878 to 1999.

form of the corona assumes one of three main types, a polar or maximum form, an intermediate or square form, and a minimum or wind-vane form. The polar form only occurs when the prominences are active near the solar poles. Next year the prominences will be near the poles, so that the type of corona is expected to be of the 'polar' or 'maximum' type.

In connexion with the passing of the moon's shadow over England this year, it is of interest not only to refer to other total eclipses visible in the British Isles, but also to inquire when the next one will take place. A very interesting map was published in the *Monthly Notices of the Royal Astronomical Society* in 1885 in a paper by Mr. J. Maguire, entitled "Total Solar Eclipses Visible in the British Isles, 878–1724." This map is here reproduced (Fig. 2) in a simplified form, to show the centres of the tracks only: those for 1927 and 1999 have also been inserted.

The eclipses here represented commence with the year A.D. 878, and show that thirteen total solar eclipses have occurred in the British Isles since and including that date. The last to take place was that of 1724, so that no total eclipse of the sun has occurred in these islands for the last 203 years.

Accounts of early English eclipses, whether total or partial, are generally alluded to in the "Saxon Chronicle." Thus, the very first record of one occurring in Great Britain, namely, the partial eclipse of A.D. 538, is referred to in the "Chronicle" in the following words: "In this year the sun was eclipsed fourteen days before the Calends of March from early morning till nine."

For the year A.D. 733, the "Chronicle" relates that "in this year Ethelbald captured Somerton; and the Sun was Eclipsed, and all the Sun's disk was like a black shield; and Acca was drawn from his bishopric." According to the Rev. S. J. Johnson, this eclipse was not total but annular, and is the first record of such an eclipse in England.

Omitting references to later eclipses, and coming to that of A.D. 1140, this was total over England, the centre of the track just skirting the south of Ireland, and leaving the east coast of England about the town of Lincoln. About this eclipse the "Chronicle" states: "In the Lent the sun and the day darkened about the noontide of the day, when the men were eating; and they lighted candles to eat by. That was the thirteenth day before the Calends of April. Men were very much struck with the wonder." This eclipse was evidently a very dark one, for William of Malmesbury stated that "while persons were sitting at their meals, the darkness became so great that they feared the ancient chaos was about to return, and upon going out immediately, they perceived several stars about the Sun."

The Scottish eclipse of 1652, when the central line passed near Wicklow in Ireland, and left the east coast of Scotland at Peterhead, is of interest because it was the first eclipse observed in the British Isles after the telescope had first been used in the eclipse of 1612.

The total eclipse of 1715 was of special importance to British observers, because London came well into the shadow belt, the central line passing over Falmouth in Cornwall and leaving the east coast at King's Lynn in Norfolk. Another interesting feature was the fact that the celebrated astronomer Halley received orders from the Royal Society "to provide for the observation to be made at their house in Crane Street," and for this purpose he published a special map showing the whole shadow path over England. With regard to this map he wrote:

"Having found, by comparing what had been formerly observed of Solar Eclipses, that the whole Shadow would fall upon *England*, I thought it a very proper opportunity to get the Dimentions of the Shade ascertained by observation; and accordingly I caused a small Map of *England*, describing the Track and Bounds thereof, to be dispersed all over the Kingdom, with a Request to the Curious to observe what they could about it, but more especially to note the Time of Continuance of Total Darkness, as requiring no other Instrument than a *Pendulum Clock*, and as being determinable with the Utmost Exactness by reason of the momentaneous Occultation and Emersion of the luminous Edge of the Sun, whose least Part makes Day. Nor did this fail of the desired Effect, for the Heavens having proved generally favourable, we have received from so many Places so good Accounts, that they fully answer all our Expectations, and are sufficient to establish several of the Elements of the *Calculus* of Eclipses, so as for the future we may more securely rely on the Predictions: Though it must be granted, that in this our Astronomy has lost no Credit."

Halley seems to have collected quite a large party at Crane Court, for he says that

"There were with us a great many members of the Society: and the Right Honourable the *Earl of Abingdon*, and the Lord Chief Justice *Parker* were of the number: . . . There were also present Gentlemen of other Nations, and among them Monsieur *le Chevalier de Louville* and Mr. *Monmort*, both of them Members of the *Royal Academy of Sciences at Paris*."

Even in 1715 the occurrence of a total eclipse was quite likely to alarm the people, for Halley thought it advisable to warn the public as he states below:

"The like Eclipse having not for many ages been seen in the Southern Parts of Great Britain, I thought it not improper to give the Publick an account thereof, that the sudden darkness, wherein the Stars will be visible about the Sun, may give no surprize to the People, who would, if unadvertized, be apt to look upon it as ominous, and to interpret it as portending evill to our Sovereign Lord King George and his Government, which God preserve."

The observation of this eclipse was favoured with fine weather, and Halley describes how the

"face and colour of the sky began to change from a perfect serene azure blue to a more dusky livid colour, intermixed with a tinge of purple, and grew darker and darker till the total immersion of the Sun."

The well-known phenomena of 'Baily's beads,' first named such after the observation in Scotland of Mr. Baily at the annular eclipse of the sun of May 15, 1836, was distinctly noted by Halley in this eclipse of 1715, for he stated that "about two Minutes before the Total Immersion, the remaining Part of the Sun was reduced to a very fine Horn, whose Extremities seemed to lose their Acuteness and to become round like Stars."

During the total obscuration, which lasted $3^m\ 22^s$, the planets Jupiter, Mercury, and Venus, as well as the stars Capella and Aldebaran, were seen with the naked eye, and "there appeared a luminous ring around the moon as on the occasion of the eclipse of 1706." This

luminous ring or corona was regarded at that time as a structureless aureole appertaining to the moon and not, as we know it now, the upper regions of the solar atmosphere, only visible during total eclipses.

Those who have observed total eclipses are familiar with the feelings of weirdness of the occasion, the chilly and damp nature of the air, and the behaviour of animal life, and many who will observe their first total eclipse this year will also be able to corroborate the following account of the 1715 eclipse given by Halley:

"I forbear to mention the *Chill* and *Damp* with which the Darkness of the Eclipse was attended, of which most *Spectators* were sensible and equally *Judges*: or the Concern that appear'd in all Sorts of *Animals, Birds, Beasts,* and *Fishes* upon the Extinction of the Sun, since ourselves could not behold it without some sense of Horror."

The eclipse of 1715 was followed by that of 1724, which took place in the month of May, and was the last to be observed as total in Great Britain. The track of totality passed over the southern portion of Ireland and the south-west portion of England, London being situated just outside the northern boundary. This eclipse was well observed, and Halley again played an important part in connexion with it.

After June 29, 1927, the next total eclipse that will be of special interest to observers in the British Isles is that which will occur in 1999 on August 11 (see Fig. 2). The central portion of the track just skirts the extreme southern coast of Cornwall, so that totality will only be visible to those stationed in the extreme south-west of England. At that remote epoch it is difficult to forecast what the work of the astronomer will be. It is safe to say, however, that the problems now studied during total solar eclipses will all be solved, but it is almost as certain that new problems will have arisen which will necessitate possibly still greater attention being paid to the study of the sun under eclipse conditions. Even if there were no scientific reasons for observing total solar eclipses, they must still attract close attention by reason of the remarkable solar phenomena which then become visible and the weird and awe-inspiring feelings which are aroused by the spectacle.

Spinning Electrons.

By R. H. FOWLER, F.R.S.

THE past fourteen or fifteen months have seen some striking advances and simplifications in theoretical physics. The trench warfare of the preceding three years, which consolidated the ground and marked out slowly the key positions for the new attack, is past. That attack has been launched with almost complete success. The first fury of the advance is perhaps now over. At least it is now possible to survey our older difficulties afresh, to find in many cases that they are no longer formidable. It therefore seems the right moment, and perhaps of general interest, to try to indicate the parts played in this advance by the more striking of the ideas associated with it—in this article the spinning electron. In a later article it may be possible to discuss similarly the other primary conception—the new mechanics, and particularly Schrödinger's equation. Without any assertion of finality in the description of electronic interactions by its means, the importance of the spinning model of the electron can scarcely be over-estimated. Yet the spinning electron has been so lost in the far wider ideas embodied in the new mechanics that it is as yet scarcely appreciated at its full value. It is convenient therefore to devote this article to it alone.

Without prejudice to the difficult prior questions of internal structure, we may regard the electron merely as a singularity in space—the source of the external field by which it is known to us. Until recently this singularity has always been assumed to be the simplest possible, with the external field of an electrostatic point charge acting radially and symmetrically in all directions. The first serious suggestion that the electron should be treated as a more complicated singularity appears to have been made by A. Compton (*Jour. Franklin Inst.*, **192**, 145, 1921). In connexion with a survey of gyromagnetic, diamagnetic and ferromagnetic phenomena he suggested that the singularity might be such as to give rise to the magnetic field of a magnetic doublet besides the usual electrostatic field. Structurally, such an electron must have an axis of symmetry—the doublet axis—and it is natural to think of its magnetism as arising from a spin of its charge about this axis, which will therefore also be its axis of mechanical angular momentum. The fields above mentioned are of course the fields of the electron relative to a set of axes in which its centre is at rest. Relative to other axes they must be derived by the transformation of Lorentz.

We will now show in turn how the use of this more complicated model of the electron resolves the remarkable set of paradoxes in which atomic theory had involved itself by the spring of 1925, owing, as we now see, to the use of an inadequate mechanical model. The most clear-cut of these depends on the statistical conception of weight, so that its appeal is perhaps not so direct as that of some of the others. We know, by a purely enumerative study of atomic spectra and their structure in magnetic fields, the total number of states which must be associated with any one spectral term of an atom or ion. This total is the statistical weight of the term. We know further that spectral terms can be grouped into sets, each characterised by a maximum multiplicity R. If R is one, all the terms are single. If R is two (for example, for sodium), the S terms of the set are single and the rest double, and so on. The weight, as counted above, for an S term of a spectrum of maximum multiplicity R is always R. Now the normal state of any once ionised atom is the core of the atom during the various stages of capture of the next electron. The weight of the core is therefore R, indicating that it can split under perturbation into just R different states. The new electron then comes in, and describes its possible orbits about the core in an approximately central field of force. If the electron is a point charge there seems no escape whatever from the conclusion that the total

number of states of total quantum number n must be asymptotically equal to n^2 for large n, and the total number of states of core and orbital electron Rn^2. The actual number found is $2Rn^2$ for all n in all cases. No form of the quantum theory yet propounded offers a rational escape from this paradox, *unless the electron has a structure*. The difficulty of avoiding the enumerative difficulty in any other way is exceedingly grave, though it lies rather deep and is not readily appreciated. Its gravity comes from the fact that it depends solely on the number of degrees of freedom and an asymptotic approximation at great distances to the law of the inverse square for the force between the electron and the ion, which can scarcely be called in question. If, however, the electron spins and can set its axis at just two inclinations relative to the plane of its orbit, the paradox disappears.

The second paradox was the better-known anomalous Zeeman effect. By Larmor's theorem the action of a magnetic field on any stationary state of any atom should split the state into a number of states equidistantly spaced, and this spacing should be the same whatever the original state. As a result every spectral line should split into a certain triplet called the normal Lorentz triplet. In fact, such triplets are rare, being found only for lines of singlet systems. The general more complicated splitting structures found can be formally described by assigning to each state a splitting factor g depending on the type of the state. Larmor's theorem asserts that $g=1$ always. It has been known for some time that the anomaly could be formally explained if the magnetic moment of the atom arose from two sources, of which one was the orbital angular momentum contemplated by Larmor's theorem. The other source must then be such that its ratio (magnetic moment)/(mechanical moment) is twice the ratio of the magnetic and mechanical moments arising from orbital motion. The spin of the electron provides just this source of supply, and exact examination shows that it provides a complete explanation.

The third paradox was the so-called relativity-doublet formula, for the separations found between pairs of X-ray or pairs of optical terms. Familiar cases are the separations of the $K\alpha_1$, $K\alpha_2$ X-ray doublet and the D-lines of sodium. The separations which obey the theoretical formula vary in absolute magnitude by a factor of 10^7, which is accounted for by its salient feature, a factor approximately Z^4, where Z is the atomic number. It was thought most unlikely that any other type of perturbation could supply just this vital factor, but it is impossible rationally to accept this origin. For if we do, the sodium doublet, for example, must be interpreted as due to the difference of energy, owing to the variation of mass with velocity, of orbits of azimuthal quantum numbers one and two and the same total quantum number in an inverse square field. At the same time the much greater difference between the *pair* of P orbits and the S orbit, for example, must be interpreted as a difference of energy due to differences of penetration into a non-inverse-square field again by orbits with different azimuthal quantum numbers one and two. The pair of P orbits must for one purpose have the same and for another different azimuthal quantum numbers! If, however, the electron has a magnetic moment, there will be a secular perturbation of its axis by the magnetic field which arises from the linear velocity of the electron in the field of the nucleus, and a corresponding secular perturbation of the plane of the orbit. We can at once show from this that the energy of a single orbit in a central field of force splits up into a set of energies the differences of which vary as Z^4 as required. Finally, if the ratio (magnetic moment/mechanical momentum) required for the Zeeman effect is assigned to the electron, and the calculation of the perturbation exactly carried through, we obtain the proper quantitative formula for the doublet separation. This now enters as the difference of energy between orbits, otherwise the same, for which the momentum of the electron $h/2\pi$ has its two different orientations with respect to the plane of its orbit.

It was of course this success which finally established the value of the spinning electron. The idea and its development in this connexion we owe to Goudsmit and Uhlenbeck. Bichowsky and Urey obtained independently most of the same results. The finally correct numerical form of the separation formula is due to Thomas.

Two further paradoxes may be mentioned. One was that it appeared from a study of the behaviour of spectra in strong magnetic fields (Paschen-Back effect) that four quantum numbers must be used to specify the orbit of an electron. If the electron is a structureless point, with therefore three degrees of freedom, three quantum numbers are the maximum allowed by any form of quantum theory yet proposed. But if the electron has a rigid structure, it has in all six degrees of freedom. If further, as is assumed, its axes of spin and angular momentum always coincide, its orbits can be fully described by five quantum numbers, of which one, defining the magnitude of the spin, is invariable and may be ignored.

The last paradox to be mentioned is the following. In spite of numerous attempts to produce a coplanar model of the helium atom, most physicists have remained convinced that the normal state of helium must correspond to orbits filling three-dimensional space round the nucleus. But there was then the grave difficulty that a diamagnetic atom could not result. Two equal moment-vectors cannot have a zero resultant unless they are oppositely directed and the orbits coplanar. But when the moments of the electrons are added, there are four vectors to combine and the difficulty disappears.

We see then how the spinning electron has brought order out of chaos in the broad outlines of atomic theory. Its necessity and its successes are qualitatively independent of the new mechanics. Without in any way underrating the importance of the new mechanics, it is fair to say that its first effect on the determination of atomic weights and energy values is confined to small adjustments, such as replacing an integer n by $n+\frac{1}{2}$, or n^2 by $n^2-\frac{1}{4}$. (It is not until we come to the extremely important resonance theory of Heisenberg that the new mechanics brings in primary effects on the energy values.) These refinements are of course necessary for the correct theory. But the broader difficulties we have been discussing depend solely on the spinning electron for their solution, and order reigns once again.

It would not be right in a description of the recent work on the spinning electron to pass over in silence a remarkable essay by L. V. King.[1] This embodies an attempt to break right away from the recent trend of atomic physics, to find in h a characteristic constant of a spinning electron, and to develop thereby an almost classical theory of matter and radiation which hopes to avoid all the old classical difficulties without appeal to external postulates such as those of the quantum theory. The exposition given hitherto is, it must be confessed, difficult to follow, and it is difficult to believe that the author has really proved all that he states. A fuller exposition would clear up such points. There is much to admire in gallant excursions such as this; whether they turn out right or wrong it is by such excursions that physics lives.

[1] "Gyromagnetic Electrons and a Classical Theory of Atomic Structure and Radiation." (Montreal: Louis Carrier; Cambridge: Heffer.) 5s.

Obituary.

MR. T. S. P. STRANGEWAYS.

THOMAS STRANGEWAYS PIGG STRANGEWAYS, who died prematurely after a month's illness at Cambridge on Dec. 23, was a retiring man of strong character who had done remarkable work in pathology and tissue culture. Born on Dec. 28, 1866, his original name was Pigg, which he changed to Strangeways on his marriage. Educated medically at St. Bartholomew's Hospital, where he obtained the Matthews Duncan gold medal (1895) and took the qualification of the Conjoint Examining Board (M.R.C.S., L.R.C.P.) in 1896, he was assistant curator of the Museum and came under the inspiring influence of the late A. A. Kanthack, with whom he early collaborated in the *Journal of Pathology and Bacteriology* and in the *Transactions of the Pathological Society of London*. He accompanied that distinguished pathologist when in 1897 he left St. Bartholomew's to become professor of pathology at Cambridge.

Strangeways was appointed demonstrator of pathology in 1897, and held this office under Sir German Sims Woodhead until after the War, so that many generations of Cambridge medical students hold his teaching in grateful remembrance. His handbook on "Clinical Pathology and Practical Morbid Histology" passed into a seventh edition in 1912. He was made an honorary M.A. of the University in 1900, and in 1905 became the first Huddersfield lecturer on special pathology, this endowment being provided by a fund collected by Sims Woodhead from friends residing in or connected with Huddersfield.

Up to this time, Strangeways' life and work had been those of an ordinary university demonstrator, but he now struck out a new line in the intensive study of special diseases of a chronic nature and, under the ægis of a strong committee, energetically and successfully organised a special hospital for the investigation of selected cases. This research hospital, at first in a small private house, was in 1912 properly accommodated in a specially built hospital which was opened on May 24 by the late Sir Robert Brown of Preston, a generous benefactor to the institution. Already four thousand cases of rheumatoid arthritis had been exhaustively investigated pathologically, clinically, and therapeutically; researches had been made into gout, purin metabolism, and the opsonic index by Strangeways and the keen collaborators he gathered together; the results of these researches were collected in the five well-illustrated volumes of the "Bulletin of the Committee for the Study of Special Diseases." The museum of the research hospital contained 2000 arthritic joints dissected and mounted by him.

For the first three years of the War the work was suspended, as the hospital was given over to wounded officers, but continuation of the work showed that at least seven pathological forms of rheumatoid arthritis can be recognised clinically. In 1923 the wards of the hospital were again closed for a time in order to concentrate on tissue culture *in vivo* and *in vitro*, with the object of studying cancer patients in the hospital. The extremely valuable results thus obtained appear in Strangeways' papers in the *Proceedings of the Royal Society*, and his books, "Tissue Culture in Relation to Growth and Differentiation" (1924) and "The Technique of Tissue Culture *in Vitro*" (1924). His observations on the effect of X-rays and radium on tissue cells growing *in vitro* deserve special attention. Thus beginning as a pathologist, he became a biologist, as was eloquently shown in "G. P. B.'s" tribute in the *Times* of Dec. 30.

Strangeways had the power of communicating his enthusiasm to others, and was a lovable collaborator. He bore his infirmity of deafness with admirable patience, and has left a memory behind him which his friends will ever regret. Unfortunately his family are left with very scanty means, and five of his seven children are boys whose education is not completed, the youngest being eight and the eldest twenty-one years of age.

H. R.

PROF. R. W. PHILLIPS.

THE late Prof. Reginald W. Phillips, who had been head of the Department of Botany at the University College, Bangor, for nearly forty years, was born at Talgarth, Breconshire, on Oct. 15, 1854. He took the two years' course of training at the Bangor Normal College, where he was certificated as elementary school teacher in the December of 1874. During 1875 he was headmaster of a school in Ferndale, but soon left to become lecturer at his old college, where he remained until 1881. He then became a scholar of St. John's, Cambridge, at the same time studying for the London B.Sc. In 1884 he was appointed head of the Department of Biology at the newly established Bangor College, and a little later he became professor of botany. As the University of Wales had not then come into existence, the college confined itself to the preparation of students for London degrees; and as there was no efficient system of secondary education the devoted band of teachers at the college had, for years, to hold matriculation classes, in addition to the ordinary degree courses.

Prof. Phillips was a keen observer, and an excellent field naturalist. He became an enthusiastic student

of the marine algæ; especially of the Florideæ. He supplied the article on "Algæ" to the eleventh edition of the "Encyclopædia Britannica"; and during the years 1895–1897, contributed to the *Annals of Botany* a series of valuable studies of "The Development of the Cystocarp in the Rhodomelaceæ," "The Rhodymeniales," etc.

In 1898 Phillips obtained his London D.Sc., and at this time became so engrossed in problems of Welsh education, acting as chairman of the governors of the Bangor secondary schools, and later on adding to these duties those of magistrate, that he dropped his research work—a source of grief to those who, like the present writer, knew what a loss this meant to science.

In the October of 1922 he retired from the service of the college, but in spite of frequent attacks of heart trouble and of the disease which ultimately proved fatal, he took up once more his interrupted algological studies and the following papers were published: "On the Structure of *Spyridia filamentosa*," *Annals of Botany*, **38**, 1924; "The Ceramidium of *Polysiphonia*," *New Phyt.*, **23**, 1925; "On Vacuolar Pseudopodia in *Callithamnion sp.*," *Rev. Alg.*; "On the genera Phyllophora, Gymnogongrus, and Ahnfeldtia and their Parasites," *New Phyt.*, **24**, 1926; "On the Form of the Protoplast in Cells of the Genus Ceramium and those of *Dasya coccinea*," *New Phyt.*, **25**.

During the past year Phillips suffered much from spinal trouble; he was taken to London and operated upon, but unsuccessfully; and on Dec. 2 he died at Leominster.

Mr. S. M. Edwardes, C.V.O., C.S.I.

The premature death from bronchial pneumonia of Stephen Meredyth Edwardes, at the age of fifty-four years, which took place on Jan. 1 at Fielden, near Boxmoor, is a loss to the study of Indian history and archæology deeply to be deplored. Mr. Edwardes was a son of the Rev. Stephen Edwardes, fellow of Merton College, Oxford, and was educated at Eton and at Christ Church. In 1894 he passed into the Indian Civil Service, and was posted to the Bombay Presidency. The intimate acquaintance with conditions among the native population of the city which he soon acquired, and his profound knowledge of its history, on which he was widely recognised as the foremost authority, were employed to full advantage in his census volume of 1901, the additional volumes of the "Gazetteer" which he compiled between 1906 and 1910, and his "Rise of Bombay" and "Byways of Bombay." This knowledge, in combination with his personal qualities, made him eminently fitted for the post of Commissioner of Police, to which he was appointed in 1910. His well-balanced and admirably judicious "Crime in India," published in 1925, showed that no one could have been better qualified to represent India at the Geneva conference on traffic in women and children which he attended in 1921.

On his retirement, Mr. Edwardes became secretary to the Indo-British Association, an organisation formed to oppose the Montagu-Chelmsford reforms; but his chief interest lay in research. In 1923 he became joint editor with Sir Richard Temple of the *Indian Antiquary*. He revised Grant Duff's "History of the Mahrattas" and the fourth edition of Vincent Smith's "Early History of India." He was engaged in a comprehensive study of the Mogul period in collaboration with Prof. Garrett of Lahore, and in this field had already published a study of "Babur: Diarist and Despot." In 1926 he was selected to succeed Miss Ella Sykes as secretary of the Royal Asiatic Society.

Sir Francis Fox.

By the death on Jan. 7, at the age of eighty-two years, of Sir Francis Fox, the engineering world loses one of its oldest and most distinguished representatives. Four years younger than his brother Sir Douglas Fox (1840–1921), Sir Francis Fox was the son of Sir Charles Fox (1810–1874), whose earliest engineering experience was gained under Ericsson at the famous Rainhill locomotive trials and under Robert Stephenson on his London and Birmingham Railway; and he also became known as the constructor of the Great Exhibition building of 1851. From about 1860 onwards, father and sons were responsible for railways, bridges, and tunnels in both hemispheres, among which may be mentioned the Mersey Tunnel, the Liverpool Overhead Railway, the Great Northern and City, and Charing Cross and Hampstead Tubes; railways in India, Argentina, Canada, and Africa, and also the great bridge over the Victoria Falls on the Zambezi River. The firm in its earliest days was Fox, Henderson and Co., but was changed first to Sir Charles Fox and Sons and then to Sir Douglas Fox and Partners.

In his book, "Sixty-three Years of Engineering, Scientific and Social Work," Sir Francis Fox gives an account of many of these undertakings, and it is there he illustrates the remarkable accuracy with which tunnels can now be bored, the discrepancy in the tunnel between Hampstead Heath Station and Belsize Park, London, 4000 feet long, being only $\frac{1}{4}$ in. In the case of the Simplon Tunnel, of which he was one of an international commission, the error was $3\frac{3}{8}$ in. in $12\frac{1}{4}$ miles.

In later years Sir Francis Fox did much important work in connexion with the preservation of old bridges, churches, and cathedrals; using the grouting machine for filling cracks and crevices in the masonry with liquid cement. In his valuable work on the preservation of Winchester Cathedral he was associated with Mr. T. G. Jackson, R.A. In 1912 he was also called upon to report on the condition of St. Paul's Cathedral.

No notice of the career of Sir Francis Fox, however, would be complete without reference to the social work for the less fortunate which he did in London with his brother. During the War, too, he visited the hospitals, lectured to the convalescent, and was instrumental in supplying large quantities of bandages by removing the linen from old engineering plans obtained from many sources. Knighted in 1912, Sir Francis Fox was twice married and leaves one son and three daughters, of whom the eldest, Dr. Selina Fox, was the founder of the Bermondsey Hospital and Medical Mission, a work in which Sir Francis took the greatest interest.

News and Views.

THE radio-telephone service between London and New York was opened successfully to public use on Jan. 7. Those who took part in the conversations for the first time were most favourably impressed by the clearness of the articulation, the voices of the speakers being at once recognisable. After sunset on Jan. 7 on the eastern side of the Atlantic the atmospheric conditions became very bad, which is quite an unusual occurrence for this time of the year. Yet still nearly all the subscribers who had booked times in advance were able to hold conversations. In six minutes the *Times* exchanged more than 600 words with its correspondent in New York, there being only one or two pauses for repetition. Sixty-eight years ago, Queen Victoria sent a message to President Buchanan at the rate of one word a minute, and eighteen years later Graham Bell talked to the future Lord Kelvin by telephone over the length of a room. Kelvin was filled with wonder, and pictured many developments which have come to pass. But even he never imagined that easily recognisable tones could be transmitted through 3000 miles of empty air without wires or cables almost as quickly as light. First we send signals, next we speak, and in the future we doubtless shall be able to see over thousands of miles. At present this long-distance telephone service is limited to telephone users in the neighbourhood of London and New York, but we look forward to this restriction being removed shortly, as telephone communication is now possible with towns on the Pacific Ocean. We do not think that differences in local times will have much effect on the traffic in long-distance communication.

THE sixteenth report of the Development Commissioners for the year ending Mar. 31, 1926, is arranged in four sections, the first two of which relate to the advances recommended for the development of agriculture, rural economy, fisheries and harbours, and describe the purposes for which these advances are being used. The third part relates to action taken in connexion with the compulsory acquisition of land, while the fourth deals with the financial position of the Development Fund at the close of the year. The research institutes, the activities of which are described, are the result of a scheme planned fifteen years ago, about half of them being already at work at the beginning of the War. After the armistice the interrupted programme was resumed, and there has since been a rapid increase, both in the scope of the work and in the financial needs of the stations. Grants in respect of maintenance from the Development Fund have increased approximately from £35,000 in 1919–20 to £160,000 in 1925–26. The original programme for establishing institutes has now been substantially completed, and although new branches of inquiry must be anticipated, it may be stated that a period of relative stability has been reached.

PARALLEL with the scheme for research institutes, a new plan has been developed for investigating local problems and providing advice for farmers. The principal extension in this case is in connexion with soil surveys, the agricultural departments having the co-operation of the Geological Survey. Developments have also occurred in another inter-departmental scheme, namely, that between agricultural institutes and the Meteorological Office, and some twenty stations are now carrying out investigations on the effect of weather on crops. In both these cases the methods of observation are of a tentative nature at present, and will, in all probability, be modified as the work extends. Variety testing of crops is a further important line of investigation which has only recently been developed, but work of this nature is already being carried out at five stations. As regard rural developments, the newly formed county rural community councils are proving successful. Both English and Scottish fishery departments, in addition to sharing in the general hydrographical and plankton investigations and statistical surveys organised by the International Council, are chiefly concerned with that part of the scheme which deals with the herring, cod, plaice, and haddock fisheries. Reports of the work done at the various laboratories are given, together with the papers published during the year. The experiment on land reclamation and improvement at Methwold, carried out at heavy cost to the Development Fund, is but briefly referred to, since a fuller report for the benefit of agriculturists is being prepared by the Ministry. The report concludes with a schedule of the loans and grants made in the past year, the total advances amounting to £558,392 as compared with £513,279 in the previous year (1924–25).

PROF. A. V. HILL, University College, London, Foulerton research professor of the Royal Society, is sailing on Jan. 15 for the United States, where he is to deliver a course of eight Lowell lectures at Boston during March, entitled "Living Machinery," and to act as visiting lecturer in chemistry at Cornell University for the semester February to May inclusive. The scheme of visiting lectureships at Cornell, arranged by Prof. L. M. Dennis through the generosity of Mr. G. F. Baker, enables the University each semester to bring men of science from abroad to work there; that is, to continue their researches and to give series of lectures upon them. Chemistry seems to be interpreted at Cornell in a liberal sense, for Prof. Hill is to work on the physiology of severe muscular exercise in man, using the Department of Chemistry as his headquarters, athletic students as experimental subjects, and the Department of Physical Training as an experimental ground. His lectures will deal with such subjects as speed of movement, rate of recovery, and the limits of muscular exertion. Prof. Hill is also to give two lectures at the Harvard Medical School, and one at the Yale Medical School, and to attend the annual meeting of the American Physiological Society in April. His two predecessors in the visiting lectureship at Cornell have been Prof.

Cohen of Utrecht and Prof. Paneth of Berlin. Prof. Hill expects to return to London at the end of May or beginning of June.

THE Secretary of State for Scotland and the Minister of Agriculture and Fisheries have appointed a Wool-Breeding Council "to consider, and advise the Ministry of Agriculture and Fisheries and the Board of Agriculture for Scotland on questions relating to the improvement and utilisation of wool grown in Great Britain." The Council consists of representatives of the Ministry and the Scottish Board, of the woollen and worsted industries, of sheep breeders, and of scientific workers. The last are represented by Prof. A. F. Barker, Dr. S. G. Barker, Dr. F. A. E. Crew, Prof. Cossar Ewart, Sir Robert Greig, Mr. C. C. Hurst, Dr. Thomas Oliver, Prof. R. C. Punnett, Dr. James Ritchie, Prof. J. Lorrain Smith, and Prof. R. G. White. At a preliminary meeting held at Carlisle on Dec. 16, various aspects of sheep-breeding problems were discussed, and it was decided to obtain, as a guide for future breeding, the opinions of manufacturers as to the defects, from their point of view, in wool from the different breeds of sheep in Great Britain, and the directions in which improvement was desired. Preliminary statements were made as to the desirability of instituting certificates for rams with fleeces free from kemp, on lines similar to the certificates now issued for bulls under the Ministry's scheme. It was recommended further that cross-breeding experiments with unstable breeds of merinos should be discouraged, and that grants from public funds should be confined to institutes where there existed suitable facilities for properly controlled and observed breeding experiments.

IT is now thirty-seven years ago since the earliest of the 'tube railways'—the City and South London Railway—was opened for traffic. It had an earthed return; that is, the electric current taken by the motors returned to the generators through the earth. When this railway was reconstructed two years ago, an insulated cable was provided for the return current. In an interesting paper by A. R. Cooper on the electrical equipment of the track on the underground railways of London, read to the Institution of Electrical Engineers on Jan. 6, the working results obtained by experience were summarised. In addition, extracts from Acts of Parliament, from the report of Lord Rayleigh's committee on vibration troubles, and from Duddell's reports (1913 and 1914) on sudden pressure rises caused by the accidental earthing of the positive rail, were given. It is generally supposed that the use of the track rails for returning the current is much cheaper than the installation of an insulated fourth rail. This is not necessarily true, as the fourth rail can carry currents for signalling purposes.

ONE of the most serious troubles in connexion with electric train working is due to ice forming on the conductor rails. Snow does not prevent the 'shoe' from collecting current; the breakdown occurs when there is a film of ice on the rails. This occurs when sleet falls on a rail the temperature of which is below freezing-point. Occasionally oil is fed on to the rails through the collecting shoes, and it is found that this sometimes prevents the ice from adhering. Consistent results, however, have not been obtained. To melt the ice from the rails, very heavy currents flowing for a considerable time have to be used, and so the method of electrically heating the rails is rarely employed. When the atmospheric conditions are such that trouble may be expected, a special car, fitted with steel strip brushes and oil sprays and hauled by a battery car, is used; but this method is not always effective. The loss in weight of conductor rails varies from 0·2 to 1·2 lb. per yard per annum. Mr. Cooper says that, in the interests of safety, it is desirable to change track rails or axles which have been affected by electric burns. He considers also that in the future it is very unlikely that any electric railway will employ the insulated return.

A SHORT time ago the Gassiot Committee of the Royal Society appointed the Astronomer Royal, the Director of the Meteorological Office, and Dr. Chree, to consider what observations of terrestrial magnetism and atmospheric electricity should be made during the eclipse of June 29 next. The sub-committee met on Dec. 16, when the following recommendations were made:—*Terrestrial Magnetism.*—(*a*) That quick runs should be taken on all magnetographs in the British Isles during the period 4 h. to 8 h. G.M.T. on the three days June 28, 29, and 30. (*b*) The vertical force coils at Eskdalemuir and Lerwick should be in action if possible. (*c*) It was considered that field observations and eye observations of magnetic elements are not required. *Atmospheric Electricity.*—(*d*) Where possible the electrographs should be put on to quick run from 4 h. to 8 h. G.M.T. (*e*) As complete a set of eye observations of all elements of atmospheric electricity as can be arranged should be taken during the period 4 h. to 8 h. (*f*) The programme arranged for the day of the eclipse should be carried out on the previous and following days also.

REPORTS received from the Canadian Department of the Interior and from independent sources tell of the success which has followed the policy of transporting surplus bisons from Wainwright Park to Wood Buffalo Park, which by proclamation of the Governor-General on October 23, 1926, was constituted a Dominion Park with an area of 17,300 sq. miles. This was the sole territory of the only truly wild survivors of the American bison, a distinct species or race, the 'wood buffalo,' and among these, estimated to number some 1500, have now been dumped plains bisons numbering 1634 in 1925 and approximately 2000 in 1926. From the point of view of the Canadian authorities the experiment has proved a success: they have got rid of a surplus of 3634 plains bisons which were seriously overstocking Wainwright Park, and the transported animals have made good in the much more severe conditions of the North-West Territories. But from the scientific point of view the

danger to which reference was made in NATURE (Feb. 20, 1926, p. 275) still threatens. While, curiously enough, the 'wood buffalo' has to a large extent simply ignored the imported 'plains buffalo,' and, according to earlier advices received from Canadian correspondents, the two races have tended to segregate into two camps, there has already begun the cross-breeding which was feared, and which, in view of the now overwhelming superiority in numbers of the imported form, may end in modifying or swamping the distinctive characters of the little band of native stock. It may be added here that investigations being carried out by Prof. W. Rowan, of the University of Alberta, suggest that in the skeleton of the 'wood buffalo' there lie differences which clearly mark it off from the 'plains buffalo,' and confirm the distinctiveness of the two species, originally determined by external characters alone.

THE second annual report, 1925–1926, of the Imperial Forestry Institute situated at the University of Oxford has been issued. This Institute is still in its first stages of existence, but the report gives evidence of some progress having been made within the past year. The idea underlying the creation of the Institute is to give post-graduate courses to men holding a degree or diploma in forestry and to provide refresher courses to forest officers on leave or who are deputed by their governments. The first object was already provided, we are given to understand, at other universities without any expense falling on the Treasury. The second could equally, and in fact actually was provided, at a university other than Oxford. The University of Cambridge, for example, has maintained that it is capable of conducting instruction up to the standard required. The fine buildings erected at universities outside Oxford, notably Cambridge and Edinburgh, have probably cost something in the neighbourhood of £40,000 and would be worth a far larger sum at the present day. These buildings are equipped for research. It appears from the report that the proposal is now put forward that a sum of £75,000 is to be spent on new buildings to accommodate this new Institute at Oxford. On the face of it the scheme appears to be a laudable one. Nevertheless, it would seem to demand further careful consideration if this money, or the bulk of it, is to be provided from the Treasury. Two points appear to demand a public and unbiassed inquiry before the Government is committed to the scheme; they are: (1) Are not the existing schools of forestry capable of giving all the education required, both up to the degree and post-graduate, and to undertake research? (2) Is it advisable to shut up forestry education in a water-tight compartment?

THE resignation of Prof. A. W. Porter from the honorary secretaryship of the Institute of Physics was recently received by the Board of the Institute, and was accepted with great regret. Prof. Porter has been associated with the Institute from its inception, and its growth is largely due to his efforts. Prof. A. O. Rankine, of the Imperial College of Science, has been appointed to succeed him. Mr. Thomas Martin, who has recently held the positions of secretary of the British Empire Exhibition Committee of the Royal Society and of the Optical Convention, 1926, has been appointed secretary of the Institute. He succeeds Mr. G. S. W. Marlow, who has been acting secretary since the death of Mr. F. S. Spiers. The office of the Institute of Physics has been transferred to 1 Lowther Gardens, Exhibition Road, London, S.W.7, and all communications, including those relating to the *Journal of Scientific Instruments*, should now be sent to the new address. A tenancy of the premises to be occupied at 1 Lowther Gardens has been granted to the Institute, on very generous terms, by the Royal Commissioners of 1851; and the Commissioners, in placing this spacious accommodation at the disposal of the Institute, are giving great assistance to its work and to that of its participating societies.

THE Air Ministry has issued an official communique giving an account, with full itinerary, of the Cape to Cairo flight of the Royal Air Force in 1925. The flight was composed of four aeroplanes under the leadership of Wing-Commander C. W. H. Pulford. A spare plane was sent to Aboukir, another spare plane and two engines were ready at Kisumu on Lake Victoria, and a third plane and four engines were ready in South Africa. Radio apparatus was not carried on account of its weight, its lack of value in Central Africa, and its demand for a skilled operator. The flight started from Heliopolis on March 1, and returned there from Cape Town on May 27, one day ahead of the time-table. The actual time of flying of the leader's aeroplane was 68 hours 21 minutes on the outward and 72 hours 34 minutes on the homeward journey. The flight was so successful that the account of it is almost devoid of incidents. The aeroplanes and engines proved equally reliable. The only repairs that were necessary were the replacing of one magneto, two airscrews and all the oil tanks. The whole flight of 14,000 miles was done on time in spite of the great range of climates that was traversed. On the return to Egypt the aeroplanes were flown to England.

THE Italian National Committee for Geography has decided to raise funds for studies in Palestine. The studies will be mainly geographical, whereas similar institutions already in existence are mainly devoted to historical and archæological research. Some indication of the proposed work is given in the December number of the *Geographical Journal*. The first project to be undertaken will be the charting of the Dead Sea and the mapping of the Jordan trough on a large scale. Geological survey and limnological researches will also be carried out and it is proposed to take observations, over a long period, of changes in the bed of the Dead Sea and the meteorological conditions in the district. Other schemes include the foundation in Jerusalem of a library and collection of maps dealing with Palestine, and the publication of a series of memoirs especially with regard to old cartography, for which much material is available in Italy. The elaboration of the plan and the organisa-

tion of the expedition is in the hands of a committee under the chairmanship of Cav. Filippo de Filippi. The expedition is expected to start in November and has the sanction of the British Government and the Governments of Palestine and Transjordania.

To every one who has a receiving set, Pitman's "Radio Year Book" for 1927 will prove of great interest. It contains a great deal of information about British broadcasting and makes attempts to pierce the future. J. Swinburne gives a very characteristic 'pessimistic view' of broadcasting. He points out the fundamental error in the theory of universal education in art, literature, and machine reproduced music. Lavish endowment has little effect on the efficacy of education, or even of research. We can be improved only from the inside. "We cannot become musicians or even musical . . . by sitting with telephones over our ears, or near loud-speakers. No one can be improved, and he can improve himself only by hard work." J. L. Baird tells of the very rapid progress of television, and prophesies that televisors will be on sale before the end of this year. The cover of the book shows a domestic scene of a family gazing at the moving picture of a theatrical performer shown by the televisor and simultaneously hearing the words and music. 'Mentor' states that the day will come when we will be able to sit at home and see the Cup Final or the Derby; or possibly the record of these events will be bottled up and broadcast again during the evening for the benefit of the workers who have no time during the day to sit television gazing. For the last century the monotony of their lives has been driving the country dwellers to the lures and lights of the towns. Will broadcasting and television tend to stop this migration? Prof. J. A. Fleming gives practical details about insulators. He points out that there is considerable surface leakage on porcelain insulators when they are wet, and describes how to make a very simple and efficient insulator to replace them. The wiring of houses for radio reception in several rooms is described. A defect of the system is that any one listening on the telephones in one room will hear most of what is being said in other rooms where there are loud-speakers.

THE new magnetic observatory at Matochkin Shar (Novaya Zemblya), which is associated on the administrative side with the U.S.S.R. Hydrographical Department and on the scientific side with the Central Geophysical Observatory at Pavlovsk, has had considerable recent additions to its equipment. It now operates two sets of Eschenhagen magnetographs, one of higher sensitiveness, with scale values per 1 mm. of 1′·0 for declination (D), 6·6γ for horizontal force (H) and 5·4γ for vertical force (V); the other of lower sensitiveness, 1′·5 for D, 18γ for H, and 14γ for V. The magnetograph house has double walls of wood, and is maintained at a temperature of about 0° C. during the winter. The absolute instruments are housed in a separate pavilion free from iron. They consist of a dip inductor and two magnetometers, one for D, the other for H.

LORD BUCKLAND has promised to contribute a sum of £35,000 in seven annual instalments of £5000 to the National Museum of Wales, Cardiff. The donor has expressed the hope that this will enable the construction of the east wing of the building to be taken in hand. This range of galleries will cost, it is estimated, £46,000, and it is to be expected that Lord Buckland's generous gift will stimulate the growth of a fund which will make possible the completion of the whole of the projected museum buildings.

THE Faraday Society is arranging a general discussion to be held at Oxford on April 22-23 on "The Theory of Strong Electrolytes." The first day of the meeting will be devoted to ionic mobility and the second to the activity of strong electrolytes. In common with earlier discussions of the Faraday Society, the meeting will be distinguished by the presence of well-known scientific workers from the continental countries of Europe, and Great Britain will also be well represented. Accommodation for those attending the meeting is being arranged at Exeter and Lincoln Colleges, and it is hoped to obtain special facilities on the railways.

IN sending his appreciation of the work of Sir J. J. Thomson for our Cavendish Laboratory issue of Dec. 18, Prof. A. Sommerfeld asked that it should be printed in German unless contributions from other men of science abroad were also translated into English. Though we regret that this was not done, as the communications received from the Duc de Broglie, Mme. Curie, and Prof. Langevin were printed in French, yet we can assure Prof. Sommerfeld, who has written to us upon the matter, that no invidious distinction was thereby intended. The fact is that French is more familiar than German to most of our readers, and it was on this account alone that we printed the English translation of Prof. Sommerfeld's note. If contributions had been received in any other language than French, they would have been dealt with in the same way.

A NON-PARTY political literary periodical entitled *The London Weekly* (Price 6*d*.) has recently been started by the Commonwealth Review Ltd., under the editorship of Dr. L. Haden Guest, M.P. The first issue contained an article by Mr. L. S. Amery, Secretary of State for the Colonies, on "A Constructive Empire Policy," which is followed up in the second issue by an article on the same subject by Mr. Philip Snowden. We have also read an informative article by Florence B. Low describing the prospects for British teachers in Canada, while Major A. G. Church contributes an article entitled "Migration." Major Church discusses the migration of peoples within the British Empire, and makes a strong plea for the introduction of the scientific spirit into this problem. Every factor which has any bearing whatsoever on the question must be considered. In conclusion, he remarks that since agriculture is the main industry of the Empire, it is time that a systemic survey of its agricultural resources were made with the view of their proper development.

IMPERIAL Chemical Industries, the great chemical merger formed by the amalgamation of Brunner Mond and Co., Ltd., Nobel Industries, Ltd., the United Alkali Co., Ltd., and the British Dyestuffs Corporation, Ltd., under the chairmanship of Sir Alfred Mond, is to make its first appearance to the public at the British Industries Fair organised by the Department of Overseas Trade at the White City, London, on Feb. 21–Mar. 4, where it will have the largest individual exhibit in the Chemical Section of the Fair. The main object of the exhibit is to make an expression of Imperial Chemical Industries' individuality as one group. It will be Imperial in its significance as showing the wide influence of the company in British commercial affairs. It will be practical in the sense that the man in the street will be able to visualise its numerous activities, and it will be scientific in the sense that the buyer of chemical goods will at once see the intimate relationship which exists between the products made in the factories belonging to the respective component parts of this great organisation.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A junior technical officer at an Admiralty Experimental Establishment — The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (Jan. 20). An assistant analyst in the Scientific Research and Experimental Department of the Admiralty—The Secretary to the Admiralty (C.E. Branch), The Admiralty, Whitehall, S.W.1 (Jan. 31). Two demonstrators in agricultural botany in the Department of Botany of the University of Leeds—The Registrar, The University, Leeds (Jan. 31). A director of the laboratories of the Clinical Research Association, Ltd.—The Secretary, Watergate House, York Buildings, Adelphi, W.C.2 (Jan. 31). A professor of anatomy in the University College of South Wales and Monmouthshire —The Registrar, University College, Cardiff (Feb. 26).

Our Astronomical Column.

RECENT SUNSPOT AND MAGNETIC DISTURBANCE.—Several observers noted a spot on the sun's disc seen with the naked eye through the morning mist on Jan. 8. The spot was not an unusually large one, but it is of interest on account of the frequent changes which took place within the stream (of which the leader was the naked-eye object), and also its probable connexion with a magnetic disturbance recorded at Greenwich on Jan. 7 and 8. The most noticeable feature shown by the chief spot was a very bright tongue or 'bridge' which crossed the umbra from south to north on Jan. 3-8. On Jan. 7 this 'bridge' appeared to separate the whole spot nearly completely into two portions. The magnetic disturbance, of moderate intensity, commenced about noon on Jan. 7 and died out at 3 hr. on the following day. The greatest deviation of the declination magnet from its normal position was about 0°·5. The table of important spots for 1927 is continued as follows :

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Area.
2	Jan. 2-14	Jan. 8·5	13° S.	1/1100 of sun's hemisphere.

As regards the sun's general activity, Mr. A. M. Newbegin writes, "Prominences continue active numerically, and metallic outbursts are occurring with much greater frequency, but the big displays of great prominences have not begun yet."

WEATHER CONDITIONS IN NORWAY FOR THE ECLIPSE OF JUNE 29, 1927.—*Cracow Observatory Circ.*, No. 22, contains a useful note by K. Kordylewski and Z. Eckstein giving cloud-measures for various points in Scandinavia based on many years' observations (32 in some cases). The best conditions are found on the railway from Bergen to Oslo, and at Gällivare in northern Sweden. The cloud-ratio in these regions varies from 5 to 6, 10 being complete cloudiness. Finse has the best ratio, 5·0, and an average of 8 clear days per month. Vardö, in the extreme north of Norway, has the high cloud ratio 7·3, and 3 clear days per month. The experience of the 1896 eclipse in this region was not encouraging.

A NEW PHOTOGRAPHIC STAR CATALOGUE.—The catalogues brought out by the Astronomische Gesellschaft, which cover the sky from 81° N. decl. to considerable S. decl., are known to all astronomers. It has now been determined (*Astr. Nach.* No. 5469) to form new photographic catalogues of the region from the North Pole to S. decl. 5°. The plan will be that adopted by Prof. Schlesinger of taking plates 5° × 5° on a scale of 1 mm. to 100″. The objectives will be 4-lens combinations by Zeiss with aperture 206 mm. Pulkovo will photograph the region 90° to 70° N. decl., the remainder being divided between Bergedorf and Bonn. Each observatory will measure its own plates, but the reduction of star places will be done at a single observatory. The re-observation of reference stars is being undertaken by six observatories. The work will begin in 1928, and it is hoped to finish it in three years.

THE DISTRIBUTION OF INTENSITY IN STELLAR ABSORPTION LINES.—An interesting account of pioneer work in this subject by Miss Payne and Dr. Shapley appears in the *Proceedings of the American Academy of Arts and Sciences* (vol. 61, No. 10) under the above title. A considerable amount of theoretical work has been done on the structure of absorption lines, and practical observations of this kind (which have hitherto been scanty) are of considerable importance. The spectra examined by the authors were all taken with the 16-inch refractor at Harvard, using two objective prisms and a range of different rectangular apertures. These spectra were analysed by a Moll thermo-electric microphotometer, and the intensities, as shown by the photographic tracings, were measured from reference lines (recorded on each tracing) representing 'darkness' and 'clear film.' A line representing the continuous background of the spectrum was drawn in each case by hand across the absorption line tracings, and the intensity drop from continuous background to line was measured graphically for various lines in the spectra of eleven stars. The principal object of this paper is to discuss the method of working and accuracy of the results obtainable. Some results of interest appear, however, even from these preliminary measures of eleven stars. In particular it may be mentioned that, even at the centres of the strong absorption lines of hydrogen and calcium, there is some residual light, of intensity averaging about twenty-five per cent, of the background light.

Research Items.

SUMERIAN TABLETS.—The Manchester Museum has published copies of all of the "Behrens Collection" of Sumerian tablets excepting three, which are defaced and consequently useless. The complete collection contains 50 tablets from Drehem and Umma. The Drehem tablets, eight in number, tally in subject matter with the many others from this site which have been published, and deal with the daily business of Drehem. They contain records of animals for offerings. The Umma tablets belong to the same class, recording the daily details of the administration of animals, barley, and other products, wood, silver, and copper. As these tablets are contemporary, they afford a valuable source of information on Sumerian life and religion, while also serving to check the grammatical and religious texts composed later in Sumerian by authors who were not Sumerians, and when Sumerian had ceased to be the language of the people.

A EUROPEAN PARALLEL TO THE DURGĀPŪJA.—Dr. Sten Konow, in the *Journal and Proceedings of the Asiatic Society of Bengal*, N.S., vol. 21, No. 3, argues that although the goddess Kāli is now usually considered to be of non-Aryan origin, there are features in Kāli worship which may point to the existence of an old, not only Aryan, but also Indo-European goddess going back to the time when Indian and European tribes were one people. This view is based upon the account given by Tacitus in the "Germania," ch. xl., of the worship of Nerthus—Mother Earth—by certain German tribes. The features of this worship essential for the purpose of comparison are the position of the priest as the husband of the goddess, the procession and the ablution in a sacred lake. The ceremony may be concluded to be a fertility rite. Various attempts have been made to arrive at a derivation of the name Nerthus. It is rarely used, and Sahlgren has suggested that it is an epithet employed instead of the real name, which was taboo. If so, it should be explained by some feature in the festival, and it is suggested that it is connected with the Sanskrit *Nart*, *Nṛt*, to dance, to act, *i.e.* a description of the symbolic or magic acting in the ceremony. The ideas connected with the base *nṛt* are connected with Siva, the consort of Kāli, the latter, however, playing the more prominent part in the popular fertility rites, she being the great Earth Mother comparable to the chthonic deities and demons of fertility elsewhere. The features of the Durgāpūja in which Kāli is worshipped include days of preparation and feasting, a ceremonial procession, and lastly an immersion in water, which men may not see on penalty of death. The deity comprises the male and female element, thus in herself personating the divine couple represented by the priest and Nerthus in the European parallel.

THE RELATION OF GONAD AND PLUMAGE IN THE FOWL.—Messrs. Pézard, Sand, and Caridroit have demonstrated that in the case of the hen, if the amount of ovarian tissue is sufficiently reduced by operation, the female assumes the plumage characterisation of the male (*C. R. Soc. Biol.*, 92, 566 and 1034, 1924; 93, 1094, 1925; 94, 1074; *C. R. Acad. Sci.*, 177, 1087, 1924). F_1 hens out of a Brown Leghorn ♀ × Faverolle ♂ mating were used. The male plumage assumed was that of the Faverolle. The ovary regenerated, and associated with this increase in ovarian tissue the plumage again became as that of the female, first Brown Leghorn, later Faverolle. The authors argue that these serial changes indicate that the Brown Leghorn type of plumage coloration is a response to a lesser ovarian stimulus than is that of the Faverolle. They conclude that there are racial differences in the threshold of response. Evidence that the conception of differential thresholds of response to gonadic stimulus applied even to individual feathers was also obtained. The occurrence of feathers male on one side of the rachis, female on the other, led the authors to the conclusion that each side of the feather is ambivalent and that it can assume the male or female characters alike, but that the two sides at any given moment during development may not respond similarly to the same stimulus.

HOMOLOGY OF THE ALA TEMPORALIS AND ALISPHENOID BONES.—Dr. Kesteven (*Jour. Anat.*, vol. 61, pt. 1, 1926) discusses at some length the homologies of these bones in the vertebrate series. With regard to the ala temporalis, he concludes that this bone in mammals has been derived from and is homologous with the pila pro-otica of the lower vertebrates. In this conclusion he is in opposition to the views of Broom, which are accepted by Watson, Gregory, and Noble, who regards this bone as a remnant of the palæopterygoid cartilage. As to the alisphenoid bones, the author concludes that they are homologous throughout the whole craniate series. While accepting the views of Gregory and Noble that the so-called epipterygoids of the cynodont reptiles are homologous with the alisphenoid bones of mammals, he denies that they are homologous with the epipterygoids of other reptiles.

OCEANOGRAPHY OF THE BALTIC AND FISHERY RESEARCH.—The current quarterly number of the *Journal du Conseil permanent pour l'exploration de la mer* is mainly devoted to accounts of the water movements in the Baltic and its entrance into the North Sea. Prof. Otto Petterson discusses fluctuations occurring between one year and another in the inflow of the salter North Sea water, which passes in as a bottom current, carrying with it fish of considerable economic importance to the Baltic fisheries. Evidence of long-period fluctuations in the herring fishery is cited, and these are attributed to secular fluctuations in the tide-raising force. Dr. Palmen has applied Bjerknes' circulation theory to hydrographic observations made in the Gulf of Finland, and finds fair agreement between the currents calculated by this means and those observed. The determination of the age of cod from the number of 'winter rings' in its scales has presented difficulties owing to the formation of false rings during an unfavourable period in the life of the fish, such as may be brought about by temporary lack of food. Mr. Graham outlines a method which assists in distinguishing between such false and the true winter ring during the first year's growth, and hopes to extend the application of the method to older fish.

DEVONIAN VOLCANIC ROCKS OF NEW BRUNSWICK.—The *Bull. Geol. Soc. America* of Sept. 30 contains an interesting account by W. V. Howard of the Devonian rocks near Dalhousie, New Brunswick. The volcanic rocks include andesites, dacites, latites, and associated tuffs. Six excellent analyses reveal an unusual richness in soda for rocks of these types, and it may be significant, as the author points out, that some of the pre-Cambrian rocks of New Bruns-

wick and Maine share the same characteristic. Despite this, however, there is no evidence of consanguinity between the Dalhousie volcanics and those of the contemporaneous Aroostook series in Maine. Yet there is a striking resemblance, both mineralogically and chemically, between the rocks of the Dalhousie eruptions and those of the Pentland Hills and other Old Red Sandstone volcanic districts of Scotland. This resemblance extends even to the curious detail that on both sides of the Atlantic the volcanic series of this epoch are free from the great swarms of dykes which are usually found around ancient volcanic centres.

A NEW DESENSITISER FOR PHOTOGRAPHIC PLATES.—"Jute Red" (or Red 39,651) is a mixture of dyes which dissolves readily in lukewarm water to form a one per cent. reddish-orange solution. It is supplied by the Soc. Anon. des Matières colorantes de St. Denis, of Paris. M. Rene J. Garnotel claims (*British Journal of Photography*, Dec. 17) for it that it has many advantages over previously known desensitisers when applied to either negative or positive emulsions. If the skin or nails get stained by it the colour is entirely removed by a short wash with soap and water. Its aqueous solution (1 part in 5000) replaces some of the water of the developer formula without any risk of the precipitation of any constituent, and this is not only a simpler method of working than the use of a preliminary desensitising bath, but also does not interfere at all with the Watkins' factorial method of development. Formulæ are given for its use with M.Q. developers and for autochromes. The dye is completely eliminated in the ordinary course of washing in all cases.

MENTHONES AND DERIVED SUBSTANCES.—A noteworthy advance in the chemistry of the menthones and derived substances is recorded in the Sept. issue of the *Journal of the Chemical Society*. A short while ago Prof. John Read and Miss A. M. R. Cook were successful in isolating a number of pure derivatives of *dl-iso*menthone, starting from the eucalyptus ketone, *dl*-piperitone. They have now extended their operations to the preparation and characterisation of *dl*-menthylamine, *dl-neo*menthylamine and *dl-iso*menthylamine. In a further paper, by Prof. Read and Dr. G. J. Robertson, corresponding derivatives of the pure optically active forms of these bases are described, and a scheme is advanced for representing their relative molecular configurations. Certain striking similarities between the menthylamines and the *iso*-menthylamines are correlated with their closely similar molecular configurations, which differ only in the disposition of the groups about one of the three asymmetric carbon atoms concerned; a parallel relationship is anticipated between the *neo*-menthylamines and the as yet unknown *neo-iso*menthylamines. A new optically inactive menthol is also mentioned by Prof. Read and Miss Cook, and it is likely that additional information on the stereochemical relationships of this important group will be forthcoming as a further consequence of these interesting researches. Incidentally, a fuller knowledge of the chemistry of the terpene group as a whole should result; and it seems that Prof. Read and his assistants have opened up what may prove a very fruitful field of investigation.

POLARISATION OF LIGHT EMITTED BY POSITIVE RAYS.—E. Rupp (*Ann. der Phys.*, No. 22, p. 615, 1926) has recently examined the variation of the polarisation of the light, emitted by a beam of positive rays of decreasing intensity, with the angle at which the beam of positive rays was observed. He dealt with positive rays of hydrogen, helium, and lithium, since these atoms possess the simplest electron structures. The results showed in general that the light polarised with its vector parallel to the beam of positive rays increased in intensity with the angle of vision. When observed in a direction at right angles to the beam, the intensity of the light polarised parallel to the beam was always greater than that of the light polarised at right angles thereto. The variation of the polarisation was greatest for hydrogen positive rays, and was more pronounced for higher velocities of the rays. In the case of helium and lithium rays the variation depended on the spectral series to which the emitted light belonged. Rupp considers that there is probably some connexion between the polarisation of the light emitted by a beam of positive rays of decreasing intensity and the polarised light produced by a beam of parallel electrons which has been studied by Kossel and by Skinner. In fact, the results could be expressed by saying that atoms, moving in a regular manner through an arbitrary arrangement of molecules or electrons, make impacts which result in the emission of polarised light.

OPTICAL CONSTANTS OF OPTICAL GLASS.—The catalogue of optical glass recently issued by the Parsons Optical Glass Company, of Little Chester, Derby, marks an important departure from tradition. The foundations of the usual method of specifying the optical constants of glass date from more than one hundred years ago, when Fraunhofer succeeded (about 1813) in measuring the refractive indices of his telescope glasses for some of the chief dark lines of the solar spectrum. Since that time it has been very usual to achromatise a lens such as a telescope object glass for visual observation by uniting the foci for the *C* and *F* lines. Photographic achromatism is usually secured by uniting *D* and G^1 (the latter being a line of the hydrogen spectrum). The choice of the wave-lengths for achromatism has, however, been periodically discussed, and has been criticised by Gifford and others. Certain conditions for visual achromatism used in optical designing by some workers, such as Conrady, have hitherto necessitated a certain amount of preliminary calculation for the refractive index for "the wave-length of brightest light" in the solar spectrum, approximately 0·555 $\mu\mu$, which must be done with the aid of a suitable interpolation formula. Furthermore, the refractive indices hitherto listed have not supplied sufficient indication of the variation of focus with wave-length when achromatism is so established that the minimum focus falls in the regions of shorter wave-length for photographic purposes. This catalogue, following the suggestions of Hasselkus, makes use of five lines in addition to the usual ones, two of helium at 706·5 $\mu\mu$ and 587·5 $\mu\mu$, and three of mercury at 546·1 $\mu\mu$, 435·9 $\mu\mu$, and 404·7 $\mu\mu$ respectively. The standard refractive indices are listed for the helium line, 587·5 $\mu\mu$, which is capable of more satisfactory performance on the refractometer than the double line of sodium. By the aid of this additional information the computer's task should be considerably facilitated, though the mercury green line at 546 $\mu\mu$ is decidedly on the short side of the maximum visual intensity, and a little experience will be needed to make the best use of the additional information. There is little need to direct attention to the wide and useful range of optical glasses now offered; the firm is prepared to make up intermediate types of glass to customers' requirements.

Annual Exhibition of the Physical and Optical Societies.

THE seventeenth annual exhibition of the Physical and Optical Societies was held on Jan. 4, 5, and 6 at the Imperial College of Science, London, and covered a wide range of electrical, optical, and other physical apparatus. This exhibition has rightly come to be regarded as an opportune occasion for the various manufacturing firms to bring to notice their latest improvements, and this year's exhibition reflects great credit on the ingenuity and originality in design and excellence of workmanship of the apparatus shown. There is an atmosphere of courtesy and entertaining informality in these annual events which cannot fail to enhance the interest of the visitors and evoke their admiration. Prof. A. O. Rankine, as secretary, is to be heartily congratulated on his success.

Seventy-four firms exhibited apparatus, and it is regretted that the limited space available in this journal does not permit mention of all the instruments. Reference may be made to the illustrated catalogue of the exhibition for fuller details, and some exhibits embodying new features are noted below.

The attractive lectures in the evenings, and subsections devoted respectively to recent results in physical research, lecture experiments in physics of special interest to teachers, and famous historical physical experiments again appeared in the programme.

The lecture on the first evening was by Prof. E. N. da C. Andrade on light and electricity as it might have been given in 1709 with the apparatus of the time, and, it may be added, under conditions which were dramatically realistic and were greatly appreciated by the audience. The lecturer, who impersonated Francis Hauksbee, and his assistant Mr. Paul, appeared in the picturesque costume of the period, and the hall was appropriately illuminated by candles, which were lighted by flint-and-steel and tinder box. All the experiments were repetitions of those actually performed by Francis Hauksbee, a contemporary of Newton, and were selected as having particular relation to present-day concepts of the electrical constitution of matter. The electric glow accompanying ionisation when matter is finely subdivided *in vacuo* was demonstrated with such simple apparatus as vessels containing oil or mercury and partially evacuated, and then shaken; a mercury jet *in vacuo*; and a rotating glass globe rubbed by the hands. By courtesy of the Royal Society, the actual air pump made and used by Hauksbee was employed in the lecture. This treasured veteran of pioneer apparatus, quaint in design and portraying the combined efforts of wood-turner, joiner, and engineer, was successfully coaxed by Mr. Paul to resume duty after more than two centuries, to the accompaniment of a few merry clanks due to the hand-cut gears, with perfect results.

On the second evening a discourse was given by Dr. C. V. Drysdale on "Progress in Electrical Instrument Design and Construction." Reference was made to the many improvements introduced by Profs. Ayrton and Perry some forty years ago, the more modern improvements being due to the utilisation of new materials possessing properties valuable in instrument design, for example, synthetic resins, chromium gells, and magnetic alloys of the chromium-steel and nickel-iron class. A demonstration was given of the effective magnetic screening afforded by mumetal, and reference was made to the use of this alloy in transformer design on account of its high permeability and low hysteresis. The necessity of studying the bearing of basic formulæ in instrument design was emphasised in the application to d.c. and a.c. instruments and machines, conductors, etc.

The lecture on the third evening was delivered by Mr. J. L. Baird on "Television." The development of this difficult branch of physics was traced from its inception in the early part of the present century down to work done barely twelve months ago. One of the first attempts was a model of the eye comprising sixty-four selenium cells and made in 1906. Later came the single cell in conjunction with an exploring beam produced by vibrating mirrors, then the photo-electric cell replacing the selenium cell; still later the cathode-ray tube was added to the combination of mirrors and cell, and then the rotating prismatic disc replacing the mirrors. A résumé of the lecturer's own research then followed. His apparatus comprises direct current and alternating current motors, lenses spirally arranged on a rotating disc coacting with a slotted disc, and a photo-electric cell, the current variation of which is utilised in the wireless transmission of the image. Reception is effected by similar means. A model of the transmitting portion of the lecturer's original apparatus used in 1925 was on exhibition, and no doubt the bulkiness of the complete plant precluded an actual demonstration. The discourse was repeated the same evening, but one item not referred to in the lecture should be recorded, namely, that Mr. Baird successfully effected the transmission of moving images of human faces at the Royal Institution on Jan. 27, 1926.

The research and experimental section inaugurated at the annual exhibition last year again proved instructive and of special interest in indicating the trend of progress in the application of modern physics to the arts and manufactures. The Research Association of British Rubber and Tyre Manufacturers exhibited a sieving apparatus for the detection and estimation of grit in fine powders by means of wire gauze and a stream of water. The British Research Association for the Woollen and Worsted Industries included in its section a balance for estimating moisture regained by textile materials in drying ovens, an electrical device for controlling room humidity, and a roller setting gauge. The Admiralty Research Laboratory supplied eight exhibits, comprising phonic signalling apparatus, a camera of the revolving-drum type for use with an oscillograph, and other electrical apparatus used in tests involving sonic frequencies. The development of fog-signalling and sound-locating apparatus was illustrated by the Air Defence Experimental Establishment.

Devices for solving practical difficulties continually arising in specialised technical operations were shown by the following firms and institutions: Mr. Conrad Beck, microscope aberration tests; Dr. G. D. Bengough and Mr. J. M. Stewart, protecting and colouring aluminium; the Brown-Firth Research Laboratories, chromium steels; Prof. W. Cramp, a magnetic balance; Mr. H. Dewhurst, a rapid bolometer in operation; The General Electric Co., Ltd., optical and electrical apparatus; Mr. Hallimond, a magnetic separator; W. T. Henley's Telegraph Works Co., Ltd. (Research Dept.), wire and cable testing and phenomena; Metropolitan-Vickers Electrical Co., Ltd. (Research Dept.), valves, electric furnaces, chromium plating, welding, etc.; The National Institute for the Blind; the National Physical Laboratory; and The British Thomson-Houston Co., Ld., together contributed an important collection.

The lecture experiments in physics comprised working models designed to illustrate wireless phenomena; synchronous and induction motors; three-phase currents; wave motion; and magnetic fields. Other apparatus demonstrated cloud experiments,

condenser capacity by analogy with models immersed in a solution of copper sulphate, and the rotation of bodies with dielectric surfaces when suspended between the poles of a Wimshurst machine.

In the section devoted to famous historical experiments, Prof. E. V. Appleton exhibited a coil from King's College and used by Joseph Henry in his work on self-induction; Sir Charles Wheatstone's step-by-step telegraph designed in 1840, and a variable resistance box and bridge by the same inventor; and James Clerk Maxwell's model illustrating the induction of currents; while Sir William Bragg exhibited apparatus used by Tyndall in his investigation on so-called spontaneous generation.

Of the almost bewildering assemblage of apparatus, the following exhibits are selected for particular notice: C. Baker, for epidiascopes; The Cambridge Instrument Co., Ltd., an oxygen recorder for boiler feed water, a carbon dioxide recorder for flue gases, a magnetic bridge permeameter, and a glass electrode potentiometer; Crompton and Co., Ltd., their "S.M.S." hygrometer and new wattmeter; W. Edwards and Co., rotary vacuum pumps; Adam Hilger, Ltd., the Guild trichromatic colorimeter and spectrographic apparatus; H. Hughes and Sons, Ltd., echo-sounding gear; Klaxon, Ltd., the 'Audiwave' machine for relieving deafness; Negretti and Zambra, meteorological and electrical appliances; L. Oertling, Ltd., special physical balance with 22 ft. light beam; Ogilvy and Co., dark ground condenser, 1·20 N.A., objectives, and colorimeter; H. Tinsley and Co., electrical and stroboscopic apparatus; and Carl Zeiss (London), Ltd., the "Bitukni" binocular microscope attachment, microscope stand G, Nordenson photographic ophthalmoscope, and direct vision monochromator with wavelength scale. H. W. H.

The Science Masters' Association.

AT the kind invitation of the Vice-Chancellor of the University, the annual meeting of the Science Masters' Association was held at Oxford on Jan. 4-7. The membership of the Association has grown rapidly in the last few years, and at this, the twenty-seventh, annual meeting, some 450 members were present out of a total of 1200. Formal proceedings opened on Tuesday evening, when Brig.-General H. Hartley delivered his presidential address in the large hall of the City of Oxford School. Choosing as his subject the rise and development of the ionic theory, the president gave a masterly survey of both the fundamental work and recent advances, pointing out the way in which the difficulties presented by strong electrolytes are being overcome. To the evident relief of his audience, General Hartley said that practically no change was necessary in the method of teaching elementary work on the theory. On the motion of Sir Richard Gregory, seconded by Mr. H. A. Wootton, a hearty vote of thanks was accorded the president for his address, but much to the disappointment of the Association Prof. H. E. Armstrong, who was present, could not be prevailed upon to speak.

On succeeding days, lectures on various scientific subjects were given by members of the University of Oxford and others, two of the most attractive being that of Prof. E. B. Poulton upon "Protective Mimicry in Insects" and that of Prof. H. H. Turner upon "Eclipses" with special reference to the forthcoming total solar eclipse visible in England. Prof. Poulton's lecture, to judge from the applause it evoked, met with warm appreciation. It was admirably conceived and delivered, and was illustrated with a large number of exquisite lantern slides. We believe it should have been of the greatest value to science teachers, in that it showed how natural history may be made to afford a sound training in scientific method in an extremely attractive way.

The Association was fortunate in securing Prof. Turner's lecture on the total eclipse, not merely on account of the intrinsic value and interest of the lecture, but also because Prof. Turner demonstrated in an inimitable way how difficult astronomical conceptions could be made clear to boys and girls. He captured his audience at once with his small spheres for the earth and moon, indiarubber balloon for Jupiter, and large carriage-umbrella for the sun. After a very lucid description of the causes of eclipses in general, he related the story of several famous examples of the phenomenon, winding up with a graphic account of the Einstein eclipse of 1919. He then described the course of the total eclipse of June next, and urged upon teachers the importance of making arrangements to allow as many of their pupils as possible to see this event, which is likely to prove unique to most Englishmen now alive. Prof. Turner suggested that camps should be formed in suitable spots along the course to accommodate children for the preceding night, and said that he had been in communication with the Board of Education and with the authorities of the Boy Scouts' Association. It is desirable that arrangements should be made some time in advance, and science teachers would do well to lay the matter before their respective headmasters and headmistresses at the earliest opportunity. Fortunately, the date of the eclipse (June 29) does not clash with matriculation, school certificate, or higher certificate examinations, and we therefore hope that the school authorities will view with leniency any alterations in routine which may be necessary.

Through the efforts of the president and of the local secretary, Mr. H. R. Raikes of Exeter College, visits were made to the various colleges, the Bodleian Library, the Clarendon Press, the Morris Works at Cowley, and other places of interest. The wonderful collection of historic scientific instruments at the Old Ashmolean proved very popular, and one heard on every hand the wish expressed that some one would do for Cambridge what Dr. Gunther has done so excellently for Oxford. The collection is rendered additionally valuable by the series of "Old Ashmolean Reprints" now in course of publication, and by Dr. Gunther's small but delightful handbook.

In the Clarendon, electrical, and other laboratories, demonstrations and exhibits had been prepared by members of the University. This feature, which entails a great deal of work on the part of the demonstrators and exhibitors, is always warmly appreciated by members of the Association, who find it of the greatest value as a concentrated refresher course and as a source of new ideas with which to infuse their school lessons.

As in previous years, there was an exhibition of scientific books and apparatus. On the table reserved for books written by members of the Association there were no less than forty-nine exhibits, a number which says much for the enthusiasm and literary energy of our teachers of science. It was pleasing to note that these books were by no means all text-books; some dealt with the history of science, some with science in its more general aspects, and one at least—Dr. I. B. Hart's well-known book on the mechanical investigations of Leonardo da Vinci—was evidence of sound and exacting original research.

The large size of the publishers' exhibit was an unmistakable sign of the importance they attach to this annual meeting. In spite of many counter-attractions,

their stalls were always surrounded by crowds of members, and if the keenness of the latter on the latest literature of their subjects is any indication of their educational ability, science teaching in the schools of Great Britain is by no means in the parlous state described intermittently by one or two pessimists. The same interest was shown in the excellent exhibit of scientific apparatus staged by the principal firms; it was clear to an observer that many masters had waited for the exhibition before giving orders for apparatus, and were now busily engaged in spending their grants to the best advantage. The epidiascope, an instrument of incomparable educational value, was a principal focus, and though the price is still too high for a good many schools, we imagine that the makers must have been very well satisfied with the result of their exhibit.

At the business meeting of the Association, held on Thursday morning, the most important step was the alteration of the membership rule to include, under certain conditions, science masters not at present eligible. The chairman, Mr. E. J. Holmyard (Clifton), pointed out that if the Association is to retain control of science teaching in the boys' schools of Great Britain, it is essential that no one doing appropriate work should be ineligible; at the same time, the moment is not opportune for any radical change in the required qualification for membership.

The president and chairman of the Association for 1927 are Sir Thomas Holland and Mr. C. E. Sladden (Eton College) respectively. Before the close of the meeting the members unanimously and enthusiastically asked the chairman to convey a message of congratulation and good wishes to Canon J. M. Wilson, one of the pioneers of science teaching in England and a man whom the whole association holds in affectionate regard. A sympathetic reference was also made to the death of Sir William Tilden, president of the Association in 1904.

At the end of the meeting the chairman, on behalf of the Association, conveyed a very hearty vote of thanks to the Vice-Chancellor of the University of Oxford for the splendid hospitality with which the University had received its members.

University and Educational Intelligence.

ST. ANDREWS.—University College, Dundee, will benefit to the extent of £25,000 under the will of the late William Gibson of Ellieslea, Broughty-Ferry, Dundee. This sum becomes payable on the death of the testator's two sisters, and is to be used to build and equip a laboratory for study and research in pathology and bacteriology.

A COURSE of four free public lectures on "The Total Eclipse of the Sun in June in Northern England" will be given by Mr. A. R. Hincks at Gresham College, Basinghall Street, E.C.2, on Jan. 18, 19, 20, and 21 at 6 o'clock. No tickets will be required.

ON and after Jan. 17 a new series of conducted tours will be started for school teachers in the exhibition galleries of the Imperial Institute. Guide lecturers will meet parties of school teachers at 3 P.M. daily, except Saturdays, at the east and west entrances, and conduct them through the various courts, indicating the utilisation and economic value of the various products which are exhibited. It is hoped that teachers will bring at a later date organised parties of school children from their schools and give them practical lessons in economic geography and Empire development in these galleries. Head teachers who wish to send representatives from their schools should make application in writing to the Secretary, Imperial Institute, South Kensington, S.W.7, at least three days in advance. The guide lecturers will also be available to conduct parties of school children at 10 A.M. and 11 A.M. daily, except Saturdays; each party should be limited to about twenty children, accompanied by a teacher. Applications for dates for these tours should be made in the same way to the Secretary, Imperial Institute, South Kensington, S.W.7.

ACCREDITED colleges and universities in the United States are listed in Bulletin 1926, No. 10, of the Bureau of Education. The lists represent, not national governmental approval, for the Bureau makes no attempt to rate or to standardise the collegiate institutions of the country, but recognition by a number of voluntary agencies and by State universities and State departments of education. It is on these lists that all who desire to learn the standing of colleges and universities in the United States must rely for information. A notable step towards the standardisation of the methods employed by these accrediting agencies was taken in 1922 when the American Council on Education, pursuant to the recommendations of a report approved by a conference held in 1921, defined standards for accrediting colleges, junior colleges, and teacher-training institutions. These standards have been adopted in entirety or with certain modifications by the several national and regional associations and by a number of the State departments of education and Church boards of education. Of these associations, the best known outside America is the Association of American Universities. This body has signified its approval of 171 institutions, of which 34 are universities of complex organisation, usually with graduate schools 16 technological institutions, and 121 colleges. These lists are also given in the "Universities Year-book of the British Empire."

THE New Education Fellowship (11 Tavistock Square, London, W.C.1) is organising a fourth world conference, to be held at Locarno on August 3-17 next. The general theme of the conference is to be "The True Meaning of Freedom in Education." Among the speakers and group leaders are to be Profs. Bovet of the University of Geneva, Decroly of Brussels, Lombardo-Radice of Rome (editor of *L' Educazione Nazionale*), and Carson Ryan of Swarthmore, the editors of *Das werdende Zeitalter*, Dr. Alfred Adler of Vienna, author of "Individual Psychology," Dr. Adolphe Ferriere, editor of *Pour l'Ère Nouvelle* and founder of the International Bureau of New Schools, and several people actually engaged in the teaching of children. The announcement explains that although much of the conference proceedings will be devoted to problems of the teacher in relation to the child, yet time will be given to the discussion of the personal problems of the teacher, who, it is pointed out, needs to study the art of true freedom; this comes not from unrestraint but from right inner control. The Fellowship aims at discovering the principles of this art both for the child and for the teacher. Time is to be given to investigating the problems of the secondary school and to discussing how far progressive methods can be applied to them without prejudicing examination results. The organisers, mindful of the urgent need of what a contributor to the *Times Educational Supplement* of Dec. 4 calls "a triple alliance" of parents, teachers, and employers, have provided for attention being given not only to the child at the school and in the home but also to post-school problems.

Calendar of Discovery and Invention.

January 16, 1834.—After a voyage of two months from Portsmouth, Sir John Herschel, on Jan. 16, 1834, reached Cape Town. Re-erecting his famous 20-feet telescope at Feldhausen, near the base of Table Mountain, during the next four years he carried out his great survey of the southern hemisphere, observing more than 4000 nebulæ and star clusters, and 2095 double stars. He also made many observations of relative stellar brightness, of Halley's comet, of the satellites of Jupiter, and of sunspots.

January 17, 1783.—Of capital importance in the industrial development of Great Britain were the two inventions of Henry Cort—the rolling mill and the puddling furnace. The former was patented on Jan. 17, 1783, the latter on Feb. 13, 1784. Dudley, the Darbys, Huntsman, and others, had improved the methods of making cast iron and steel, but the main British supply of wrought iron came from Sweden and Russia. Cort's improvements were the results of years of work at his foundry at Fareham, but no sooner had he brought out his invention than misfortune befell him and he was completely ruined. England, however, benefited immensely by his work, and by 1860, just before the Bessemer process was taken up, there were 8000 puddling furnaces in use.

January 17, 1867.—On Dec. 4, 1866, Werner Siemens had written to William Siemens: "I have had a new idea, which in all probability will succeed and may give important results." What that idea was, was disclosed in a paper read to the Berlin Academy of Sciences on Jan. 17, 1867. Werner Siemens then described the first dynamo. In sending the description to his brother for the Royal Society, Werner remarked: "It is successful beyond expectation even in small dimensions. It will be a most important thing." Wheatstone's invention of the dynamo was contemporary, but Werner Siemens was the first to publish particulars of such a machine.

January 18, 1799.—Paper-making is one of the oldest industries, but the first to invent an endless paper-making machine was Louis Robert, an employee of François Didot, of Essones, France. A patent was granted to Robert on Jan. 18, 1799, and in the following years the French Government awarded him 8000 francs. The first machine, however, was made by Hall, of Dartford, and in 1804 the patent was purchased by Henry Fourdrinier, who spent £60,000 on improving it. In England at the present time there are about 260 paper-mills, with a total annual output of 1¼ million tons of paper.

January 20, 1881.—The evolution of the solar system is regarded as one of the most interesting questions presented by modern astronomy, and to this question G. H. Darwin devoted many years of his life. One of his most important papers was read to the Royal Society on Jan. 20, 1881. He showed that in consequence of the effects of tidal friction, the evolution of the earth and moon had been probably unique in the solar system and concluded that as a result of the tides our day and the time of revolution of the moon in its orbit are both lengthening.

January 21, 1795.—During the French Revolution the Committee of Public Welfare took up the matter of education. In September 1794 it was decided "there should be established in Paris a normal school where instruction in the art of teaching science should be given to persons already possessing scientific knowledge." Through this came the foundation of the École Normale, which began its work on Jan. 21, 1795. E. C. S.

Societies and Academies.

LONDON.

Linnean Society, Dec. 2.—J. **Ramsbottom**: The Society of Amateur Botanists. Mordecai Cubitt Cooke (1825–1914) was appointed head master of the new Trinity School, Lambeth, at the age of twenty-three years. Here he conducted evening botanical classes under the old Science and Art Department. In the later 'fifties he occasionally took his pupils for country rambles. Afterwards they were joined by outsiders, and in 1860 constituted themselves into the Society of Amateur Botanists. This was planned for excursions, interchange of specimens, communication of papers, and the establishment of a library, herbarium, and museum. Cooke was the first and only president. Excursions were held on alternate Saturdays and meetings on alternate Wednesdays. The meetings were held first at the Metropolitan Club, Edgware Road, and then over the shop in Piccadilly of Robert Hardwicke, the publisher of natural history works. A letter in the first volume of *Hardwicke's Science Gossip* (1865) from W. Gibson, suggesting an association of amateur microscopists "something on the plan of the Society of Amateur Botanists," led to the formation of the Quekett Microscopical Club. The new club enrolled 155 members in its first year. Excursions were carried out as with the Society of Amateur Botanists, many of whose members joined the new club. The Society languished and may be said to have been killed by the Quekett.—C. E. **Salmon**: Some interesting British plants. *Myosotis brevifolia* Salm. is a new species, found in marshes in the Cross Fell district, and bearing short, broad, blunt leaves; it produces numerous rooting stolons above ground; its corolla is pale blue, almost as large as that of *M. repens*, the calyx is deeply divided, rather more than half-way, and the segments are oblong, rounded or blunt at the apex; its style is very short. Other plants were also described.

Dec. 16.—E. **Ashby**: Notes on the flora of the Grampian Mountains of Victoria, Australia. The range is situated in Western Victoria, and covers an area of about 60 miles by 30 miles; the rocks are sandstone, with quartzite and intrusive rock in a few places. It forms an ecological islet rising abruptly from hundreds of miles of undulating plains, and is a meeting-place of the east and west as regards its flora. Fifteen species are endemic, including four species of the Leguminous genus Pultenæa, and a terrestrial orchid, *Caladenia iridescens*, which flourishes high up in the barren stony mountain soil.—W. T. **Calman**: The giant teredo. The giant teredo, *Kuphus arenarius* (Linn.), first described by Rumphius two hundred years ago, has hitherto been known chiefly by its massive shelly tube, which may be so much as four feet in length and three inches in diameter at the wider end. A complete specimen was collected by Capt. Burgess, of the Mission steamer *Southern Cross*, in the Solomon Islands. It comprises some thirteen inches of the posterior end of the body, with the siphons and pallets. Instead of boring in wood like the other Teredinidæ, Kuphus lives embedded in the mud of mangrove-swamps, with the siphons projecting from the surface. Possibly it is the full-grown condition of a timber-boring species (perhaps *Teredo mannii*) which is set free by the decay of the wood.—J. R. **Norman**: Ambicoloration and associated variations in flat-fishes. Ambicoloration in flat-fishes is of particular interest on account of the other variations towards symmetry which accompany complete (or almost complete) pigmentation of the blind side. The modification of

the scales on the blind side to resemble those of the ocular side in the dab, and the development of bony tubercles on the blind side of the body in the turbot are characteristic variations of this nature. Another correlated variation is the delayed or arrested migration of the eye, which leads to the formation of a characteristic fleshy hook on the head. In the southern flounder of Australia, in which only a single pelvic fin is normally developed, two symmetrical pelvics of equal size are present in completely ambicolorate examples. The tendency is for ambicoloration in flat-fishes to affect the head last of all.

Geological Society, Dec. 15.—J. H. **Davies** and A. E. **Trueman**: A revision of the non-marine lamellibranchs of the Coal Measures, and a discussion of their zonal sequence. The Coal Measure lamellibranchs of the genera Carbonicola, Anthracomya, and Naiadites are discussed. A description of the sequence in South Wales is given and six zones are recognised. The succession in the north of France is closely comparable with that in South Wales. The relative abundance of the various genera is different, possibly indicating somewhat different conditions of deposition. The sequence in North Staffordshire is also discussed. It is concluded that the lamellibranchs afford a reliable basis for the correlation of the Coal Measures, and especially of that part of the Coal Measures which contains the more important seams.—L. Merson **Davies**: The Ranikot beds of Thal (North-West Frontier Provinces of India). Ranikot beds have never before been known to exist in India outside a very limited area in Sind; the new exposures are at Thal, on the Afghan frontier, more than 500 miles north of any hitherto known of the kind. Many new species, mostly corals, are found in the Thal beds. A particular examination has been made of the foraminifera of the Thal beds. The age of the Ranikot series is pre-Ypresian. The Upper Ranikot may be correlated with the Middle Landenian of Europe, and the Lower Ranikot with the Lowest Landenian and Montian.

DUBLIN.

Royal Dublin Society, November 23.—H. H. **Dixon** and T. A. **Bennet-Clark**: The electrical stimulation of plant tissues. The passage of an electrical current through a tissue leads to a change in electrical resistance and to a change in permeability. The stimulating current used was a sine-wave single-phase alternating current of 50 cycles, of which the voltage was controlled by a potentiometer, and the duration of the stimulus by a pendulum device. Pieces of ivy (*Hedera helix*) leaf, cut 1 cm. square, were used and were found to maintain a nearly constant resistance in the apparatus for so long as three days. A moderate stimulus (say 120 volts for 0·1 sec.) is immediately followed by a very rapid fall in resistance, which becomes less and less rapid, and, after a few minutes, the resistance rises a little and falls again. Finally, it starts to rise slowly, recovering in about an hour to the value it originally had before stimulation. Both a positive and negative deviation of resistance is initiated by the stimulus: their relative magnitudes depend on the magnitude of the stimulus. The smallest possible current causes a response if a certain minimal potential across the membrane is exceeded, and as the stimuli are increased, at first the positive reactions increase the more rapidly and predominate over the negative; with still larger stimuli the negative reactions predominate to an increasingly great extent over the positive reactions, which finally become unnoticeable after very large stimuli. The positive reactions only predominate within a small range of intensities of stimulus, and also only when the energy content of the stimulus is less than 0·01 joule under the conditions of these experiments. With stimuli all of the same energy content, the higher the intensity at which this energy is supplied the more effective it is. The relation between the intensity and the response is S-shaped. In consequence of this it is suggested that a given quantity of energy produces in any cell a definite alteration of resistance whatever the voltage at which it is supplied. It is supposed that the ability of a current to stimulate a cell is determined by the potential difference across the membranes of one cell. A series of stimuli to a single leaf square gives the same response as a single one of the combined duration of the series, provided that the intervals are not too long. We could not detect any conduction of the stimulus from the stimulated zone to any other region of the leaf. Advance of the season and also rise of temperature greatly increased the sensitivity of the tissues; the positive and negative reactions were not affected to the same extent.—H. P. **Lewis**: *Caninia cylindrica* Scouler and other large Caninias from the carboniferous limestone of Ireland.

Royal Irish Academy, November 30.—J. J. **Nolan** and G. P. **de Sachy**: Atmospheric ionisation. The conditions of equilibrium between small ions, nuclei, and large ions in the atmosphere are investigated. It is shown that, when positive and negative large ions are present in equal numbers, the ratio of the concentration of the small ions of the two signs is connected with the ratio of their mobilities by the equation $n_+/n_- = (k_-/k_+)^m$, where m is not far from unity and possibly $= \frac{3}{4}$. For n_+/n_- in atmospheric air the value 1·24 is found. In room air $n_+/n_- = 1{\cdot}11$ and $k_-/k_+ = 1{\cdot}16$. The value of the recombination constants of small ions, positive and negative, with large ions and nuclei are determined. It is found that both small and large atmospheric ions may be resolved into a number of distinct groups.

EDINBURGH.

Royal Society of Edinburgh, December 6.—H. Graham **Cannon** and Miss S. M. **Manton**: On the feeding mechanism of a mysid crustacean (*Hemimysis Lamornæ*). This organism feeds on large food masses and on minute suspended particles filtered from the surrounding water. The food stream is produced by the rotary swimming movements of the exopodite of the trunk limbs, aided by a paddle-like action of the maxillary exite. The suspended particles are filtered off by the proximal endite of the maxilla and pushed into the mouth by the combined action of maxillules, maxillæ, and the proximal endite of the first trunk limb. Large food masses are held by the mandibular palps and bitten into by both the incisor processes of the mandibles and by the distal endites of the maxillules. Storch's view that the primitive feeding mechanism of the Crustacea is a filter-feeding process is criticised, and an alternative hypothesis that it resulted from the paddling activities of primitive biramous appendages is put forward.—J. H. **Awbery** and Ezer **Griffiths**: Further experiments with the Ewing ball-and-tube flowmeter. This instrument measures the rate of flow of liquid or gas by the height to which a sphere is carried up a conical glass tube. The results of varying the liquid, the size of the sphere, and the inclination of the meter, have been investigated, and the observations are grouped together by making use of the theory of similitude. There is apparently no simple method of calibrating the instrument for one liquid from the results obtained with another.—E. A. **Baker**: The law of blackening of the photographic plate at low densities. (Second Paper.) iv.—Results for isochromatic and blue-sensitive plates and filtered light. Further low

density results are given, and explained on the assumption that the formation of the latent image takes place in two stages, the first being reversible, with the further assumptions that the number of absorbers in a grain is small, and that they are of at least two kinds.—Frederick Walker: The igneous geology of Ardsheal Hill. The summit of Ardsheal Hill is an igneous complex formed of a number of rock types of varied composition. The four principal types are kentallenite, appinite, granophyre, and hornblende-porphyrite. In common with other neighbouring intrusions, this complex is probably of Lower Devonian age.

PARIS.

Academy of Sciences, Nov. 29.—Emile Borel: A theorem on the linear forms with a symmetrical skew determinant.—H. Andoyer: The method of Delaunay.—Georges Perrier: The parallel of Meknès (triangulation and levelling).—P. Villard: The utilisation of the energy of naturally occurring warm water. Remarks on the subject of the note by G. Claude and P. Boucherot. The energy of hot springs could be more easily utilised in the manner suggested by G. Claude and P. Boucherot than that derived from tropical seas.—F. Widal and M. Laudat: Study of the modifications brought about in the nitrogen formula of blood serum by renal impermeability. Study of the distribution of the nitrogen compounds in a case of Bright's disease.—Georges Claude: The utilisation of the thermal energy of the sea. In January 1923 Tito Romagnoli published a paper on the utilisation of the thermal energy of the deep Italian lakes which to some extent anticipates the recent communication by the author on the same subject. Campbell in 1913 also made similar suggestions.—G. Sauvageau: Remarks on a note by Chemin and Legendre on the existence of free iodine in *Falkenbergia Doubletii*. Reply to criticism.—Krawtchouk: The distribution of prime numbers.—Enea Bortolotti: The angle of two conjugated directions.—René Garnier: Plateau's problem.—V. Smirnoff: The series of polynomials.—André Roussel: The extremum of certain double integrals.—Podtiaguine: The theory of growth [of functions].—H. Galbrun: Sound waves and zones of silence in the atmosphere.—Paul Stroobant: The movement of the whole of the helium stars.—L. d'Azambuja. The structure of the solar chromosphere.—Jarry-Desloges: Contribution to the study of the planet Mars. During 1926, Mars underwent important superficial modifications, greater than any observed during the preceding twenty years. Details of the observed changes are given.—Robert Lévi: The atom in the theory of universal and discontinuous action.—C. Ledoux: Method and apparatus for rapidly calculating the point in radiogoniometry.—Mlle. Paule Collet: Paramagnetism independent of temperature. Solid potassium permanganate, after purification by numerous recrystallisations, has a paramagnetism independent of the temperature, and this is the same as the salt in solution within the limits of experimental error. This salt forms a third example not in agreement with the law of Curie.—A. Danjon: The interferential study of scintillation and the conditions of stability of telescopic images. The diameters of stellar images take, under the effect of atmospheric agitation, values which are independent of the aperture of the objective when the latter exceeds 1 metre. Lord Rayleigh's rule applies to the deformation of images produced by scintillation.—C. Mihul: The structure of the third order of spectrum of oxygen.—D. K. Yovanovitch and Mlle. A. Dorabialska: The calorific effect of the β and γ-rays of radiothorium.—Mme. E. Tiegler-Soru: The ultraviolet spectrum of potassium nitrate and its variations as a function of the *p*H.—E. Raguin: The tectonic situation of the marbles of flaky structure near the Col de la Leysse (Savoy).—Yves Milon: The presence of glaucon in the Vindobonian shell marls of Brittany.—L. Joleaud: The tectonic of the Carib regions of South-American Columbia.—N. Menchikoff: Geological observations made in the course of the expedition of Prince Kemal-el-Dine Hussein in the Lybian desert (1925–1926).—L. Blaringhem: The segregation in mosaic of the fertile hybrids of wheat and barley.—Jules Amar: Oxygen-carbon dioxide antagonism. The antagonism of the two principal gases of the blood, oxygen and carbon dioxide, normally conditions the respiratory working. By increasing the proportion of either gas a mechanism of defence can be set up against intoxication by breathlessness, over-fatigue, stuffy atmosphere, and it is a method of treatment of respiratory syncope.—J. G. Szuman: The influence of the testicle on metabolism in the Gallinaceae.—Mme. L. Randoin and Mlle. A. Michaux: Comparative variations in the content of the suprarenal capsules in water, fatty acids, and cholesterol in the normal guinea-pig and in the guinea-pig submitted to a diet minus the antiscorbutic vitamin. The most marked change in the suprarenal capsules of guinea-pigs with experimental scurvy is the continuous fall in the proportion of cholesterol present. The proportion of fatty acids falls at first, but afterwards regains the normal. The water remains constant.—J. Benoit: The histophysiological study of the testicular nodules of regeneration in the domestic cock.—Gilbert Ranson: The resistance of young *Gryphoea angulata* to heat and their exceptional mortality in 1926.—Emile André and Henri Canal: The oil of *Mesoplodon bidens*. This oil resembles cachalot oil and oil of *Hyperoodon rostratus*. These three oils form a chemically homogenous group, the composition of which constitutes a marked physiological character of survivors of a fauna now extinct.—Georges Truffaut and N. Bezssonoff: The conditions which allow of co-operation between nitrogen-fixing bacteria and maize.

ROME.

Royal National Academy of the Lincei, Nov. 7.—G. Armellini: The difference between the visual magnitude and the bolometric magnitude of stars in relation to the absolute temperature.—L. Herrera: Appearances of struggle and of parasitism with simulations of infusoria. The name "colpoids" is suggested for the infusoria-like preparations made from soap solution and a solution of olive oil in petrol. These colpoids are spherical, elliptical, or of irregular and often ameboid form. Their dimensions vary from 100 to 800 microns or even more, and many of them are visible to the naked eye. Certain of the phenomena accompanying their mutual encounters exhibit very close resemblance to those observed with the struggling and parasitism of living infusoria.—Alessandro Terracini: Characterisation of Bianchi's systems of ∞' surfaces.—E. Raimondi: Approximate calculation of the dynamic effect of a current flowing between a lamina and an indefinite plane wall.—Arnaldo Masotti: Uniform translation of a circular cylinder in a channel with plane parallel edges.—U. Barbieri: Astronomical determination of latitude computed at Mondovi in 1925.—Bianca Nannei: Cycles of elastic hysteresis in bismuth wires. The cycles followed by the elastic behaviour of steel and iron wires are due principally to a hereditary elastic effect which is gradually dissipated, whereas with bismuth wires they represent a phenomenon of permanent deformation, also distinctly hereditary in character.—Umberto Crudeli: Electromagnetic fields

having the electric (magnetic) field zero at the circumference and the magnetic (electric) field tangential at the circumference.—M. Philibert: Further observations on the apparent duplication of the optic axis of calcite by Federow's plate. This duplication is only apparent and is caused by the anisotropy of the spherical segments of the Federow's plate, which behave like a doubly refracting biaxial substance. Far from being negligible, this double refraction of the segments gave rise to an axial angle of 14° in one case investigated.—G. Carobbi: New researches on noteworthy Vesuvian sublimates. Microscopic and crystallographic examination of material from the inner walls of a fumarole situated in a laval canal of the cupola formed on Vesuvius in April-May 1924 reveals the presence of boric acid in the form of sassoline and of potassium fluoborate as avogadrite.—Guido Cusmano: New process of dehydrogenation of menthol. When sodium is heated with menthol to about 300°, hydrogen is liberated in abundance and the mass becomes spongy, the sodium mentholate first formed losing hydrogen (2 atoms) to form a sodio-menthone, which again loses hydrogen (4 atoms) to yield sodium thymolate.—G. Scagliarini and G. Tartarini: Additive compounds of halides of bivalent metals with organic bases (iii). With cobalt and nickel chlorides and cobalt bromide, urotropine forms additive compounds of the form, $CoCl_2$, $C_6H_{12}N_4$.—Ettore Remotti: Photo-reactive behaviour in tadpoles and fry fed with thyroid. When tadpoles and the fry of *Salmo lacustris* and *S. irideus* are subjected to treatment with thyroid, their sera undergo important modifications in the colloidal equilibrium, these modifications being attributable partly to increased dispersion.—Silvio Ranzi: Investigations on the placodes of Cyclostomi, Ganoidei and Teleostei with respect particularly to the fate of the first epibranchial placode.—Constantino Gorini: Behaviour of *Bacterium typhi* in milk. Contrary to the opinion held up to the present, the typhus bacillus is capable of coagulating milk. The mechanism of the change is novel and peculiar and consists of an alkalifying, solubilising phase, followed by an acidifying and coagulating phase. The former phase is preceded by a transitory acidification, the conclusion drawn being that the organism is able to attack lactose, but prefers the casein, which is first proteolysed with production of bases. In the favourable medium thus created, the lactose is decomposed with development of acidity. The passage from the first to the second phase would be characterised by a process of reversion of the casein from the dissolved to the colloidal state.

SYDNEY.

Linnean Society of New South Wales, Oct. 27.—J. R. Malloch: Notes on Australian Diptera (ix).—Two genera and ten species are described as new in the families Ephydridæ, Agromyzidæ, Ortalidæ, Sapromyzidæ, Helomyzidæ, Neottiophilidæ and Muscidæ, the new genera belonging to Ortalidæ and Muscidæ.—Lucy M. Wood: On some land planarians from Barrington Tops, N.S.W., with descriptions of new species. The collection described comprises six species, representing the three genera Geoplana, Artioposthia and Platydemus, four of the species being regarded as new.—E. W. Ferguson: Revision of Australian Syrphidæ (Diptera). Part ii. Subfamily Milesiinæ. Five genera (1 new) and 21 species (10 new) are described. Four species of Graptomyza (subfamily Volucellinæ) are also described, three of them being new.

VIENNA.

Academy of Science, November 18.—L. Moser and A. Brukl: Determination and separation of the rare metals from other metals (viii.). Determination of thallium as thallium chromate and its separation from other elements. Sulphosalicylic acid is used to separate some metals, potassium cyanide and sodium thiosulphate separate others.—A. Winkler: Geological studies in the tertiary region of south-west Styria. Conglomerates and delta deposits.—R. Seka and O. Schmidt: Amino-derivatives of dinaphthanthracene-diquinone.—O. Kühn: A new hydrozoon from the Jura of Stramberg.—L. Waldmann: The geological structure of the Moldau-Danubian primitive rocks on the map sheet Gmünd.—H. Küpper: The facies relations of the newer palæozoic in Carinthia. Limestones and the Carboniferous.—E. Jahoda: Luminescence and coloration of alkali chlorides when treated with Becquerel rays. A red fluorescence was due to the presence of manganese.

Official Publications Received.

BRITISH AND COLONIAL.

The Deeside Field. (Issued under the Auspices of the Deeside Field Club.) Third number. Edited by J. B. Philip. Pp. vi+88+28 plates. (Aberdeen: D. Wyllie and Son.) 3s. 6d.

Transactions of the Optical Society. Vol. 27, No. 5. Pp. ii+277-336+xiv. (London: Optical Society, Imperial College of Science.) 10s.

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 1, No. 6: The Development of the Hypophysis Cerebri in Man, with a Note upon its Structure in the Human Adult. By Dr. David Waterston. Pp. 125-145+3 plates. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 4s.

Proceedings of the Liverpool Geological Society. Session the Sixty-seventh, 1925-1926. Part 3, Vol. 14. Edited by C. B. Travis. Pp. xvi+197-284+3 plates. (Liverpool.)

FOREIGN.

Bulletin of the American Museum of Natural History. Vol. 56, Art. 4: Contribution to the Knowledge of the Fossil Hyracoidea of the Fayûm, Egypt, with Description of several New Species. By H. Matsumoto. Pp. 253-350. (New York City.)

Proceedings of the United States National Museum. Vol. 69, Art. 21: Distributional Notes on some Neotropical Bugs of the Family Nabidæ, with Description of a New Species. By Halbert M. Harris. (No. 2647.) Pp. 4. (Washington, D.C.: Government Printing Office.)

The American Museum of Natural History. Guide Leaflet Series, No. 65: The Art of the Lapidary. By Herbert P. Whitlock. Pp. 29. (New York City.)

CATALOGUES.

Catalogue of B.D.H. Fine Chemical Products, including Organic and Inorganic Chemicals, Analytical Reagents, Indicators, Standard Stains. Pp. 108. (London: The British Drug Houses, Ltd.)

Diary of Societies.

SATURDAY, JANUARY 15.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 3.—J. S. Carson: Dry Cleaning of Coal.—Paper by L. F. H. Booth, Screening and Washing Plant at Deaf Hill Colliery, open for further discussion.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section) (at Manchester College of Technology), at 7.—W. Jolley: My Impressions of American Foundries.

MONDAY, JANUARY 17.

CAMBRIDGE PHILOSOPHICAL SOCIETY (at School of Agriculture, Cambridge), at 4.30.—Prof. T. B. Wood: Animal Calorimetry.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—G. B. Michell: The Comparative Chronology of Ancient Nations in its Bearing on Holy Scripture.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—G. S. Laird-Clowes: Ships of Early Explorers.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Circle) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Prof. W. M. Thornton: What is Electricity? (Faraday Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.—L. C. Grant: Wired Wireless.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—A. N. May: Electric Lighting for Public Service Vehicles.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Award of Prizes and Studentships.

ROYAL SOCIETY OF ARTS, at 8.—Dr. L. C. Martin: Recent Progress in Optics (Cantor Lectures) (1).

HUNTERIAN SOCIETY (at Mansion House), at 9.—Dr. J. M. T. Finney: The Influence of John Hunter on American Surgery.

ROYAL SOCIETY OF MEDICINE (Social Evening), at 9.30.—Prof. A. W. Sheen: Medicine in Ancient Greece.

CHEMICAL INDUSTRY CLUB.

TUESDAY, JANUARY 18.

SOCIETY OF GLASS TECHNOLOGY (at Manchester College of Technology), at 2.30.—Prof. W. E. S. Turner: The Effect of Cullet on the Melting of Glass.—Prof. J. F. Ponomareff: Investigation of the Glassy State by the Method of Forced Crystallisation.—Violet Dimbleby and Prof. W. E. S. Turner: The Durability of Some Soda-Lime Magnesia Glasses.—Prof. W. E. S. Turner and F. Winks: The Thermal Expansions of Some Boric Oxide Containing Glasses.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. R. Whytlaw Gray: Smokes as Aerial Disperse Systems (1).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—A. W. Flux: Indices of Industrial Productive Activity.

MINERALOGICAL SOCIETY, at 5.30.—Dr. A. Brammall and Dr. H. F. Harwood: The Temperature-range of Formation for Tourmaline, Rutile, Brookite, and Anatase in the Dartmoor Granite.—A. Russell: Notice of an Occurrence of Niccolite and Ullmannite at the Settlingstones Mine, Fourstones, Northumberland; of Stichtite at the Island of Unst, Shetlands; and Serpierite at Ross Island Mine, Killarney, Co. Kerry, Ireland.

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Derby Technical College), at 6.45. — R. M. Chamney: Telephonic Repeaters.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—J. E. Pryde-Hughes: The Land of the Magyar.

HULL CHEMICAL AND ENGINEERING SOCIETY (at Grey Street, Hull), at 7.45.—H. W. C. Henderson: The Lodge-Cottrell Electrical Precipitation Process.

WEDNESDAY, JANUARY 19.

SOCIETY OF GLASS TECHNOLOGY (at Grand Hotel, Manchester), at 2.30.—Prof. W. E. S. Turner: The Present Position of the Glass Industry in Germany. — Prof. J. F. Ponomareff: Developments in the Glass Industry in Russia.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Dr. A. Currie: The Medical History of the First Three Wives of Henry VIII. and their Offspring.—W. R. Dawson: Contributions to the History of Mummification.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—L. J. Chubb: The Geology of the Austral or Tubuai Islands (Southern Pacific).—W. Campbell Smith and L. J. Chubb: The Petrology of the Austral or Tubuai Islands (Southern Pacific).

INSTITUTION OF CIVIL ENGINEERS, at 6.30. — H. R. J. Burstall: The Testing of Heat Engines.

INSTITUTION OF AUTOMOBILE ENGINEERS (Informal Meeting) (at Junior Institution of Engineers), at 7.—Cinema Films of Engineering Interest.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—A. R. Cooper: Electrical Equipment of Track on the Underground Railways of London.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—H. E. Yerbury and others: Informal Discussion on The Electricity Bill.

MERSEYSIDE AQUARIUM SOCIETY (at 1 Falkland Road, Egremont), at 7.30.—Dr. J. Cotton: Aquatic Insects.

ROYAL METEOROLOGICAL SOCIETY (Annual General Meeting), at 7.40.—Presentation of Buchan Prize to C. K. M. Douglas.—Sir Gilbert T. Walker: The Atlantic Ocean (Address).

ROYAL MICROSCOPICAL SOCIETY (Annual Meeting), at 8. — Dr. J. A. Murray: Nuclear Degeneration due to Multipolar Mitosis (Presidential Address).

ROYAL SOCIETY OF ARTS, at 8.—Sir John Cadman: Development of the Petroleum Industry in Persia.

FOLK-LORE SOCIETY (at University College), at 8.—Miss Canziani: Folklore of the Abruzzi.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 8.15.—H. Sutton: Electrodeposited Coatings for Prevention of Corrosion.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 8.30.—Dr. J. M. T. Finney: Some Considerations Concerning the Pathology and Treatment of Gastric and Duodenal Ulcers.

INSTITUTE OF CHEMISTRY (London Section).

THURSDAY, JANUARY 20.

ROYAL SOCIETY, at 4.30.—A. Egerton and S. F. Gates: On Detonation of Gaseous Mixtures of Acetylene and of Pentane.—J. Topping and Prof. S. Chapman: On the Form and Energy of Crystalline Sodium Nitrate.—J. Topping: On the Mutual Potential Energy of a Plane Network of Doublets.—W. H. George and H. E. Beckett: The Energy of the Struck String.—*To be read in title only*:—S. R. Milner: An Analysis of the Electro-magnetic Field into Moving Elements.—D. Buchanan: Periodic Orbits of the Second Genus near the Straight-Line Equilibrium Points in the Problem of Three Bodies.—Prof. E. C. C. Baly, R. A. Morton, and R. W. Riding: The Measurement of Absorptive Power.—R. A. Morton and R. W. Riding: Absorption Spectra of Nitrates in the Region 300 $\mu\mu$.—J. S. Foster: Observed Stark Patterns in Helium.—J. E. Lennard-Jones and B. M. Dent: Some Theoretical Determinations of the Structure of Carbonate Crystals.—Prof. H. T. Barnes: Some Physical Properties of Icebergs: and a Method for their Destruction.—Prof. J. W. McBain and W. B. Lee: Adhesives and Adhesions: True Chemical Compounds as Adhesives.—Prof. W. L. Bragg: The Structure of Phenacite, Be_2SiO_3.—H. H. Potter: On the Proportionality of Mass and Weight.—D. M. Y. Somerville: The Relations connecting the Angle-Sums and Volume of a Polytope of n Dimensions.—P. A. M. Dirac: The Physical Interpretation of the Quantum Dynamics.—Prof. H. M. Macdonald: The Intensity of the Radiation from a Source of Electric Waves, when the Electric Constants of the Medium in the Neighbourhood of the Source are Different from the Electric Constants at a Distance from it.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—J. R. H. Weaver: Romanesque and Early Pointed Architecture in Spain (1).

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—G. Dunsheath: 33,000-Volt Cables with Metal-sheathed Cores, with special reference to the S.L. Type.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Watergate House, Adelphi), at 7.30.—J. N. H. Tait: Mixture Distribution in Multi-cylinder Petrol Engines.

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (jointly with Society of Chemical Industry, Edinburgh and East of Scotland Section) (at 36 York Place, Edinburgh), at 7.30.—Dr. C. H. Lander: The Importance of Fuel Research in the Coal Problem.

INSTITUTION OF CIVIL ENGINEERS (Yorkshire Association) (at Hotel Metropole, Leeds), at 7.30.—J. Cleminshaw: The Construction of Sewers in Tunnel.

CHEMICAL SOCIETY, at 8.—H. J. Emeléus: The Glow of Arsenic.—H. J. Emeléus and R. H. Purcell: On the Origin of the Spectrum of the Glow of Phosphorus.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, Cavendish Square), at 8.15.—Prof. J. W. W. Stephens: The Hæmoglobinurias.

ABERNETHIAN SOCIETY (at St. Bartholomew's Hospital).—Prof. W. Blair Bell: Team Work in Research, with Special Reference to the Nature and Treatment of Cancer.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch) (at Manchester).—G. Arrowsmith: Steam Turbines.

FRIDAY, JANUARY 21.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Sections), at 4.—Dr. L. J. Llewellyn and others: Discussion on Climacteric Arthritis.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—H. A. F. Lindsay: Recent Developments in Indian Trade.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6.—Prof. W. C. McC. Lewis: Some Physico-Chemical and Bio-Chemical Aspects of Malignant Growths.

JUNIOR INSTITUTION OF ENGINEERS, at 6. — Exhibition of Scientific Instruments and Apparatus.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. A. L. Mellanby and Prof. W. Kerr: Use and Economy of High Pressures in Steam Plant.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—E. B. Watton: Automatic Voltage Regulators.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section, jointly with Institute of Chemistry) (at 39 Elmbank Crescent, Glasgow), at 7. — J. W. Donaldson: The Volatility and Carbonisation of Oils for Cylinder Lubrication.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—The Pictorial Aspects of the Lantern Slide.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Dr. W. G. Shannon: Petrography and Correlation of the Sedimentary Rocks of the Torquay Promontory: Section II.—Permian Rocks.—E. A. Merrett: The Geology of the Lower Valley of the Gade.—W. F. Fleet: The Heavy Minerals of the Keele, Enville, 'Permian' and Lower Triassic Rocks of the Midlands, and the Correlation of these Strata.

ROYAL SOCIETY OF MEDICINE (Obstetrical Section) (jointly with Medico-Legal Society) (at 1 Wimpole Street, W.), at 8.—Dr. J. S. Fairbairn, Lord Riddell, Dr. T. W. Eden, and Sir Travers Humphreys: Discussion on The Ethical, Legal, and Medical Aspects of Abortion.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Sir Henry Gauvain and others: Discussion on Light Treatment in Surgical Tuberculosis.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir William Bragg: Tyndall's Experiments on Magne-Crystallic Action.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section) (at Manchester).—R. S. Horsfall: Modern Industrial Chemistry.

SATURDAY, JANUARY 22.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. W. Tristram: English Medieval Wall-Painting.

PHYSIOLOGICAL SOCIETY (at National Institute for Medical Research).

PUBLIC LECTURES.

SUNDAY, JANUARY 16.

GUILDHOUSE (Eccleston Square), at 3.30.—G. A. de Zoyza: The Soul of Buddhism.

TUESDAY, JANUARY 18.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Dr. R. Campbell Thompson: Conceptions of the Cosmos in Ancient Babylonia.

UNIVERSITY COLLEGE, at 5.30.—Dr. E. G. Richardson: Acoustics of Buildings. (Succeeding Lectures on January 25 and February 1.)

GRESHAM COLLEGE, at 6.—A. R. Hicks: The Total Eclipse of the Sun in June in Northern England. (Succeeding Lectures on January 19, 20, and 21.)

WEDNESDAY, JANUARY 19.

INSTITUTE OF HISTORICAL RESEARCH (University College), at 5.30.—N. B. Jopson: The Prehistoric Relations of the Slavs with their Neighbours. (Succeeding Lecture on January 26.)

UNIVERSITY COLLEGE, at 5.30.—Dr. A. Kihlbom: Modern Sweden: the Land and the People. (Succeeding Lectures on January 26 and February 2.)—Major C. Davenport: The Origin of the Book.

THURSDAY, JANUARY 20.

UNIVERSITY COLLEGE, at 5.—Dr. D. T. Harris: The Biological Action of Light. (Succeeding Lectures on January 27 and February 3.)

KING'S COLLEGE, at 5.30.—Prof. R. J. S. McDowall: The Mind Physiology.

NORTHAMPTON POLYTECHNIC INSTITUTE, at 7.—R. Genders: Steel and its Thermal Treatment: The Carbon Steels.

SATURDAY, JANUARY 22.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Mrs. H. M. Dunn: Benares, the Sacred City.

SUNDAY, JANUARY 23.

GUILDHOUSE (Eccleston Square), at 3.30.—S. N. Mallik: Hinduism.

CONFERENCE.

JANUARY 19.

ROTHAMSTED EXPERIMENTAL STATION, at 11.30 A.M.—The Culture and Manuring of Sugar Beet:—J. M. Van Bommel Van Vloten: Continental Experience with the Growth of Sugar Beet.—T. G. Fowler: What the Factory wants and how the Farmer can supply it.—I. J. Schapringer: Effect of Climate on the Cultivation of Sugar Beet.—R. N. Dowling: Experiments with Sugar Beet in the Midland Counties.—C. J. Clarke: Practical Experience in South-West England.—H. J. Page and C. Heigham: Manurial Experiments with Sugar Beet at Rothamsted and Woburn.