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CONTENTS.

Progressive Physics.

THE conception of segregation and integration put forward by Herbert Spencer in his "First Principles" seems to be illustrated by changes in the character of the correspondence columns of NATURE in recent years. During the War, and even before, few communications to these columns were published from scientific workers outside Great Britain; the process of segregation tended to collect them around separate geographical centres. Since then, however, the international outlook of science has begun to reassert itself, and investigators everywhere desire to make their methods or results as widely known as possible. Early publication serves a useful purpose, not only as a preliminary announcement of work to be described more fully later in a special journal or before a scientific society, but may also save other investigators from devoting time to a piece of research work which is being carried on elsewhere.

This function of the correspondence columns of NATURE has become increasingly important since what Prof. Smithells has called 'electronomy' became a branch of physical science, and stimulated active work in a wide and fertile field of mathematical and experimental inquiry. At the present time, more attention is devoted to explorations of this field than to any other scientific region; and this activity is reflected in our correspondence columns as it is in the *Proceedings of the Royal Society*. NATURE is, however, an international journal of science, and communications for publication as 'Letters to the Editor' come from many countries.

An accumulation of such correspondence is relieved to a slight extent this week by the publication of a Supplement containing a number of letters on atomic physics and related subjects. The variety and intricacy of the subjects dealt with in these letters illustrate most forcibly the difficulty inevitably encountered by any physicist who attempts to keep himself familiar with even the barest outlines of work being carried on outside his own special branches, and *pari passu*, the problem in selection of material which confronts teachers of the more advanced portions of the subject.

The value of the critical accounts of current research which appear from time to time in the *Physikalische Zeitschrift*, the new *Physical Review Supplement*, and other journals, and in the small monographs now being published in Great Britain as well as in Germany and France, cannot be overstated, whilst Prof. Sommerfeld's "Wellenmechanischer Ergänzungsband", probably in as wide use as his classical "Atombau und Spektrallinien", offers the wave-mechanics as a useful

tool and mode of expression of results to those whose interests are primarily experimental. At the same time, the theoretical equipment which is essential for a full appreciation of the implications of the new mechanics is so heavy that the active co-operation of a trained mathematician is as necessary in much laboratory work as the services of a glass-blower and mechanic.

There is at least one important branch which does not happen to be represented in the supplement, namely, that concerned with the line spectra of atoms. Hund's theory of spectra, which permits of the prediction of the exact types of spectral terms that will result from any configuration of the electrons of an atom, has already led to such great advances in the analysis of complicated spectra that the analysis of *all* line spectra now appears to be only a question of time. There are still notable gaps, particularly in connexion with extreme ultra-violet spectra and the spectra of the rare earths, but these no longer offer the seemingly insuperable barriers they once presented. It must be remembered, too, that Hund's theory correlates the terms of spectra with the discrete energy states of the atoms in far more detail than in the parent theories of Bohr and Sommerfeld, so that, for example, H. N. Russell's analysis of the arc spectrum of titanium is in effect a statement of the individual energies of hundreds of known configurations of neutral titanium atoms, and gives these energies with the high precision of spectroscopy.

This subject still offers a wide field for experimental research, as does the problem of the intensities of lines, of particular importance in astrophysics in view of the wealth of material offered by stellar spectra. The origin of the lines of the coronal spectrum of the sun has still, however, to be established, and the 'forbidden' lines of oxygen, nitrogen, and iron found in some stars and nebulæ have still to be produced in the laboratory.

Band spectra continue to attract much attention, and here again Prof. Hund has been largely instrumental in placing the theory of molecules on a sound basis. The fortunate fact that Raman spectra can be obtained without extraordinary difficulty is also leading to the accumulation of much valuable information about the properties of molecules—there are no less than five communications on this subject in our Supplement; and it is perhaps not looking too far ahead to envisage a time when an enumeration of the infra-red frequencies of a new compound will be regarded as necessary to its description as melting-point and crystal structure.

The extent to which experimental research has been fostered during the last decade by the large commercial laboratories, in particular by those interested in the production of lamps and wireless apparatus, has still perhaps to be appreciated fully. Quite apart from the work done directly by these bodies, which includes such important contributions to pure science as Davisson and Germer's work on the diffraction of electron waves and Langmuir's investigations of the properties of highly ionised gases, a high standard for manipulation has been created, the necessity for which arises from such facts as the making or marring of the electron-emitting properties of a filament by a layer of impurity on the surface one atom thick. The widespread use of diffusion pumps, the less general, but highly desirable use of induction furnaces for degassing metals *in vacuo*, and the introduction of new types of glass for containing vessels have come largely from their example and pioneer work.

In one respect, however, the activities of the commercial laboratories and other non-academic establishments are a little disquieting. As Prof. Andrade has pointed out, twenty-five or thirty years ago the young man who wanted to devote his life to experiment turned automatically to the universities; now, if he wants to earn a living, he turns, almost automatically, away from them (*Journal of Scientific Instruments*, February 1930, p. 49). It is highly probable that the universities will nevertheless continue to be the home of theoretical physics, and it may be questioned if this partial divorce of the two main branches of the subject will be for the ultimate good of either.

Problems of Plant Physiology.

Growth and Tropic Movements of Plants. By Sir Jagadis Chunder Bose. Pp. xxix + 447. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1929.) 21*s.* net.

ON examining the prolific publications of Sir Jagadis Chunder Bose, concerning various plant physiological phenomena, one is inevitably impressed by the unique style which he adopts in attacking the various problems with which he has dealt. His methods are often stupendous in their departure from orthodoxy (for which, maybe, he is to be congratulated), in experimental accuracy, and in the forethought for possible experimental error. His results, too, have often astounded many of his contemporary workers; but their value, unfortunately, is too often uncertain, through his being rather precipitate in drawing his conclusions.

Such a generalised opinion of his works is scarcely changed by this publication, "Growth and Tropic Movements of Plants", his latest work. Yet, whatever one may feel about the value of the bulk of this author's work from a purely physiological point of view, one must admit its value in other ways. There probably are very few plant physio-

logists who have attacked so many controversial problems in such an original manner. This, at any rate, stimulates thought and criticism in others, which is all to the common good. Such may be said of nearly all Bose's work, and especially of his well-known exploits into the mysteries of plant responses and the ascent of sap in plants.

In this new series of investigations, Bose has certainly maintained his reputation as an original worker along unusual lines. His methods are exclusively his own, and in an admirable fashion does he go on, not from where a previous worker left off, but in a manner peculiar to himself. In this work on growth and tropisms, the experimental method is, in general, brilliant; if not for its accuracy, then for its originality. But these phenomena, like all others, demand an ultimate exposition of the truth. This can never be cloaked, as an ideal, however enthusiastic one might become over a certain theory. One feels, therefore, to do this, we should strive for it in as simple a way as possible. Simplicity, so far as it can be indulged, is always the more desirable, so long as it maintains a practicably natural state of affairs, and this is possibly where Bose still remains at fault, for his experimental methods are usually far too complex in construction.

In striving to give weight to his convictions, Bose—broad-minded as he is in his outlook on science (the science of the universe, as he calls it elsewhere)—misses the mark very badly in his unfortunate exclusiveness where the work of others is concerned. Correlation of results of different workers is not only helpful to the student, but also is it essential, if such results are to carry any degree of conviction. This exclusive attitude of Bose, this failure to emphasise contrasts and comparisons with the work of others, has been exemplified so often as sometimes to prove exasperating; and such aloofness is demonstrated here again.

The majority of the methods involved in this new series of investigations are similar to the previous ones adopted by the author, in that the plant is made to record its own autograph. Yet one or two are worthy of special note.

Several new methods are described for the measurement of growth in plants. The author's criticism against the orthodox type of instrument, the auxamometer, is that an undesirable length of time is necessary before any appreciable result can be obtained. The auxanometer, in any case, is of little use, except for demonstration purposes, and such criticism is so clear as to be unnecessary. However, the new apparatus is undoubtedly much more desirable than the auxanometer.

Bose's high magnification creseograph is a splendid piece of apparatus which obviates many of the usual errors. In it is used the optical lever, which the author introduced into experimental physiology several years ago. Much experimental error, such as tension due to levers, stretching of connexions and friction at the fulcrum, has been ingeniously eliminated.

This creseograph is claimed to be highly sensitive, measuring a very small increase in growth, over an exceptionally small period of time. To quote an actual statement, Bose claims that this apparatus permits the record of growth elongation of 0·00005 mm. and a difference can be seen over an interval of 0·05 second. This is indeed sensitive as compared with methods which have been previously at the disposal of the plant physiologist.

In his studies of growth phenomena, Bose still maintains his conception of rhythmic pulsations in life processes. This is exemplified in his statement that growth is a pulsatory movement, being the resultant difference in each pulsation between elongation and recovery. This suggestion is a very plausible one, no doubt, but the experimental evidence obtained by the investigator appears to be considerably lacking in conviction.

Two other methods of measuring growth are described in the book. One is termed the "Method of Falling Weight", and the other the "Method of the Inclined Plane". Neither, however, seems to be so sensitive as the optical lever creseograph. In all three cases, the author takes change in linear dimension as an expression of growth. This, of course, cannot be accepted without reservation, yet, in spite of this and other drawbacks, the methods (and especially the first) might be used with advantage in any plant physiology laboratory, if only for demonstration purposes.

Many studies on the effect of conditioning factors of growth are described. These, however, have produced few observations of paramount importance, and, on the whole, the results are rather disappointing. In these investigations, too, Bose betrays a definite determination to introduce new methods, to the exclusion of other already established ones, which may be better. This is clearly emphasised in his experiments on the effect of temperature, although his own method is perhaps better, for obtaining gradual changes in temperature. Otherwise, a gas or electric thermostat would perhaps meet the case much more efficiently.

In all this work on growth, surprisingly little has been brought forward of any value from the point of view of newness or possible revolution of ideas:

that, we would naturally look for, since our knowledge of growth phenomena is so deplorably inadequate at present. The first section of the book, therefore, apart from one or two methods which are decidedly well worthy of note, is disappointing.

In the second part of his book, Bose has attacked the problems involved in plant tropisms. Here his investigations begin with the assumption that he is out to prove that the average physiologist is quite wrong in his conception of the various mechanisms involved in tropistic curvatures. Despite the many theories put forward, the average thinker is quite prepared to admit that we know practically nothing of this section on plant life processes. Bose's reference to the generalisation that shoots are positively phototropic and roots are negatively phototropic, as being " hasty ", is quite unnecessary and ill-founded, since this generalisation has been rejected for some time now.

Bose's methods of attacking these problems are very similar to the previous ones, and again, some might well be applied to demonstration experiments, although the author emphasises again their extreme sensitiveness. No new facts have been exposed, except perhaps that in all probability (although Bose states it dogmatically) the latent period may be much shorter than has been hitherto supposed. This is interesting and leads one to suggest that possibly, when a still more sensitive recorder has been devised, it may be established that no appreciably latent period really exists.

In his investigations on geotropism, carried on along similar lines, the author states that it is unnecessary to assume that geotropic reaction is really different in the root from that in the shoot. Although many theories, concerning either one or the other or both, have been put forward by various workers, nothing has been genuinely accepted, and this assumption certainly has not. His use of the term ' stimulus ' and so forth involves a definite meaning for them, just as definite, so he states, as such terms in animal physiology. This is only natural, of course, in view of his conception of a plant nervous system ; but even now, in spite of his observations, it seems doubtful whether plant physiologists are justified in accepting these terms.

Concerning the geoperceptive region, Bose makes some observations which, reactionary though they may be, might prove of considerable interest. By means of an electric probe (which we have met before in this author's works), he has attempted to show (and has himself concluded) that such a region exists as a cylindrical layer, some distance below the surface of the organ. This layer, one assumes from his statements, is not absolute, since it apparently merges insensibly, with declining excitability, from a maximum to a minimum nearer the surface and a minimum nearer the centre. Such an observation may prove of value ; but one cannot help suspecting that the methods used and the results so far obtained make the whole conception very questionable at the moment.

All irritabilities, according to Bose, should not be considered as separate phenomena, but rather as variants of a common one. This observation only voices the suspicions of many plant physiologists. It therefore is of little value, and especially since the experimental evidence brought out is insufficient to warrant this assumption, although it certainly does not tend in any other direction.

The evidence, on the whole, in the latter half of the book is meagre and lacking in conviction. Much has been done which is of great interest from an experimental point of view ; but little new is there to evince any theoretical considerations. In fact, one might almost say that Bose could, with just as much confidence, have postulated his theories of tropisms from the few facts that have already been established by previous authors, with simpler methods.

The whole book may be described as a practical note-book—one written by a student with endless originality, perseverance, conception of method, and amazingly delicate technique ; but also with a tendency to misconstrue results and form precipitate conclusions. Nothing really new has been added to our very scanty store of knowledge of these subjects—a little more detail perhaps—and much has been done which one feels might just as well have been left undone, at any rate, for the time being. We really know so little about natural phenomena and natural conditions, that to examine the effect of unnatural or artificial ones, as Bose all too frequently has done here, seems almost sacrilege, at the moment.

One might say that, instead of being content with a toy of simple proportions, Sir Jagadis has assembled one of more complicated parts and enormous dimensions. Thus, with enthusiasm has he spent much time with his ingenious contrivance and made it do all manner of wonderful things (perhaps with more exactitude than the simpler one, and, if so, this is desirable) ; but it has done nothing new ; and, in such cases, there is always the risk of missing the wood for the trees, or, worse still, finding the wrong wood. Much more desirable would it be to get a greater mass of trustworthy facts and, coupling them with those obtained by

other workers, make more possible deductions, rather than to set out to impress an idea at all costs, which, after all, may be wrong.

Until this is done (and one feels that we have not been helped to any appreciable extent by this latest work), we must perforce remain in the morass of scientific hypothesis, which is decidedly unsound where tropisms are concerned, until such time as we obtain the evidence necessary to our attaining a more substantial conception of the actual truth. L. J. F. BRIMBLE.

Science in the Fifteenth Century.

Science and Thought in the Fifteenth Century; Studies in the History of Medicine and Surgery, Natural and Mathematical Science, Philosophy and Politics. By Lynn Thorndike. Pp. xiv + 387 + 10 plates. (New York: Columbia University Press; London: Oxford University Press, 1929.) 24*s.* net.

IT is most satisfactory to be able to record that the last few years have been marked by an ever-increasing output of literature dealing with the early history of the natural sciences, and the excellent advice of the Hebrew poet,

"Let us now praise famous men",

has been taken by many, who have thereby followed the good example of NATURE, which for several years past has made references from time to time to the achievements of bygone scientific worthies. In spite of absence of manuscripts and other first-hand documents in the United States, the same ends are being pursued by our friends across the water; and by none with greater enthusiasm than by Prof. Lynn Thorndike of Columbia University. His most recent book comprises a series of studies chosen to illustrate the thought and science of the fifteenth century, a period which is less well known than the earlier, and perhaps more fruitful, period of Roger Bacon, but which is also well worthy of investigation.

To place the subject in its proper light and atmosphere, the main characteristics of fourteenth century science are outlined in a useful introductory chapter, which is calculated to astonish even those mechanical creatures of habit who, having "stopped thinking and reading twenty years ago", repeat "old slurs and disparaging generalisations at the expense of the middle ages". Our author quotes many examples of the high culture and advanced thinking of scholars of the twelfth, thirteenth, and fourteenth centuries, such as Occam, Buridon, Albert of Saxony, and also Nicolas Oresme, whose ideas concerning physics and astronomy were remarkable. By 1326, Richard of Wallingford, father of trigonometry, had brought measuring instruments and clocks to a marvellous state of perfection. Gunpowder, the blast furnace, the mariner's compass, and many other inventions, were all available for useful purposes: even so elaborate a surgical operation as rhinoplasty had been successfully accomplished.

The status of medical practitioners in the fifteenth century is illustrated by early Italian disputations as to the relative importance of medicine and law, in which it is argued that the lawyers have attained to a higher social position than the doctors, because they do not soil themselves by plunging their hands into viscera, and so on. Is this, perhaps, the reason why the Royal Society includes so few surgeons among its fellows even at the present day? But it may be that the science of medicine is still, as John of Arezzo suggested, "under the rule of Mars and Scorpion . . . invidious, malevolent, plotting against and hating all others". Then appropriately follow chapters dealing with the surgery of Leonard of Bertipaglia; an anonymous "Practica Cirurgie" assigned to John Braccia of Milan, or to Peter of Tossignano who used to prescribe caustic water; and lastly, an autopsy by Bernard Tornius, of which both the original text and a translation are printed. Among minor medical writings, one by John of Arezzo on poisonous mushrooms, their appearance, black, livid, or green when cut open; their being rendered harmless when cooked with wild pears; and the symptoms of poisoning, and its cure by vomiting, have a perennial interest.

In dealing with Nicholas of Cusa, Prof. Thorndike strikes a more controversial note, and points out that, at least so far as the astronomical system with which the name of Cusa is associated is concerned, it is probable that exaggerated praise has been meted out to him. For, so far from being an important precursor of Copernicus, Cusa scarcely carried his system beyond that of Ptolemy. All he appears to have said is that the earth has a movement, and its position varies a little in consequence. The work of Cusa's protégé, George von Peurbach, the Virgilian scholar and inventor of the geometer's quadrate, is next discussed. He is remembered as the translator of six books of the Almagest, but unfortunately his version, having been made *breviorem lucidioremque* than the original Greek, is a poor substitute for it. His reputation, like that of Regiomontanus, has "received rather undue emphasis from modern German historical scholarship, whereas until recent years the English, French, Italian, and Spanish

mathematicians of the fourteenth and fifteenth centuries have been less studied and written about".

The French arithmetic of Jehan Adam composed in 1475 concludes this section of the book. The remainder deals with treatises on politics, moral philosophy, and other matters, but many readers will take pleasure in being introduced to the "De Constitutione mundi", by John Michael Albert of Carrara, the probable sources of whose information are carefully traced by the author.

We owe a debt of gratitude to Prof. Thorndike and to the Dunning Fund for this volume of miscellaneous studies now presented to us.

Greenland.

Greenland. Published by the Commission for the Direction of the Geological and Geographical Investigations in Greenland. Editors: Prof. M. Vahl, Vice-Admiral G. C. Amdrup, Dr. L. Bobé, Prof. Ad. S. Jensen. (Published at the Expense of the Carlsberg Fund.) Vol. 2: *The Past and Present Population of Greenland.* Pp. iv+415. (Copenhagen: C. A. Reitzel; London: Oxford University Press, 1928.) 35*s*. net.

THE first volume of "Greenland" was reviewed in NATURE of Mar. 23, 1929. This, the second of the three volumes planned, deals exclusively with the past and present inhabitants. Of the six articles, three are concerned with Eskimo ethnology and archæology, and three with the now extinct tenth century colonisation by Norsemen.

Dr. Birket Smith provides a full and interesting account of the present-day Greenlanders, their distribution, mode of life, and material culture. A contrast is made between the high-arctic type at Etah (Sir John Ross's Arctic Highlanders) and the subarctic kayak-using people farther south. The former can still be named Eskimo; the latter are Greenlanders, half Eskimo, half European. They appear to have none of the disadvantages so often implied by the term 'half breed', but on the other hand, with usages and habits modified by Danish influence, it can even be claimed that Greenlanders are in many ways superior to unmixed Eskimo stock. Their number at the present time is about 14,000, compared with 6000 at the beginning of last century. Dr. Birket Smith's description is the only full and accurate account of these people written since the publication of Dr. Rink's "Danish Greenland" in 1877.

Shorter articles deal with intellectual culture, and with Eskimo archæology. The latter, though brief, is fairly exhaustive, little excavation having as yet been undertaken. The nature of the older (Thule) culture is explained. Eskimo origins and the lines of immigration are discussed; from this it appears that the balance of evidence now is in favour of the view that north-east Greenland was peopled by way of the north, and that the track of the immigrants lay so far north as lat. 83° N.

The first of the articles on the Norse settlements is a general account by Finnur Jonsson based on historical records. This is followed by a description of the farm sites by Daniel Brunn; in this article reference is made particularly to the economic conditions considered likely at the time of the occupation. Finally, Dr. Norlund summarises the finds made at the Herjolfsnes burial ground in 1921, when well-preserved clothing of fourteenth and fifteenth century type was found in ground now permanently frozen. Dr. Norlund concludes that the colony died out as a result of the consequences of unsatisfactory diet, and that there was a complete absence of any intermingling with Eskimo. The view that there had been a setting-in of colder conditions is apparently not so confidently held. The three articles on the Norse settlements are brief accounts of a subject on which lately a good deal has been written: they show that Danish writers at any rate have refrained from making the history of the old colonies in any way fictitious or unduly sensational.

Both Eskimo and Norse sections of the book constitute most admirable accounts of the past history of Greenland and of the living conditions found there to-day. This book is definitely the authoritative work on Greenland and Greenlanders. Apart from its being indispensable, it is exceedingly well written and well produced.

J. M. WORDIE.

Our Bookshelf.

Die Tierwelt der Nord- und Ostsee. Begründet von Grimpe und E. Wagler. Herausgegeben von G. Grimpe. Lieferung 15. Teil 9a: *Aculifera*, von H. J. Nierstrasz und H. Hoffmann; Teil 11 f: *Thalassobionte* und *thalassophile Myriapoda*, von O. Schubart; Teil $12h_3$: *Pisces.* Pp. 64+20+141+164. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1929.) 8·80 gold marks.

WITH the fifteenth *Lieferung* (12 h 3) of this work the portion dealing with the fishes ends, the present part consisting of an appendix dealing chiefly with distribution. The fishes can now be obtained in a separate volume entitled "Die Fische der Nord- und Ostsee". In Part 9a (Aculifera), Drs. N. F. Nierstrasz and H. Hoffmann give a good account

of the Aplacophora and of the Chitons. In Part 11 f (Thalassobionta and thalassophile Myriapoda), Dr. Otto Schubart describes the maritime and submaritime Myriapods. There are a large number of the Aplacophora in this region, but although their anatomy is fairly well known, there is a lamentable gap in our knowledge of their development and life histories, the chief work on these having been done with species from elsewhere. The same may be said of the Placophora, although more is known of this group and the eggs of a few of our common forms have been seen. All the species are very clearly described and figured with details of the plates, so that identification should be easy, and the anatomy, biology, and distribution are fully discussed.

The large number of myriapods which are more or less marine is surprising. Most of these live on the shore between or above tidemarks, and they belong to several different groups. Dr. Schubart gives a very interesting account of these, especially with regard to their biology. Some of them can remain alive under water many days, although not so long in salt water as in fresh, and in no case is it a natural habitat. Damp, salty situations are by no means avoided, the chief localities being rocky and stony shores. The internal anatomy is barely touched upon, but much space is given to the distribution and ecology of the species. Most of the illustrations are original photographs or line drawings.

A School Geometry. By A. Walker and G. P. McNicol. Part 1 (Books I.-III.). Pp. viii + 256. 3*s.* 6*d.* Part 2 (Books IV.-VII.). Pp. vi + 251-492. 3*s.* 6*d.* Part 2, Section 1 (Books IV.-V.). Pp. vi + 251-352. 2*s.* Part 2, Section 2 (Books VI.-VII.). Pp. vi + 351-480. 2*s.* (London, New York and Toronto: Longmans, Green and Co., Ltd., 1930.)

THIS book is an improved version of the type of text-book on elementary geometry that began to appear about thirty years ago. It is carefully written and the supply of exercises is better than in some of the older books, but there is the traditional emphasis on 'bookwork' which seems somewhat out-of-date. When examination papers in geometry consisted half of Euclid's propositions and half of riders demanding some real geometrical power, all that teachers could hope to do for their feebler pupils was to get them to understand enough about the subject to write out the propositions intelligently. Nowadays, what is demanded is some power of independent thought sufficient to answer simple questions which, though they can scarcely be called riders in the old sense, are definitely not bookwork. It is found possible to satisfy this demand save in very exceptional cases, and it can scarcely be doubted that the modern training is the more valuable.

The process of learning propositions in a definite sequence, whether Euclid's or some other, comes nowadays later in the geometry course, and is not generally regarded as the matter of primary importance. Therefore a text-book arranged like this one, on traditional lines, is not probably the most convenient, especially for an inexperienced teacher who is perhaps doubtful about how the reading should be arranged.

The printing and general arrangement of the book reflect the greatest credit on the printers and publishers. A. R.

Leçons sur les systèmes d'équations aux dérivées partielles. Par Prof. Maurice Janet. (Cahiers scientifiques, Fascicule 4.) Pp. viii + 125. (Paris: Gauthier-Villars et Cie, 1929.) 30 francs.

PROF. M. JANET has produced a valuable contribution to the analytical theory of partial differential equations. It opens with a clearly written introduction in which are discussed the chief problems arising out of the general theory to be considered. Then follow two chapters on " Calcul inverse de la dérivation ", existence theorems, and the linear partial equation of the second order in one unknown function. These chapters lead logically to the development of the most important part of the subject with which the book is concerned, namely, the reduction of any system of equations to the canonical system of Riquier. The final chapter is devoted to systems in involution, in which another canonical form is considered. This is based upon M. Cartan's development of the Pfaffian system.

Numerous examples providing particular applications of the general theory are given. Many of these are followed by interesting analytical notes. Finally, valuable notes upon convergence of series solutions and the characteristic multiplicity of systems, together with a bibliographic summary for further reading, are given as an appendix.

Plane Trigonometry. By Prof. J. B. Rosenbach and Prof. E. A. Whitman. Pp. ix + 216. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1929.) 10*s.* net.

THIS is, in general, quite a well-written book, though, in some respects, on old lines. It covers elementary trigonometry to the logarithmic solution of triangles, and makes a good beginning by defining the functions of angles of any magnitude with the aid of co-ordinates. Circular measure is also developed early and used frequently throughout the text. If, however, it is deemed necessary to devote a section to the theory and practical use of logarithms, there seems no reason for deferring such to the last chapter, especially when logarithms are freely used from Chapter ii. onwards. The section on the linear equation $a \cos \theta + b \sin \theta = c$ is not wholly satisfactory. Greater emphasis should be laid on the introduction of irrelevant roots by squaring than is given in Ex. 2 on p. 108. The method of transforming to a quadratic in $\tan \frac{1}{2}\theta$ does not seem to be dealt with.

There are plenty of good examples for which five-figure tables are required, but some of the calculations involved are unnecessarily heavy. The book is well printed, and answers to the examples are provided.

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 Ovary Stimulating Hormone of the Placenta.

THE production of prematurity in young female rats and mice by Smith and Engle in America, and by Zondek and Aschheim in Germany, through the use of the anterior pituitary gland transplant or emulsion has afforded a great stimulus to further investigation of the hormonal control of gonadal activity. The latter investigators have demonstrated that effects somewhat similar to those following pituitary gland implantations can be elicited in immature rats and mice by extract of pregnancy urine which has been rendered œstrin-free. They have likewise shown decidua, placenta, the corpus luteum of pregnancy, as well as pregnancy blood, to contain an ovary stimulatory hormone analogous to that of the anterior pituitary gland.

Dr. B. P. Wiesner, of the University of Edinburgh, experimented extensively with extracts of the placenta by the use of sulphosalicylic acid. He is of the opinion that his own experiments have demonstrated the existence in placenta of two hormones, one of which he called 'Rho I.', which is œstrogenic in action, causing prematurity phenomena in rodents; the other, 'Rho II.', has a luteinising action on the ovary and causes a state of pseudo-pregnancy (see Wiesner, *Edin. Med. Jour.*, February 1930, p. 73).

Dr. Wiesner visited my laboratory in September 1929, and asked me to take up the problem of concentration and purification of the ovarian stimulatory hormone of placenta which he has termed 'Rho I.'. The problem was, therefore, made a subject of special study in this laboratory, and the results of our investigations to date, which appear to be of great interest, may be summarised as follows:

1. The placenta (human or ox) contains an ovary-stimulating hormone the injection of which into immature rats and mice causes prematurity phenomena. (Confirming Zondek and Aschheim, and Wiesner.)

2. The active principle has been obtained in a fraction which is micro-crystalline in character. After repeated recrystallisations, 0·0015 mgm. of such a fraction has been found to represent one rat unit.

3. Active extracts which have been rendered protein- and lipoid-free, as well as œstrin-free have been standardised in terms of rat units. The manifestation of prematurity phenomena (confirmed by microscopic sections of ovary, uterus, and vagina) has been the basis of the biological test.

4. Active extracts have been shown to withstand *in vitro* digestion with pepsin and trypsin without appreciable loss of their physiological activity.

5. It has been repeatedly demonstrated that potent extracts may be effective when administered by the oral route. The amount of extract, administered orally, required to produce definite stimulation of the immature ovary may be very little more than the effective subcutaneous dose.

6. The effects of daily injections, over long periods, of active extracts have been studied in relation to the histology of the genital tract and also in relation to pregnancy and lactation in the adult female rat.

7. Immature female rats, as a rule, become cyclic following the induction of prematurity phenomena.

8. Several instances of normal mating have occurred in treated rats thirty-five to fifty days of age.

9. Adult rats which have received two to ten rat units daily have manifested the normal cyclic changes, have been impregnated and produced litters of normal size at the normal gestation period, and have shown no impairment of lactation. Some of these rats are now in their third pregnancy since the injections began.

10. Clinical trial of the placental extract in a selected group of cases of ovarian hypofunction, with the collaboration of Dr. A. D. Campbell, has been productive of results which are most encouraging.

This phase of our work at McGill University is now a subject of intensive study. With the co-operation of the staffs of the Royal Victoria and Montreal General Hospitals, the following types of cases are being studied:

(*a*) Delayed puberty, (*b*) dysmenorrhœa, (*c*) amenorrhœa, (*d*) metropathia hæmorrhagica, (*e*) menopause, (*f*) toxæmia of pregnancy, (*g*) certain neurological and psychiatric cases, (*h*) thyroid dysfunction.

The extract, in liquid form, is being administered by mouth.

11. It is our opinion, in the light of experimental evidence, that the hormone of the placenta with which we are dealing is not identical with the anterior pituitary ovary stimulatory principle ('Rho I.' of Wiesner). It is produced, we believe, by an active process in the placenta itself. Its physiological effects on rodents are suggestive of the all-or-nothing law. It will activate an immature or hypofunctioning ovary, but has little effect upon the normal organ, and no effect on a castrated individual.

If we are correct in this assumption, then one should be able to demonstrate that the diseased placenta produces less of the active principle. Assay experiments which are now being made on placenta, both normal and pathological, obtained at various periods of gestation, will do much to settle this point.

J. B. COLLIP.

Biochemical Laboratory,
McGill University,
Montreal, Canada, Feb. 20.

The Crystalline Style of the Mollusca and a Carnivorous Habit cannot Normally Co-exist.

THE crystalline style of the Lamellibranchs and many Gastropods consists of a gelatinous rod formed of protein of a globulin type. It would, therefore, be readily digested by any extracellular proteoclastic enzyme in the alimentary tract. Since the development of the carnivorous habit demands (with such rare exceptions as the one noted below) the presence of an enzyme capable of breaking down the flesh of the prey into soluble polypeptides and amino acids (for example, in Cœlenterates, Decapod Crustacea, and Cephalopods), it follows that a mollusc cannot normally both possess a style and be a carnivore.

A brief survey of those molluscs which possess a style will emphasise this point. The style is universally present in Lamellibranchs. Here feeding is by ciliary mechanisms, the food being selected according to size only. There is no extracellular protease in the gut, the only extracellular enzyme being that set free by the dissolution in the stomach of the head of the style and that acts exclusively on starch and glycogen (Yonge [1]). Zooplankton may survive passage through the gut. Minute particles of animal matter (for example, blood corpuscles from fish) may be ingested and digested by wandering phagocytes which pass through the gut wall into the lumen and thence back

into the tissues. More minute matter still may be digested intracellularly by the cells of the digestive diverticula. The principal food of Lamellibranchs is fine phytoplankton.

In the Gastropods the style is present in a variety of genera (see Robson [2] and Mackintosh [3]), but on examination these are seen to fall into two groups according to the mode of feeding. There are (1) those that have ciliary feeding mechanisms and (2) those that scrape their food with a radula. Examples of the first are provided by *Crepidula*, *Calyptræa*, *Capulus* (Orton,[4] Mackintosh,[3] Yonge [5]), *Vermetus* (which I have recently had the opportunity of examining on the Great Barrier Reef) and their allies among the Tænioglossa, and the Thecosomatous Pteropods (Yonge [6]) among the Tectibranchs. In the latter case the gradual loss of the radula, jaws and 'salivary' glands handed down from carnivorous ancestors, in the series *Cavolinia—Cymbulia—Gleba*, with a simultaneous evolution of a more perfect ciliary feeding mechanism and of a small style (Meisenheimer [7]), is especially striking. In the second class are included many 'scrapers' (Yonge [8]) of vegetable food, such as *Patella* in the Docoglossa, *Fissurella* in the Rhipidoglossa, and a variety of Tænioglossa including *Paludestrina*, *Turritella*, and *Aporrhais* (see Robson [2] and Mackintosh [3] for full list). Perhaps the best case is that of *Lambis* (Pterocera), which has a large firm style lying in a separate sac (Woodward [9]), the animal feeding by means of a delicate radula on the softest of filamentous weeds. As I found in Australia, this animal has no extracellular protease in the gut, the 'salivary' glands are absent or degenerate, and is so specialised a herbivore as even to possess a powerful extracellular cellulase.

The details of my investigations on reef molluscs will be published in due course.

Passing to typical carnivorous Gastropods, very different conditions are found. In *Natica*, *Murex*, *Pterotrachea*, and *Pleurobranchæa* (Hirsch [10]) there are in all cases powerful proteases in the alimentary canal secreted by the 'salivary' glands and possibly also by the digestive gland in the first two, and by the latter alone in the last two. In *Sycotypus* (Mendel and Bradley [11]) the 'salivary' glands secrete a powerful protease, the secretion from the digestive gland being concerned only with the digestion of fats and carbohydrates.

There is one exception which, to an unexpected degree, proves the rule. The Septibranchs (Yonge [12]) have lost the ciliary feeding mechanisms of the other Lamellibranchs and developed a muscular feeding mechanism operated by the movements of the septum which enables them to swallow dead or dying animal prey, such as small Crustaceans, Annelids, etc. The stomach has lost the sorting function it possesses in the other Lamellibranchs, has elongated, developed an interior horny lining and powerful circular and longitudinal muscles, and in this way become a crushing gizzard in which the prey is broken into fine fragments. The small style is apparently practically functionless. There is *no* free protease in the alimentary tract, the food particles being conveyed through the exceptionally wide ducts into the tubules of the digestive diverticula, where they are digested intracellularly.

In my first paper on *Mya* (Yonge [13]) I attributed the dissolution of the style in the stomach to a secretion from the digestive diverticula of a protease. I have since had a number of opportunities of correcting this error; the digestive diverticula of the Lamellibranchs do *not* secrete. The style, as pointed out previously in these pages (Yonge [14]), which consists of an amphoteric protein, is solid at the low *p*H of its formation (4·5-5·8 according to the species), but dissolves in the less acid contents of the stomach, thereby releasing the enzyme and lowering the *p*H of the stomach contents to about the optimum conditions for the working of the enzyme (Yonge [5]). Its disappearance in animals where the style-sac is in free communication with the intestine is due to unfavourable conditions causing a decrease in secretory activity which is no longer able to keep pace with the process of dissolution.

Summarising, it can be stated with confidence that the presence of a crystalline style in any mollusc is a certain indication that the animal in question possesses *no extracellular proteoclastic enzymes* and so cannot digest any but the very minute particles of protein matter which can be ingested intracellularly. Such an animal is, therefore, except where a powerful crushing gizzard is present as in the Septibranchs, a specialised herbivore.

C. M. YONGE.

Marine Biological Laboratory,
Citadel Hill, Plymouth,
Feb. 27.

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14 Yonge, NATURE, **117**, 691; 1926.

Contamination by Dust Particles and Intensive Desiccation.

As is stated by H. B. and M. Baker in their 1912 article, it was a letter in regard to desiccated calomel that led them to study the effects of intensive desiccation on boiling points and other physical properties of liquids, a field in which the many investigators who have since entered it have obtained results that are outstandingly discordant. In looking back at the work of Smith and Menzies, published in 1911, one can readily see that, in working with calomel, they were fortunate in being able to heat the substance to be desiccated for months at 115°, while the drying agent, in another portion of the same apparatus, could be kept at room temperature. But one can recall also a feature of the work that is not obvious, namely, that, by reason of the methods used, their dry system was presumably unusually free from contamination with atmospheric dust. Recent work in this laboratory has again brought to our attention the importance of atmospheric dust.

One finds that salt hydrates show periods of induction, not only preceding the process of dehydration, as was remarked by Faraday and has been since confirmed by many others, but also preceding the processes of rehydration and of deliquescence. This has been best observed with crystals grown from a state of lower hydration by gain of water from the vapour phase. If such crystals are grown within a closed vessel, the conditions are favourable for the formation of a virgin surface, which refuses to be readily hydrated.

Under suitable conditions the gain of water, once begun, proceeds with that change of rate through a maximum which is characteristic of an autocatalytic process. This is in agreement with Langmuir's hypothesis, which, for this case, would state that the addition reaction which transforms the lower to the higher hydrate takes place only in the region where both the solid phases are in contact. The presence

of the higher hydrate, the function of which may possibly be filled by other solids, isomorphous or otherwise, furnished by dust, promotes the reaction. Dust may even furnish particles of salts that are deliquescent under the conditions of the experiment, thus making possible hydration of the salt studied by water in the liquid phase. One could not, therefore, hope to observe, nor does one observe, the behaviour mentioned above if starting nuclei, furnished by dust, were thickly spread over the surfaces of the crystals of the lower hydrate. In such a case, the induction period would be lacking and the rate of reaction a steadily diminishing one as the zone of reaction progressed, with diminishing area, toward the centres of the crystals; and this has been the common observation in the past. The induction period observed, under suitable conditions, prior to combination with water, and the initial slowness of the process, may well explain the experimental findings reported in the literature concerning the unexpected inefficiency of such substances as anhydrous cupric sulphate or calcium oxide when used for the drying of gases.

With reference to the effect of intensive desiccation on the boiling points of liquids, F. O. Rice has very properly considered the presence of dust as affecting superheating, although without illuminative result; and he pointed out further that dust particles present, if they also must be dried, will delay the drying of a system containing a liquid. It may be added that certain substances contributed by dust particles may promote the changes under observation just as effectively as does water itself.

One should recall, also, the independent and concordant findings of Wolski and of Kenrick that ordinary distilled water contains about 20,000 motes per cubic centimetre. Other distilled liquids may be in like case. Moteless water shaken in ordinary 'clean' glass apparatus rapidly acquires many motes. Even dismissing from consideration the motes suspended in the liquid, one is able to bring forward additional reasons, beyond the mere sealing of capillaries, for timeously heating to the fusion point all glass apparatus designed for work on the effects of intensive desiccation. For example, this fusion of the glass may flux and fix the loose scale that yields the motes, and will certainly enormously diminish the area of the quasi-porous internal surface of glass that has been cleaned and roughened by cleaning solution. Again, the fusion process may engulf and incorporate beneath a relatively plane glass surface dust particles of such ubiquitous salts as sodium chloride, as well as the ash of those organic particles which, in using Baker's air current technique rather than the vacuum technique for drying apparatus, have been burned to ash.

Fuller reports of studies of these matters will appear elsewhere.

ALAN W. C. MENZIES.
Princeton University,
New Jersey, U.S.A.
Feb. 11.

The Green Flash in Southern California.

SINCE my earlier letter on this subject (NATURE, Aug. 4, 1928) was written, I have made many more observations of the flash at sunset and many of the flash at sunrise. Most of the flashes at sunset have been seen from our former residence on a hill near the old campus of the University, from our present residence and the new campus itself in Westwood Hills, from the streets of Los Angeles, and from the beaches near Los Angeles, as the sun has set over the Santa Monica Mountains, Santa Catalina Island, the ocean, or clouds lying low above the ocean or mountains. All but one of the flashes at sunrise have been seen from Westwood Hills as the sun has risen over the Baldwin Hills and other elevations east and southeast; while one of the most beautiful was seen from a peak on the eastern rim of Death Valley.

The observations of these beautiful but variable phenomena have been very numerous. Usually no record has been kept; but in the 32-day interval Aug. 20–Sept. 20, 1928, I witnessed the flash at sunset 13 times; and I am confident that I have since seen a greater number of sunset and sunrise flashes in an interval no greater. In the 32 days referred to, fogs and clouds interfered on 9 days; the background of sky was too bright on 3 days; observations could not be made on 5 days, although it is practically certain that the flash would have been seen on some of these days if it could have been looked for; and on 2 days the flash was not seen when conditions were judged favourable for its appearance. It is probable that the flash was seen also on one of the days mentioned above as having too bright a sky. On this occasion three observers in Tujunga watched the sun set over the Verdugo Hills, which were too close and too high for satisfactory observation, and two out of the three reported that they saw the flash. On account of the numerous fogs and cloudy horizons at the beaches here, it is usually easier to get the flash over the mountains or hills than over the ocean, since the elevations are likely to be high enough to be out of the fog and low enough and remote enough to give sufficient dispersion.

I have repeatedly witnessed the transition between the blue and the green of the flash, and also the yellowish green of the upper portion of the sun which often precedes the flash at sunset and follows it at sunrise.

Contrary to what appears to be the usual impression, the green flash is at least as easy to observe when the sun is considerably reddened as when it is bright. I have sometimes been surprised that the sun could be so red and yet have sufficient green left to show the flash. The blue, of course, does not appear in such circumstances.

Many of the observations referred to, including one of the most brilliant, have been over low-lying clouds. On one occasion I saw the sun flash green first over the top of a cloud, and then, a little later, through a hole in the cloud.

On a number of occasions I have seen double flashes as the sun has set, first over a low-lying cloud and shortly afterward over the ocean beneath; and on one occasion I witnessed what I believe to have been a triple flash, as follows: The sun first set over a low cloud and flashed green; then it set over the sea beneath and flashed green; and finally the light reflected from the lower surface of the cloud to the sea turned green before it disappeared.

S. J. BARNETT.
University of California at Los Angeles and
California Institute of Technology, Feb. 3.

Taxonomic Importance of the Terminal Segments of Psychodid Larvæ.

ALTHOUGH in the last quarter of a century a considerable amount of advance has been made in various parts of the world towards the classification and morphology of the imago of the family Psychodidæ, our systematic knowledge of the immature stages of the group is surprisingly scanty. This is perhaps due in the first place to the secluded nature of the breeding places of the members of this family, and secondly to the fact that, unless and until the complete life-history of each species is studied thoroughly in the laboratory,

one is not in a position to place an egg, a larva, or a pupa to a particular species. While engaged in the breeding of sandflies at the Kala-azar Research Laboratory of the Calcutta School of Tropical Medicine and Hygiene, I had an excellent opportunity of studying the immature stages and more especially the larvæ of the species occurring locally.

During a course of systematic study of the larvæ bred from strains of known species, I found that the specific differences are prominently confined to the two terminal segments in the case of the genus *Phlebotomus* and only to the last segment in the case of the genus *Psychoda*. Owing to the semi-aquatic nature of environment adapted by *Psychoda* larvæ, the terminal segment becomes modified into a tubular structure with the spiracular openings arranged at its tip; specific variation was also observed in the case of the sclerites surrounding the anal pore. The *Phlebotomus* larvæ, on the other hand, are remarkably terrestrial (with a series of pseudo-legs), and with the modification of the sclerites of the dorso-ventrally flattened terminal segment admirably adapted as an adjunct organ of locomotion in the larvæ as well as a fixing structure for the pupæ, the posterior pair of spiracles becomes shifted to the penultimate segment in the larvæ. The structural modifications of the terminal segments of two genera and five species occurring locally have been studied by me and my classification is based on the variable nature of these structures. The following genera and species have been studied: Genus *Psychoda*; *Psychoda bengalensis* Brun., *Psychoda plumosa* sp. nov.; Genus *Phlebotomus*; *Phlebotomus argentipes* Ann. and Brun., *Phlebotomus papatasii* Scop., and *Phlebotomus* (*babu*) *minutus* Rond.

A detailed work on this line is in progress and will be published elsewhere.

S. MUKERJI
(Entomologist
under the Indian
Research Fund Association).
Kala-azar Research Laboratory,
Calcutta School of Tropical
Medicine and Hygiene,
Calcutta, Feb. 13.

Integration of Sunlight in the Tropics.

A PHOTO-ELECTROLYTIC method of integrating sunlight has been described by Atkins and Poole (*Proc. Roy. Dub. Soc.*, vol. 19, p. 159). The electric current in a photo-electric cell is proportional to the light falling on it, and the latter can be integrated over any period of time, by measuring electrolytically the total quantity of electricity that passes through a sensitive voltameter in series with the cell. In Dublin, where this method of sunlight integration has been carried out, the average illumination for a bright sunny day in November was estimated as 10,000 metre candles for ten hours.

Using a modified form of the apparatus, which will be described elsewhere, similar investigations have been carried out by us in Rangoon. The observations were made during the early part of November, and it may be of interest, for comparison purposes, to record the results which have been obtained during one week, when the illumination from day to day was decidedly variable. With the apparatus employed a deposit of $8{\cdot}81 \times 10^{-10}$ gm. of copper corresponds to an average illumination of 500 m.c. for one second, and the light was integrated each day over a period of six hours.

For bright sunny days, the copper deposited varied from 9·9 mgm. to 12·4 mgm., corresponding to an average illumination of about 250,000 to 325,000 m.c. A day of variable sunlight gave a deposit of 4·9 mgm. corresponding to an average illumination of 125,000 m.c., whilst the illumination on a particularly dull day was about 60,000 m.c.

In the British Isles an average of 50,000 m.c. is quoted as a reasonable figure for a twelve-hour bright summer's day, which appears to be about the same as that obtained by us over a shorter period, during a particularly dull day in the tropics, whilst the average illumination over a sunny day in the tropics is considerably in excess of the maximum illumination attained during a summer's day in the British Isles, which is quoted as reaching approximately 150,000 m.c. A method is being devised of increasing the sensitivity of this method of sunlight integration, so as to obviate the necessity of employing very sensitive methods of chemical analysis, which is a disadvantage when a great number of records are being made.

It is intended to make a complete study of the illumination at different times of the year, and, under various conditions, also to record diurnal variations in the illumination.

J. A. C. TEEGAN.
G. R. RENDALL.
University College,
Rangoon, Jan. 15.

The Gibbs-Ewald Reciprocal Lattice.

As I received no proof of the note appearing under the above title in NATURE of Feb. 15, p. 238, I wish here to correct certain misprints and to make some slight modifications which would otherwise have been made in the proof.

In line 7, for K read k, and in the equation in line 14, read for l, the exponential e. The distance between any two adjacent planes is of cqurse $n/(u_1^2+u_2^2+u_3^2)^{\frac{1}{2}}$. [The fractional index was omitted from the original letter.—Ed., NATURE.]

In the penultimate paragraph, I wish to delete all but the first sentence; and to substitute the following: "With the usual summation convention we write

$$e^{2\pi i u_i x^i} = 1,$$

both sets of co-ordinates being referred to an affine system of oblique axes [2] of constants a, b, c, and angles α, β, γ, appropriate for the crystal under consideration." In accordance with this modification the transformation equation of the last paragraph would then read $F(u_i x^i) = 0$.

A. L. PATTERSON.
Rockefeller Institute for Medical Research,
New York City.

A Superconducting Alloy with Resistance Temperature Hysteresis.

IN some experiments made in collaboration with J. F. Allen and J. O. Wilhelm, we found that the resistance of a ternary alloy of bismuth, lead, and tin dropped slowly with temperature in the usual manner down to 9° K., where it suddenly fell to zero. On raising the temperature, the alloy remains superconducting up to a temperature of 13·2° K., at which point the resistance reappeared and rose quickly to a steady value at 13·8° K. This would appear to be the first time that a resistance temperature hysteresis effect has been observed and measured.

J. C. MCLENNAN.
University of Toronto.

Early Man in China.

By Prof. G. ELLIOT SMITH, F.R.S.

THE reconnaisance inaugurated in 1921 by Dr. J. G. Andersson on behalf of the Geological Survey of China has brought to light evidence of exceptional interest and importance for students of archæology and human palæontology. In the province of Honan, Dr. Andersson discovered a rich industry, including painted pottery, the cultural link of which with ancient Sumer is widely admitted. It provides positive confirmation of the early diffusion of culture from Mesopotamia to the eastern limits of Asia during the third millennium B.C. In addition, he recovered a number of interesting human remains in association with the early industries in Honan and Kansu. His survey has also been responsible for the discovery of the fossil remains of the early Pleistocene genus of the human family which Prof. Davidson Black called *Sinanthropus*—roughly contemporaneous with *Pithecanthropus* and *Eoanthropus*.

(1) In *Palæontologia Sinica* (Series *D*, Vol. 6, Fasc. 1) Prof. Davidson Black has completed the statistical investigation of the Kansu and Honan skulls found with the painted pottery and has compared them with specimens from later Kansu prehistoric sites as well as with more recent crania from northern China and elsewhere. In this laborious work, he has followed the mathematical methods devised by Prof. Karl Pearson and his school. The interest and value of this elaborate monograph is not diminished by the fact that the results obtained fully confirm those announced in 1925 from simple observation, before Dr. Black had begun the statistical analysis of the material. He has now established the fact that the prehistoric population of eastern Asia in the third millennium B.C. was sufficiently akin to the modern inhabitants of northern China to justify the application to them of the term 'proto-Chinese'. He notes, further, that the earlier members of his series diverge much more widely from the modern type than do those of the later prehistoric phases of culture. In certain suggestive features the earliest types present some near resemblances to the Khams-Tibetan type described by Dr. Morant.

(2) Prof. Davidson Black is to be congratulated on the promptitude with which from time to time he has placed at the disposal of anthropologists the information relating to the various discoveries of fossil remains of *Sinanthropus*. The "Preliminary Note on Additional Sinanthropus Material" issued in the *Bulletin of the Geological Survey of China* (Vol. 8, No. 1, 1929) deals with the material found in the autumn of 1928 at Chou Kou Tien in the course of excavations carried out by Dr. Birger Bohlin, Dr. C. C. Yong, and Mr. W. C. Pei. Previous to this discovery, the new genus was known only from a few teeth, but in 1928 the excavators found, in the neighbourhood of the place where the tooth-type had been recovered in the previous year, the greater part of the right horizontal ramus of an adult lower jaw with three molar teeth *in situ*, and the sockets of the premolar, canine, and distal half of the lateral incisor preserved. In addition, more than twenty teeth, both deciduous and permanent, representing many phases of wear and differences in age, were found, together with the front part of the lower jaw of a child. The fragments of jaws, adult and infantile, were embedded in blocks of travertine, and at the time the report was published the associated cranial fragments had been only incompletely freed from the stony matrix. The piece of the child's jaw was intimately associated in the block of travertine with a parietal bone of corresponding age. Although this part of the braincase had not been extracted from the matrix, sufficient of it was visible to enable Dr. Davidson Black to say that it was definitely human in type and represented part of a roomier braincase than that of *Pithecanthropus*.

The importance of this association of part of a human skull with a fragment of jaw of corresponding age is of special interest because the jaw presents simian peculiarities of conformation such as, in the case of the Piltdown jaw, aroused in the minds of many foreign palæontologists doubt as to the possibility of association with a human skull. The present report, providing more than forty photographs and skiagrams of the new specimens, and comparative data to permit an exact comparison with known specimens, makes it possible for anthropologists throughout the world to appreciate the exact nature of the material which has been found and to estimate its vast significance.

This discovery justified Prof. Davidson Black's bold action in creating a new genus on the evidence of a tooth. The far-reaching importance of the fossils found in 1928 is enhanced by the even more startling discovery made on Dec. 2, 1929, by Mr. W. C. Pei, of a complete braincase of an adult skull of *Sinanthropus*, which is uncrushed. This new specimen is unique: it is the only complete braincase of early Pleistocene man so far known. It brings home in a much more convincing way than the recovery of mere fragments, the reconstruction of which invariably excites suspicion in the minds of most people, the tremendous significance of the discoveries in China. For this braincase is more complete than the remains of either *Pithecanthropus* or *Eoanthropus*, and, contrary to the anticipations which were made last year (when a jaw was found presenting features hitherto unknown in any other human remains except *Eoanthropus*), displays a form more nearly akin to the Javanese than to the Piltdown fossil.

The photograph recently received in England, reproduced as Fig. 1, represents the skull in the state it reached the laboratory in Peking. The base is still embedded in plaster of Paris and the occipital bone is hidden almost as far as the lambda.

In the accompanying diagram (Fig. 2), made by Miss Eleanor Dale, the contour of the part of the skull of *Sinanthropus* displayed in the photograph

is shown by the line *A*. The dotted line is merely a tentative suggestion of the form of the skull with a drawing of the fragment of an adult jaw found in 1928. The contours of the cranial vaults of *Pithecanthropus* (*B*) and the type specimen of Neanderthal man (*C*), both presenting analogous forms, have been inserted for comparison, the inch-scale providing the criterion of exact size. Its resemblance to the Neanderthal skull is discounted by the significant difference in actual size.

With the photograph Prof. Davidson Black has sent the following information.

Within the main cave deposit at Chou Kou Tien, up to the present time, *Sinanthropus* remains have been recovered from five different sites, three of which, including the latest, have been discovered by Mr. Pei during the last season's work. Contrary to the reports which have been circulated, no skeletal parts other than the skull and numerous isolated teeth have been recovered during this year's excavations. Remains of at least ten individuals belonging to the genus have been found.

It should be noted that the different sites where *Sinanthropus* has been discovered within the main Chou Kou Tien deposit are all clearly contemporaneous with one another, being Lower Quaternary (Polycene) in age. This statement is based on the investigations of Père Teilhard de Chardin and Dr. C. C. Yong on the geology and palæontology. Though hundreds of cubic metres of material have been examined, no implements or artefacts of any nature have been found, nor has any trace of the use of fire been observed.

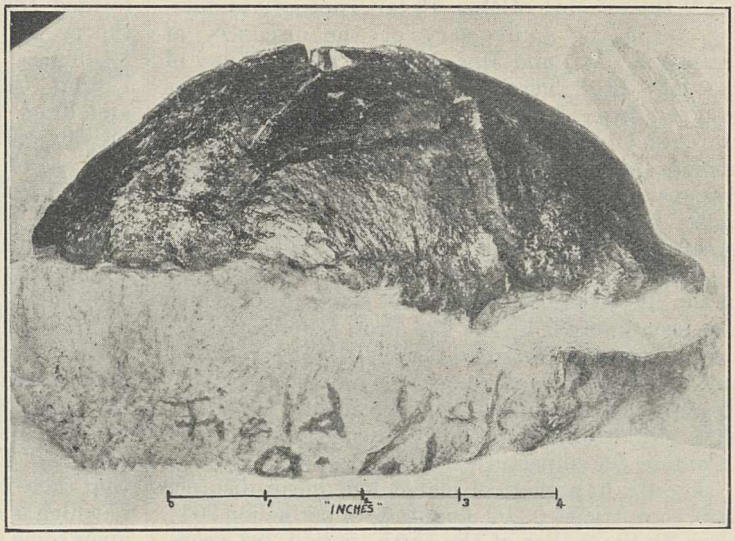

FIG. 1.—Brain-case of *Sinanthropus*.

The greater part of the left side and the fore part of the base of this unique braincase of *Sinanthropus* is still embedded in a block of very hard travertine. The vault of the skull from its massive brow ridges to the occiput, and the whole right side of the specimen was, however, encrusted with a relatively soft matrix, which was removed before the photograph was taken. It is apparent that the braincase has been almost completely preserved while most of the facial region seems to be lacking.

The skull of *Sinanthropus* is of approximately the same length as that of *Pithecanthropus* and, like the latter, is provided with massive brow ridges. However, *Sinanthropus* differs from the Java type in the following important features: Relatively well-developed frontal eminences, well-localised parietal eminences, and greater height of skull vault; all these characters pointing to a relatively greater brain capacity in *Sinanthropus*. The mastoid processes are small and rugged. The sockets in which the lower jaw articulated are well preserved on both sides, a circumstance which will be of great value when the task of reconstructing the lower jaw (shown in Fig. 2), recovered in 1928, is undertaken.

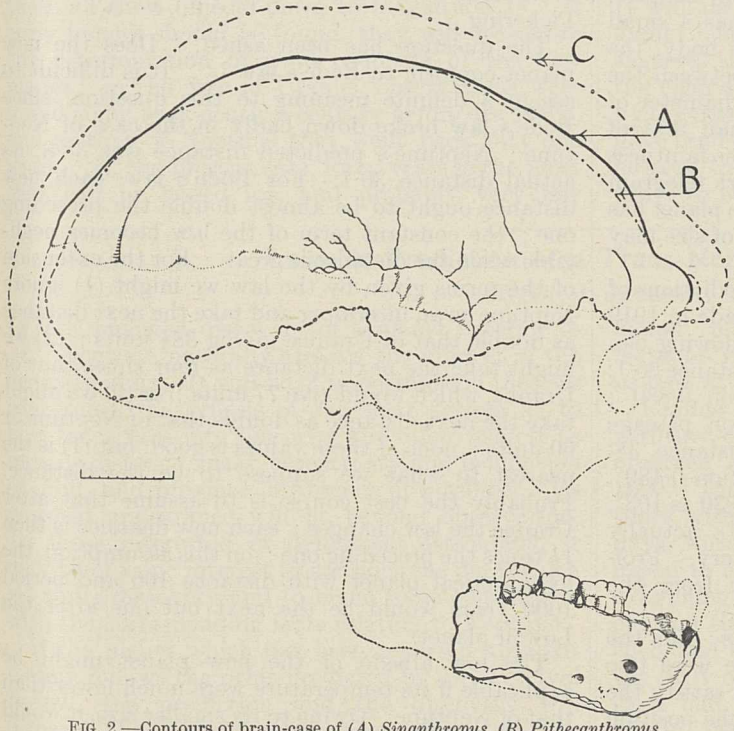

FIG. 2.—Contours of brain-case of (*A*) *Sinanthropus*, (*B*) *Pithecanthropus*, (*C*) Neanderthal man.

Discovery of a Trans-Neptunian Planet.

By Dr. A. C. D. CROMMELIN.

ON the evening of Mar. 13 (an appropriate date, being the anniversary of the discovery of Uranus in 1781, and Mar. 14 being the birthday of the late Prof. Percival Lowell) a message was received from Prof. Harlow Shapley, director of Harvard Observatory, announcing that the astronomers at the Lowell Observatory, Flagstaff, Arizona, had been observing for seven weeks an object of the fifteenth magnitude the motion of which conformed with that of a planet outside Neptune, and agreed fairly closely with that of one of the hypothetical planets the elements of which had been inferred by the late Prof. Percival Lowell from a study of the small residuals between theory and observation in the positions of Uranus. That planet was better suited than Neptune for the study, since the latter had not been observed long enough to obtain the unperturbed elements.

Lowell's hypothetical planet had mean distance 43·0, eccentricity 0·202, longitude of perihelion 204°, mass 6½ times that of the earth, period 282 years, longitude 84° at the date 1914–15. Its position at the present time would be in the middle of Gemini, agreeing well with the observed place, which on Mar. 12 at 3h. U.T. was 7 seconds of time west of δ Geminorum ; the position of the star was R.A. 7h. 15m. 57·33s., north decl. 22° 6′ 52·2″, longitude 107·5°. This star is only 11′ south of the ecliptic, making it likely that the new planet has a small inclination. As regards the size of the body, the message states that it is intermediate between the earth and Uranus, implying perhaps a diameter of some 16,000 miles. A lower albedo than that of Neptune seems probable, to account for the faintness of the body. It appears from a New York telegram that at least one visual observation of the planet has been obtained, from which the estimate of size may have been deduced.

Mention should also be made of the predictions of Prof. W. H. Pickering ; one of these, made in 1919 (*Harvard Annals*, vol. 61), gives the following elements ; Epoch 1920 ; longitude 97·8° ; distance 55·1, period 409 years ; mean annual motion 0·880° ; longitude of perihelion 280° ; perihelion passage 1720, eccentricity 0·31 ; perihelion distance 38, mass twice earth's, present annual motion 0·489°. This prediction gives the longitude for 1930 as 103°, which is within five degrees of the truth ; actually it was in longitude 108° at discovery. Prof. Pickering's later prediction is further from the truth, making the longitude about 131°.

Gaillot and Lau also made predictions ; like the other computers they noted that there were two positions, about 180° apart, that would satisfy the residuals almost equally well. Taking the position nearest to the discovered body, Lau gave longitude 153°, distance 75, epoch 1900. Gaillot gave longitude 108°, distance 66, epoch 1900. The latter is not very far from the truth ; with a circular orbit, the longitude in 1930 resulting from Gaillot's orbit would be 128°, some 20° too great. Gaillot performed the useful work of revising Le Verrier's theory of Uranus, thus giving more trustworthy residuals. Lowell pointed out that the residuals of Uranus that led to the discovery of Neptune amounted to 133″, while those available in the present research did not exceed 4·5″ ; yet even in the case of Neptune the elements of the true orbit differed widely from the predicted ones, though the direction of the disturbing body was given fairly well. He noted that in the present case it would be wholly unwarrantable to expect the precision of a rifle bullet ; if that of a shot-gun is obtained, the computor has done his work well.

Another method of obtaining provisional distances of unknown planets is derived from periodic comets ; the mean period of the comets of Neptune's family is 71 years ; it is pointed out in the article on comets (" Encyc. Brit." 14th edition, vol. 6, p. 102) that there is a group of five comets the mean period of which is 137 years ; as stated there, " This family gives some ground for suspecting the existence of an extra-Neptunian planet with period about 335 years, and distance 48·2 units ". This seems to be in fair accord with the new discovery, but probably the distance is nearer 45 than 48. Comets also suggest another still more remote planet, with period about 1000 years, a suggestion which has also been made by Prof. G. Forbes and by Prof. W. H. Pickering.

The question has been asked, " Does the new planet conform to Bode's law ? " It is difficult to assign a definite meaning to this question, since Bode's law broke down badly in the case of Neptune ; Neptune's predicted distance was 38·8, its actual distance 30·1. For Bode's law, each new distance ought to be almost double the preceding one ; the constant term of the law becomes negligible when the distance is great. For the extension of the terms given by the law we might (1) ignore Neptune as an interloper and take the next distance as double that of Uranus, giving 38½ units ; (2) we might take the next distance as four times that of Uranus, which would give 77 units ; or (3) we might take the next distance as double that of Neptune or 60 units ; none of these values is good, but (1) is the nearest to what we suppose to be the distance. Probably the best course is to assume that after Uranus the law changes ; each new distance is then 1½ times the preceding one ; on this assumption, the hypothetical planet with distance 100 and period 1000 years would be the next but one after the Lowell planet.

The low albedo of the new planet might be explicable if its temperature were much lower than that of Neptune. Owing to its smaller size, it would have lost more of its primitive heat, and would only receive half as much from the sun ; hence its gases might be reduced to a liquid form, with great reduction of their volume. This would result in a relatively smaller disc than the one that might be inferred from its mass.

Some further particulars of the discovery are given by the New York correspondent of the *Times* in the issue for Mar. 15. Quoting an announcement which had been received there from the Lowell Observatory, it is stated that the planet was discovered on Jan. 21 on a plate taken with the Lawrence Lowell telescope; it has since been carefully followed, having been observed photographically by Mr. C. O. Lampland with the large Lowell reflector, and visually with the 24-inch refractor by various members of the staff. The observers estimate the distance of the planet from the sun as 45 units, which would give a period of 302 years, and mean annual motion of 1·2 degrees.

At discovery, the planet was about a week past opposition, and retrograding at the rate of about 1′ per day; this has now declined to ½′ per day, and the planet will be stationary in April. It should be possible to follow it until the middle of May, when the sun will interfere with observation until the autumn.

The details of the Lowell Observatory positions have not yet come to hand; when they do, it will be possible to derive sufficiently good elements to deduce ephemerides for preceding years. There are many plates that may contain images of the planet; those taken by the late Mr. Franklin Adams in his chart of the heavens, those taken of the region round Jupiter some twelve years ago for the positions of the outer satellites, and those taken at Königstuhl and elsewhere in the search for minor planets; these all show objects down to magnitude 15. If early images should be found, they will accelerate the determination of good elements of the new planet; in the case of Uranus, observations were found going back nearly a century before discovery, and in that of Neptune they went back fifty-one years. In the present case, forty years is the most that can be hoped for, and probably very few photographs showing objects of magnitude 15 are available before the beginning of this century.

One of the most difficult problems will be to find the mass of the new body; in Neptune's case, Lassell discovered the satellite a few months after the planet was found, and the mass was thus determined. It is to be feared, however, that the new planet would not have any satellite brighter than magnitude 21. Stars of this magnitude have been photographed with the 100-inch reflector at Mount Wilson, but it is doubtful whether it could be done within a few seconds of arc of a much brighter body. Failing the detection of a satellite, the mass can only be deduced from a rediscussion of the residuals of Uranus and Neptune; new tables of these planets will ultimately be called for, but that task must wait until the orbit of the new body is known fairly exactly.

The perturbations of Halley's comet will also require revision; at each of the last two returns, there has been a discordance of two or three days between the predicted and observed dates of perihelion passage; it will be interesting to see whether the introduction of the perturbations of the new body effects an improvement. The late Mr. S. A. Saunder made the suggestion at the time of the last apparition of the comet that an unknown planet might be the cause of the discordance, but it was not then possible to carry the suggestion further. The discovery of a new planet therefore opens a large field of work for mathematical astronomers. It will also appeal to students of cosmogony; Sir James Jeans, in an article in the *Observer* for Mar. 16, suggests that it may represent the extreme tip of the cigar-shaped filament thrown off from the sun by the passage of another star close to it. It would have been the first planet to cool down and solidify; he says, "As a consequence of this, it will probably prove to be unattended by satellites."

Lowell's Prediction of a Trans-Neptunian Planet.

By Dr. J. JACKSON.

THE reported discovery of a planet exterior to Neptune naturally arouses the interest of the general public. It will be of importance in theories concerning the genesis of the solar system as to how far it falls into line with the other planets as regards distance, mass, eccentricity and inclination of orbit, and presence or absence of satellites. Its physical appearance will be beyond observation. To those interested in dynamical astronomy, it may be of some interest to consider the data which led to its discovery and to make some comparison with the corresponding facts relating to Neptune.

If the planet which has been reported approximately follows the orbit predicted by Dr. Percival Lowell, the prediction and the discovery will demand the highest admiration which we can bestow. It is true that the problem as regards its general form is a repetition of that solved by Leverrier, Adams, and Galle more than eighty years ago; but its practical difficulty is of quite a different order of magnitude. In short, this discovery, if it turns out to be actually Lowell's predicted planet, was extremely difficult—while Neptune was in fact crying out to be found. Let us look at the actual data.

Uranus was discovered in 1781 by Herschel. Scrutiny of old records showed that it had been observed about a score of times dating back to 1690. The fact that Lemonnier observed it eight times within a month, including four consecutive days, without detecting its character, should be a lesson to anyone who makes observations without examining them. In 1820 Bouvard found that the old and the new observations could not be reconciled, and in constructing his tables boldly rejected the early observations, but the tables rapidly went from bad to worse; the residuals amounted to 20″ in 1830, 90″ in 1840, and to 120″ in 1844. Adams used in his first approximation data up to 1840, Leverrier data up to 1845. Now Uranus had passed Neptune in 1822. As the relative motion is about 2° a year, it means that for most of the time covered by the prediscovery observations the perturbations were very small, while from the fact

that the difference between the heliocentric distances is much smaller than expected from Bode's law, the perturbations at the time of conjunction were relatively large. Consequently the prediction of the longitude of the disturbing body was very easy, while the determination of the other elements were correspondingly difficult. The fact was that the simple hypothesis of the existence of an exterior planet with any sort of guess as to size and shape of orbit would suffice to predict the longitude. In other words, most of the residuals could be closely satisfied provided that substantially correct values of the longitude of the planet and its attractive force $m\left(\frac{1}{\Delta^2}-\frac{1}{r^2}\right)$ were used. Both Leverrier and Adams easily found values of these quantities, and Galle had no difficulty in detecting the planet.

We now turn to Lowell's "Memoir on a Trans-Neptunian Planet", published in 1915. The observational basis is the outstanding residuals in the motion of Uranus during two centuries, that is, rather more than two revolutions of that planet round the sun, of somewhat less than two revolutions relative to the predicted planet and of about one relative to Neptune. The following are the values of the observed residuals of Leverrier's and of Gaillot's theories taken from Lowell's memoir.

	Leverrier.	Gaillot.		Leverrier.	Gaillot.
1709	..	+2·14″	1855	..	−0·50″
1753	+5·52″	+4·45	1858	+0·50″	−0·20
1769	+4·77	+2·47	1861	..	−0·36
1783	−3·30	−0·96	1864	+0·25	+0·18
1787	−5·12	−1·20	1867	..	+1·20
1792	−3·50	+0·10	1870	−0·50	+1·32
1796	−1·88	−0·69	1873	..	+0·75
1803	+0·40	−1·19	1876	−1·65	−0·50
1812	+2·00	−0·77	1879	..	+0·58
1817	+0·50	−0·60	1882	−2·88	+0·52
1820	−0·75	−2·37	1885	..	−0·17
1827	−2·10	+2·00	1888	−4·22	−0·85
1837	−1·10	−1·22	1891	..	−1·11
1840	+0·63	+0·78	1894	−5·63	−0·50
1843	..	+0·74	1897	..	+0·35
1846	+0·38	−1·40	1900	−4·32	+1·00
1849	..	−0·25	1903	−3·00	+0·65
1852	−1·17	−0·95	1907	..	+0·25
			1910	..	+1·10

The residuals show remarkable differences between the two theories, but Lowell deduced that the residuals exceeded their probable errors four or five times. The problem was to find from these residuals corrections to the elements of the orbit and to find the mass and the elements of the disturbing body. It might almost appear hopeless when we consider that the residuals must be affected by errors in the accepted masses of the known planets. There can be no doubt, however, that the masses adopted by Gaillot for Jupiter, Saturn, and Neptune are very accurate. Lowell's procedure was to adopt a value of the semimajor axis of the unknown body, and a complete series of values for its longitude, and then select the value of the longitude for which the sum of the squares of the residuals was a minimum. The process was repeated with various values of the mean distance until values of the variables were found giving minimum residuals. The process was of course very laborious, but Lowell carried it through with great perseverance. The following extract from his final summary may be quoted: "By the most rigorous method, that of least squares throughout, taking the perturbative action through the first powers of the eccentricities, the outstanding squares of the residuals from 1750 to 1903 have been reduced 71 per cent by the admission of an outside disturbing body."

The inclusion of further terms, of additional years and of the squares of the eccentricity, do not alter the results by any substantial amount. Lowell considered that the remaining irregularities could be explained by errors of observation. No trustworthy results could be found from the residuals in latitude so that the inclination of the orbit to the ecliptic could not be deduced, but Lowell considered that it might be of the order of 10°.

As the solution really depends on the difference of the attraction of the unknown planet on Uranus and on the sun, there are two possible solutions in which the longitudes differ by about 180°. The following elements are for the solution satisfying most nearly the position of the newly found body.

Heliocentric longitude on 1914, July	84·0°
Semimajor axis	43·0
Mass in terms of the sun's mass	1/50,000
Eccentricity	0·202
Longitude of perihelion	203·8°

This gives the longitude at the present time as about 104° compared with 107° of the new planet. The predicted magnitude was 12 to 13 or about ten times brighter than the observed; and a disc of more than 1″ was predicted. This is a rather serious discordance.

The smallness of the residuals indicated that the forces were small. The mass given above is only 0·4 of the mass of Neptune. At mean conjunction, the attraction of the predicted planet on Uranus would be only one-fifteenth of the attraction of Neptune in a similar position, and in addition it would last for a shorter time on account of the more rapid relative motion.

The discovery of a minor planet of the fifteenth magnitude is an everyday occurrence. The planet reveals itself by a decided motion relative to the stars in the course of taking a photograph. For a planet in the predicted orbit, the motion shown (mostly due to the earth's motion) would in the most favourable circumstances not be more than 2″ or 3″ an hour, and it would probably need a trail of at least 5″ for the planet to be detected. On the other hand, photographs taken on successive days would show decided motion, but the labour of finding the planet in a region containing many thousands of stars from separate photographs would be very great. Probably the Lowell observers have come across several minor planets before they were rewarded by the discovery of the very distant planet.

Astronomers all the world over will naturally look forward with great interest to see how nearly the newly discovered body moves in the orbit predicted by Lowell, and are anxiously waiting for further details of the observations.

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Atomic Physics and Related Subjects.

COMMUNICATIONS TO *NATURE*.

The Problem of Stellar Luminosity.

SIR JOSEPH LARMOR, who raised certain interesting points concerning the validity of my recent work on stellar luminosity in NATURE of Feb. 22, has kindly allowed me to see some further exposition on these points which he proposes to publish in the *Observatory*. With his further analysis of the situation I am in complete agreement. As regards the question which he thinks still outstanding, the work of Sir James Jeans and of J. Woltjer, together with my own investigations, shows that $1-\beta$, the ratio of radiation pressure to total pressure varies very slowly in the photospheric layers of a star on plausible assumptions as to the absorption coefficient. It therefore satisfies his requirement of being independent of the precise surface at which it is evaluated. But it is necessary to explain the discrepancy with other existing theories.

All formulæ so far given for the luminosity of a star are cooling formulæ. They take different forms according to the data. Thus given the radius r_1 and the actual temperature T_1 of the photosphere, the cooling L is at the rate $4\pi r_1^2\sigma T_1^4$. Given the mass M, the relative density-distribution, the surface opacity and T_1, we have the formula given in my paper (p. 38) which is due in principle to H. Vogt. Given the mass, the relative source-distribution, and the internal opacity, we have a formula due to Prof. Eddington, which he has transformed into forms involving T_c (the central temperature) and T_e (the effective temperature). The problem is, however, something much more deep-seated than a mere cooling problem. The complete solution of the problem would predict the luminosity of a given mass M when in a steady state, given simply the physical properties of the matter composing it, without any other astronomical data. This problem is so far completely unsolved. Though Prof. Eddington has pictured the astronomer on the cloud-bound planet as being capable of predicting the luminosities of the unseen stars, he would in fact be completely incapable of predicting them at all, for he would not have the slightest idea as to what to expect for their effective temperatures, and the effective temperature is an additional astronomical datum which requires to be given before Eddington's formulæ become applicable. The cloud-bound astronomer would be quite incapable of foretelling the observed mass-luminosity relation—the confining of the stars to a narrow band in the plot of luminosity against mass.

When we attempt to probe more deeply into the problem of stellar luminosity and effective temperature, using Eddington's theory as a basis, we encounter difficulties so serious that in my opinion they can only be removed by abandoning one feature of Eddington's method of approach. That theory makes luminosity 'depend' on interior opacity. But how can the opacity (a property depending on outer electronic configuration) affect the unknown subatomic generation of energy? According to his formulæ, if we change the opacity we change the luminosity. But the only way in which opacity can have a physical effect is by altering the internal temperature, and thus it would appear that the theory involves a specific dependence of rate of generation of energy on temperature, whereas no such dependence has been explicitly woven into the theory. No formula is given which determines the (effective or central) temperature of a given mass in terms of purely physical (that is, non-astronomical) data. Eddington's equations are incomplete. They are one short. The missing equation is easily supplied. It is $L=\int \epsilon dM$, where ϵ is the rate of generation of energy per unit mass. The satisfaction of this condition is not automatically provided for in Eddington's scheme of equations.

The internal contradictions that arise may be illustrated as follows. It is stated that his special model is most accurate (on the physical theory of opacity) when the generation of energy is proportional to the temperature T at any point. Put then $\epsilon=\lambda T$. Either λ depends solely on the physical properties of matter and is then an atomic constant; or it depends on the past history of the material. Consider first the former alternative. It gives $L=\lambda\int TdM=\lambda M\bar{T}=\lambda M\times 0{\cdot}584T_c$. Combining with Eddington's formula $L=\text{const.}\times M(1-\beta)^2\beta^{-1}T_c^{\frac{1}{2}}$, we find $T_c=\text{const.}\times(1-\beta)^4\beta^{-2}$ where the first factor is a purely physical constant. This would make T_c an increasing function of mass, contradicting the 'observed' constancy of T_c along the main series. Combining this again with his formula $T_c\propto M^{-\frac{1}{3}}(1-\beta)^{-\frac{1}{2}}T_e^{\frac{8}{3}}$ where T_e is the effective temperature, we find $T_e^{\frac{8}{3}}\propto M(1-\beta)^{\frac{5}{2}}\beta^{-2}$. This makes T_e an increasing function of mass, contradicting the simultaneous existence of giants and dwarfs of widely different mass but the same effective temperature. (Any formula of the type $\epsilon=\lambda\rho^s T^t$ will be found to lead to a similar contradiction.)

We are then driven back on the second alternative, that λ depends on the past history of the material and so may be different for different stars. This is the 'exhaustion effect'. But now the exhausted material may distribute itself in any way through the non-exhausted energy-generating material. There will in general be a concentration-gradient of the latter with respect to the former through the star, and though $\epsilon=\lambda T$ may describe the nature of the concentration-gradient, this no longer implies a physical dependence of ϵ on temperature. The energy-generating material may even generate energy at a rate independent of temperature, and be simply distributed through the 'dead' material so as to mimic the distribution $\epsilon=\lambda T$. We are now compelled, since a hard-and-fast dependence of ϵ on T and ρ is ruled out, to consider the other extreme, the 'uranium' model of Jeans, with local energy-generation independent of temperature (or of course any intermediate model). But the problem cannot now be studied by Eddington's method. This method *begins* with the relative source distribution (his η). The problem now becomes: given a mixture of x grams of uranium (or other radioactive material)

and y grams of calcium (or other 'dead' material), How do the x grams of uranium distribute themselves through the y grams of calcium? The relative source-distribution, which in Eddington's analysis is a datum of the problem, now becomes an unknown which has to be determined. The luminosity, in Eddington's analysis an unknown, becomes a datum.

According to his "Internal Constitution of the Stars", Eddington would meet this difficulty in two ways. He contends first that the uranium model is unstable, secondly that the luminosity (for equilibrium) is roughly independent of the source-distribution η. The following considerations show that neither of these contentions can be accepted. In the first place, he argues that if the total rate of generation L' falls below the rate of cooling L, the star will contract indefinitely (p. 303), since according to him L increases as the star contracts. But, as pointed out by Jeans, this involves the assumption that a formula derived for a special model in equilibrium holds generally. Physically a star cannot 'contract indefinitely'. It cannot *vanish*. Physical intuition of the valid kind tells us that sooner or later the star must find a (contracted) configuration of equilibrium; each element, being supplied with energy at a rate less than its momentary rate of cooling, must cool until the two balance; the energy it gains from compression will simply enable it the sooner to arrive at this state. A cooling element cannot cool at an increasing rate as it cools.

Similar considerations show that the luminosity of a star cannot be even roughly independent of the relative distribution of energy-sources, when we consider the distribution as a datum and the luminosity as a dependent variable. Eddington has offered as proof of his contention a special solution of the point-source model. But given a point-source model, of luminosity L_1, we can always derive another of the same mass and of arbitrarily smaller luminosity L_2. If we simply reduce the strength of the internal point-source, the star can only contract on itself, and hence as above find a new configuration of equilibrium. Counting up of arbitrary constants in the fundamental differential equation for a point-source model shows that the model (for given mass and luminosity) has in fact an additional degree of freedom; after arbitrarily choosing L (less than some upper limit) and the mass M, we can arbitrarily fix the radius, that is, arbitrarily fix the effective temperature. (I owe this to discussions with Mr. T. G. Cowling.) Thus we can find point-source models of given effective temperatures and *any* luminosity.

Again, take any one model, of luminosity L and mass M, with any particular source-distribution. Arbitrarily diminish the intensity of the sources. The star can only contract. It contracts either slightly or catastrophically. In the latter case the original model is unstable, but it must sooner or later arrive at a new equilibrium configuration. In either case we arrive at a state of arbitrarily smaller luminosity and the same mass, and this altered state will possess some definite source-distribution to correspond.

In Eddington's method of approach the energy-sources may be considered as a population of taps, of given relative concentration towards the centre, but capable of being turned on to any amount that may be required. It is then shown that the concentration by itself alone determines the amount they would have to be turned on for a steady state. But we have no guarantee that in the model thus constructed the physical conditions of the material at each neighbourhood will be in fact such as to turn them on to the required amount. For example, the surviving degree of adjustment by means of temperature alone leads, as we have seen, to a contradiction with observation. In the uranium type of problem, with absolute rate of generation, we cannot *begin* with a given population-concentration; we have to find it—to find the concentration-gradient of the solution of uranium in calcium from centre to boundary necessary for a steady state.

By considering an unrestricted range of relative *density*-distributions consistent with a *given* luminosity and a given mass, I have shown in *Mon. Not. R.A.S.*, Nov. 1929, that the solution of the uranium problem by equilibrium considerations only is not unique; there are an infinite number of different relative density-distributions possible, all compatible with a given L and M, specified by a certain function ϕ. The observed effective temperatures occurring in Nature restrict the forms of the ϕ's to those possessing a certain property described by giving a definite numerical value to a dependent quantity C. The question is, What are the physical considerations restricting ϕ?

I need scarcely say that, while advancing these more elastic theories, I am deeply sensible of the services which Prof. Eddington's investigations have rendered to the study of stellar structure.

E. A. Milne.

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Mar. 5.

The Growing Importance of Frequency.

The relation between energy and mass, $e = mc^2$, where c is numerically the velocity of light, indicates that energy has mass and that mass has energy; furthermore, it suggests that the conservation of mass of the chemists is at one with the conservation of energy of the physicists. This relation appears more emphatic if we so alter the unit, either of mass or of energy, that the constant c^2 becomes superfluous, and we write in consequence $E = M$. This would be correct, for example, if our new unit of energy were 9×10^{20} ergs. We do not therefore state that energy is necessarily matter, but we do state that the same abstract number will express matter in terms of energy, or energy in terms of mass. We must always be careful not to confuse, say, sheep and oxen, because we happen to see the same number of these different animals.

It is remarkable that transfers of energy take place in quanta of value hf, where f is frequency and h is Planck's constant. We can again alter our unit of energy, or our unit of time, in such a manner that h is superfluous, and the relation $e = hf$ becomes $E = F$, and this indicates that energy and frequency can be expressed by the same abstract number, so that a *conservation of energy has its counterpart in a conservation of frequency*. Thus in place of the linkages of Nature, to which we are growing accustomed, such as

$$e = mc^2 = hf = Jq,$$

we can, by adopting what I venture to call super-units, write down

$$E = M = F = Q,$$

wherein energy, mass, frequency, and heat appear all expressed with the same abstract number. We are not unfamiliar with this. Energy is expressed sometimes in ergs, at other times in equivalent calories, or even in volt-electrons.

It is the purpose of this note to urge a status for frequency comparable with that of its older brethren; if, indeed, we are not recalling the music of the spheres to a fresh harmony.

Again, the Einstein-Bohr equation

$$h\nu = W_1 - W_2$$

can be written

$$h\nu = hf_1 - hf_2,$$

or more simply

$$\nu = f_1 - f_2,$$

which expresses clearly the beat or heterodyne character of the observable frequency ν derived from two unobserved or unobservable frequencies f_1, f_2 characteristic of the atom, due to the necessity of standing waves or 'repeat patterns' of the electronic waves in their passage around the nucleus.

So, too, the Einstein transformation equation

$$T = (t - vx/c^2)/\sqrt{1 - v^2/c^2}$$

may refer to a particle moving with velocity v relatively to an observer. Now this equation, as de Broglie pointed out, involves another velocity u, which may be denoted by c^2/v and is greater than the velocity of light.

It may be thought of as a phase velocity, of which v may be shown to be the group velocity. In the case of a mass m, moving with velocity v, if we state

$$h\nu = mc^2$$
$$c^2 = uv$$
$$u = \lambda\nu$$

and multiply the left sides together, and the right sides, and equate, we have after cancelling

$$\lambda = h/mv.$$

This is the precise relation which Davisson and Germer, and G. P. Thomson, have shown to hold for an electron. Thus the frequencies of waves seem to be achieving a remarkably fundamental rôle, comparable with that of energy. Waves of what? The key to the central tower of physics has yet to be found. No less obscure is the connexion between the two different types of electric charge and their attendant waves. The linkage between energy and time, which resembles that between p and q in Dirac's equations, also suggests a close relationship between energy and frequency.

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A Cosmological Conjecture.

According to quantum mechanics, a harmonic oscillator of frequency ν has a lowest energy state the energy of which is $\frac{1}{2}h\nu$. When the electromagnetic field is treated, after Rayleigh and Jeans, and Debye, as an assemblage of independent harmonic oscillators, one of which is associated with each of the normal modes of vibration of the ether, this leads to the result that there is present in all space an infinite positive energy density. It is infinite because there is supposed to be no upper limit to the frequencies of possible normal modes.

According to Dirac's theory of the proton (*Proc. Roy. Soc.*, A, January 1930) there is an infinite negative energy density associated with an infinite number per unit volume of relativistic electrons in negative energy states. Moreover, since the electrons are handled as a wave phenomenon, for great negative energies the number of states in unit energy range presumably is the same function of the energy as the number of normal modes for the ether is of the frequency.

It is, therefore, a natural conjecture to suppose that these two infinite energy densities just cancel each other. If they do, it indicates a certain artificiality in our present theories and points to the possibility that radiation and the electromagnetic field may be assimilated into a unified theory which regards them, like the protons, as another aspect of the negative energy electrons. In such a theory, these two infinite energy densities would be balanced off at the outset and so would never appear.

We refrain from calling our conjecture a theory in deference to the views of Prof. H. E. Armstrong recently expressed in these columns.

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Minneapolis, Feb. 14.

Unimolecular Films.

The changes of state occurring in unimolecular films were the subject of a recent investigation (Lyons and Rideal, *Proc. Roy. Soc.*, **124**, A, 322; 1929). It was concluded, following Müller (*Proc. Roy. Soc.*, **114**, A, 542; 1927), that the molecules in the film were generally tilted. The suggestion was made that in the solid films of long chain substances the tilt of the molecules and therefore their areas were determined by the interlocking of zigzag chains. Since these views have recently been criticised (Adam, *Proc. Roy. Soc.*, **126**, A, 526; 1930), owing partly to a misunderstanding, a recapitulation of them and the evidence in their favour seems desirable.

The hypothesis of interlocking chains applies to *solid* films. These may be considered as consisting of unimolecular 'crystalline' sheets. The hypothesis requires that long chain substances with small asymmetric polar head groups should give such films (where the chains have lost their flexibility) with one of two limiting areas; namely, 20·6 sq. A. and 26·2 sq. A. per molecule. Clearly, substances with bulky substituents in the chain and those containing the large disc-like aromatic nucleus cannot be used to test this suggestion.

The smaller area is given by a very large number of compounds, but the larger area, as is to be anticipated, is only obtained in a few instances, and its validity has been questioned on both the experimental and theoretical sides.

The results of Adam and ourselves on the amines and their hydrochlorides show that the films of these materials are more complex than was suspected previously. A more detailed investigation is now being made, the results of which will be published on completion of the work. However, it may be stated that the solid films of heptadecylamine have been obtained both with areas of 20·6 sq. A. per molecule and 26·2 sq. A. depending on the conditions. The amine hydrochlorides (with which most of Adam's work was carried out) have yielded as yet only areas of 20·5 sq. A. per molecule in agreement with his values. The variations in area seem to be due to a fundamental property of the system and may possibly be due to a dimorphism as for the ureas (v. inf.). The X-ray data on amine hydrochlorides (Bragg, Solvay Congress Rep., 1925, 36) show corresponding anomalies which were also attributed to polymorphism.

The criticism on the theoretical side was chiefly concerned with the properties of the ureas.

The long chain ureas give an area of 26·2 sq. A. per molecule below a certain temperature, above which they give 20·5 sq. A. It was suggested that the sharpness of the transition, which occurs over a very narrow temperature range, is inconsistent with the hypothesis of interlocking chains. We consider that this sharpness is to be expected, for probably the change is due to a true transition between two distinct crystalline states. This is an example of

dimorphism in two dimensions which is comparable with that of rhombic and monoclinic sulphur in three dimensions.

The increase of chain length affects the transition temperature in a similar manner to its effect on many other physical properties.

The existence of solid films with areas of 26·2 sq. A. per molecule does, therefore, support the hypothesis of interlocking chains.

A further criticism has been brought that some films which have areas corresponding with the interlocking position may not be solid. There is, however, no sensitive process for distinguishing between a viscous liquid and a weak solid film. The ordinary method of blowing dust particles on the surface may give very doubtful results in border-line cases; since the pressures generated by blowing, although apparently small, may have a profound influence on a thin unimolecular film. The monoglyceride films of area 26·2 sq. A. per molecule for which "dust on the surface obviously does not move very easily" (Adam, *Proc. Roy. Soc.*, **117**, A, 532; 1928) are examples of such border-line cases. Here a more delicate technique is needed to establish their physical state without ambiguity.

Nevertheless, it is clear that films with an area per molecule slightly larger than that calculated for interlocking may be liquid. These films are very likely to be obtained when the angle of free tilt is close to the interlocking angle. The liquid alcohols fulfil these requirements, and the available evidence suggests that the area per molecule is slightly greater than that found for fatty acids (Adam and Dyer, *Proc. Roy. Soc.*, **106**, A, 694; 1924).

Further misconception has arisen from the bearing of this hypothesis on the results of X-ray analyses of crystals of long chain compounds. Interlocking should give rise to one of a series of calculable tilts. The principle seems to apply there, at least to a first approximation. It must, however, be remembered that the crystal is of a much more complicated structure, and disturbing influences are much more likely there than in a thin film (cf. Müller, *Proc. Roy. Soc.*, **124**, A, 317; 1929, on the mutual influence of the polar groups of the molecules forming the bimolecular layers of the crystal).

In conclusion, it may be stated that all the aliphatic compounds yet examined by X-ray methods consist of plane zigzag chains. The areas of films calculated for the interlocking positions do not depend on one analysis alone, but are based on the collected results for these different substances, and in particular on the accurate and detailed analysis of stearic acid and the hydrocarbons (Müller, *Proc. Roy. Soc.*, **114**, A, 542; 1927; **120**, A, 437; 1928) which are in such excellent agreement.

C. G. Lyons.
Eric K. Rideal.

The Laboratory of Physical Chemistry,
Cambridge, Mar. 7.

Structure of Naphthalene and Anthracene.

In a paper published in the *Proceedings of the Royal Society* (vol. A, 125, p. 542; 1929) on the structure of naphthalene and anthracene, J. M. Robertson comes to the conclusion that "the scattering centres lie nearer the *ac* planes than the *bc* planes, but no simple structure with a plane of symmetry parallel to the *ac* plane is possible", and that the scattering centres lie along a chain structure similar to hydrocarbons. On the other hand, the structure of hexamethylbenzene as determined by K. Lonsdale (*Proc. Roy. Soc.*, vol. 123, p. 537; 1929) suggests that the benzene rings in aromatic compounds should in all probability be plane structure. This has further support from the plane hexagonal structure of graphite (Ott, *Ann. d. Phys.*, vol. 85, p. 81; 1928). As regards whether the scattering centres are nearer the *ac* plane or the *bc* plane, the optical and magnetic anisotropies which have been measured by S. Bhagavantam (*Proc. Roy. Soc.*, vol. A, 124, p. 545; 1929) require that the carbon atoms should lie nearer the *bc* plane than the *ac* plane. The structure proposed by Robertson, however, does not explain the intensities of reflection from many of the crystal planes, which he supposes are due to small glancing angles for those particular reflections. But on evaluating the angle factors for the intensities it is seen that such large discrepancies cannot be explained in that manner.

I made an X-ray investigation into the structure of naphthalene and anthracene, the results of which will be published shortly. It has been found that the best agreement for the intensities of reflections from these crystals is obtained when all the carbon atoms in one molecule are supposed to be in one plane and the planes of the molecules are inclined to the cell faces. The correct positions of the molecules are obtained by first placing them along the *bc* planes, then rotating them through 25° about the *c* axis (the two molecules in the unit cell being rotated in opposite directions), and then rotating them about *b* axes through 12° and 9° for naphthalene and anthracene respectively. The agreement will be best seen by referring to the table appended herewith, where the results for some simple planes are given. Similar agreements were obtained for all the forty planes from which reflections were observed. It can be easily seen that agreements are much better than those obtained by Robertson.

Table I.

Indices.	Naphthalene.		Anthracene.	
	Theoretical Structure Factor.	Experimental Structure Factor.	Theoretical Structure Factor.	Experimental Structure Factor.
001	15·3	15·3	13·2	13·2
002	6·0	6·2	8·8	8·4
110	18·2	17·5	27·0	30·3
$11\bar{1}$	5·1	5·9	10·2	8·9
020	6·6	7·0	8·3	7·5
200	15·0	14·8	19·8	18·3
$20\bar{1}$	24·8	23·0	21·0	14·9
$20\bar{2}$	5·2	4·8	9·2	9·9
210	10·0	10·6	14·7	16·2
$21\bar{1}$	9·2	10·0	12·6	14·9

The intensities of 007, $20\bar{7}$, $40\bar{7}$, $60\bar{7}$ reflections from naphthalene and $00\bar{9}$, $20\bar{9}$, $40\bar{9}$, $60\bar{9}$ reflections from anthracene, on which Robertson bases his arguments for supposing that the scattering centres lie nearer the *ac* planes, agree qualitatively with experiment as the structure factors for the $40\bar{7}$ and $40\bar{9}$ planes respectively come out the highest among the series according to this arrangement of placing the carbon atoms.

Kedaveswar Banerjee.

210 Bowbazar Street,
Calcutta, Nov. 26, 1929.

I believe Dr. Banerjee's structure to be essentially correct. It has been clear to me for some time that the last two sections of my paper to which Dr. Banerjee refers must be amended as regards the distribution of the scattering centres in the *a* and *b* directions. During last summer, Sir William Bragg made 'abso-

lute' measurements of the intensities of the reflections from a number of anthracene planes. These measurements were expressed as ratios between the structure factors actually found, and the structure factor to be expected if all the atoms were in the reflecting planes. It was intended that these results and deductions therefrom should be incorporated with my paper, the publication of which was to be delayed for the purpose: unfortunately, owing to my absence from England, there was some confusion during the revision of the proofs and this was not done. Sir William Bragg's figures lead to a structure resembling Dr. Banerjee's so closely that it is interesting to give the following quotation from a letter which he wrote to me. It is in the form of notes upon a table of structure factors:

No. 1: "A flat molecule, axis along the *c* axis; plane of molecule making an angle of 25° with the *bc* plane. This gives good values in the *c* zone, but not in the *b* zone; especially the $20\bar{1}$ is far too weak. So next (No. 2) the molecule is tipped over a little more to the upright position (about 6°). This greatly improves the *b* zone. . . . In No. 3 a slight buckle is put in, to try to improve the notable 204. The consequences are not very striking. On the whole there is so much agreement that we cannot be very far wrong."

Plane.	*S* Observed.	*S* Calculated.		
		No. 1.	No. 2.	No. 3.
200	0·70	0·68	0·58	0·50
020	0·33	0·32	0·32	0·31
110	0·50	0·47	0·48	0·47
210	0·67	0·58	0·52	0·55
310	0·20	0·23	0·19	0·17
410	0·55	0·67	0·39	0·29
320	0·50	0·55	0·40	0·42
001	0·22	..	..	0·23
002	0·26	..	0·19	0·15
$20\bar{1}$	0·50	0·14	0·43	0·40
204	0·80	0·27	0·50	0·73

Whether the carbon atoms in these molecules lie in one plane as strictly as do the graphite carbon atoms, or those of hexamethylbenzene, can scarcely yet be stated with certainty. But the structure certainly appears to approximate to those types.

J. M. Robertson.

Physics Dept., Michigan University,
Ann Arbor, U.S.A., Jan. 6.

The Crystal Structure of Xenon.

Of the rare gases, argon is the only one of which the crystal structure is known (F. Simon and V. Simson, *Zeit. f. Phys.*, **25**, 160; 1924). We have now been able to determine the crystal structure of xenon by a method allowing the use of a very small quantity of gas: it was condensed as a very thin layer upon the surface of a quartz capillary internally cooled by liquid air. The thickness of the condensed layer can be estimated to be about 0·004 cm.

We obtained very good photograms by the powder method, using a Philips tube fitted with iron anticathode in less than $2\frac{1}{2}$ hours exposure. From the photograms, consisting of sixteen lines, three of which correspond to the $K\beta$ radiation of iron, we have been able to establish that xenon, like argon, shows a face-centred cubic structure.

The lattice constant of the elementary cell, consisting of four atoms, is $a = 6{\cdot}18 \pm 0{\cdot}01$ A.: the volume is $236{\cdot}03 \times 10^{-24}$ c.c. and the calculated density, taking as the weight of the hydrogen atom $1{\cdot}65 \times 10^{-24}$ gm., is $d = 3{\cdot}64$ gm./c.c. (The density of liquid xenon at the boiling-point is 3·06 (Ramsay and Travers).) From the previous data the atomic radius of xenon can be calculated as 2·18 A. The atomic radius calculated from gaseous viscosity measurements (A. G. Nasini and C. Rossi, *Gazzetta*, **58**, 433; 1928) is 1·70 A., thus being smaller than the crystal structure datum: we may point out, however, that the two figures bear the same ratio as for argon. The radius calculated from the present measurements is very similar to those, calculated by Goldschmidt, of the positive ions monovalent iodine, divalent tellurium, and tetravalent tin, having the same number of external electrons (Geoch. Verteilungsgesetz d. Elem., *Norske Vidensk. Akad.*, Oslo, **7**, 54; 1926).

We are now examining the crystal structure of krypton, but a modification of the present apparatus will be necessary, since the vapour pressure of krypton, at the temperature reached as above, is somewhat too high. A more detailed account of the present research and of the work on krypton will appear elsewhere.

G. Natta.
A. G. Nasini.

Royal Polytechnic, Milan.

Behaviour of Electrons in a Gas Tube.

The late Mr. Campbell Swinton observed (*Proc. Roy. Soc.*, **61**, 79; 1897) that a carbon anticathode in a gas X-ray tube under certain conditions showed a ring of fluorescence which he considered due to the hollow nature of the cathode stream. The following preliminary account of some experiments with a gas X-ray tube of the Shearer type shows that the effect can be more complex than is usually suspected.

The anticathode end of a Shearer tube was replaced by a brass tube of approximately the same length and

Fig. 1.

diameter. The tube was waxed in the usual way to the glass cylinder of the X-ray tube and was sealed at the other end by a glass plate so that the luminescence due to the electron stream from the cathode could be viewed end on.

It is found that the glass fluoresces in a very striking manner. At a pressure just greater than that at which the tube would normally be worked when producing X-rays, two bright concentric rings appear. The outer one is rather diffuse, the inner is remarkably sharp. As the pressure is decreased the inner ring subdivides into others equally well defined, and later, a bright point of fluorescence appears at the centre of the rings accompanied by intense local heating of the glass and the production of X-rays. The tension applied to the tube was of the order of 10,000 volts, and the effect observed was the same whether the

current was alternating or rectified. An increase in voltage seems merely to intensify the rings and to result in their further subdivision. That the rings are caused by electrons is shown by the fact that they can be moved by a magnet. That they do not occur at different moments of a single discharge cycle can be shown by viewing them in a rotating mirror.

The accompanying photograph (Fig. 1) was taken at an angle of about 45° to the glass plate so as to avoid the general illumination inside the tube and clearly illustrates the multiple ring formation.

W. A. Wood.
J. Thewlis.

National Physical Laboratory,
Teddington, Middlesex.

The Diffraction of X-Rays by Vitreous Solids and its Bearing on their Constitution.

The diffraction of X-rays by glasses has been the subject of many investigations during the last fifteen years, notably by Scherrer, Wyckoff, and Seljakow. Scherrer obtained broad diffraction bands similar to those obtained with liquids, whilst Wyckoff obtained, in general, more complicated patterns consisting of lines, bands, or lines superimposed on bands. The latest contributors to this subject are Parmelee, Clark, and Badger (*Jour. Soc. Glass Technology*, **13**, 285; 1929), and Clark and Amberg (*ibid.*, p. 290), who have also obtained broad diffraction bands for silica and felspar glasses. Quite apart from the validity of any of these measurements, no previous workers appear definitely to have identified the diffraction bands with small crystallites in the glass.

With the view of obtaining more precise data on the constitution of glasses we have recently examined the diffraction effects produced by passing copper $K\alpha$ radiation through silica, wollastonite, sodium borate, potassium borate, boric oxide, selenium, potash and soda felspars, glucose and sucrose, in the glassy state. Results have also been obtained with the more usual soda–lime–silica and boro-silicate glasses.

We have been able to show that silica glass corresponds to either cristobalite or tridymite crystallites, of average size $1{\cdot}5\text{-}2{\cdot}0 \times 10^{-7}$ cm., with the evidence very much in favour of cristobalite. Also we have shown that wollastonite ($CaSiO_3$) glass corresponds to the crystalline pseudo-wollastonite and that sodium borate $Na_2B_4O_7$ corresponds to crystals of this substance.

In the case of potash felspar ($K_2O \cdot Al_2O_3 \cdot 6SiO_2$), it has been found that the crystallites of the glass are mainly silica (probably cristobalite). The identity of the remainder is as yet uncertain. Boro-silicate glass containing 70 per cent SiO_2, 17 per cent B_2O_3, and other substances in minor proportions gives a very similar band. It has been found, in further confirmation of the observations, that potash felspar glass devitrifies to cristobalite and that wollastonite glass, which, it is to be expected, is much more stable, devitrifies to crystalline wollastonite at 900° C.

We are not in agreement with the observations of Parmelee, Clark, and co-workers on the positions and number of bands obtained with fused silica and with felspar glass. We obtained for fused silica one band with a spacing of 4·33 A., whereas they obtained two bands, one at 7·1 A., and a faint one at 2·5 A. Our work was carried out with copper $K\alpha$ radiation, whereas they worked with the radiation from a molybdenum target. We have repeated our measurements with molybdenum $K\alpha$ radiation, and again obtain the strong band at 4·33 A., together with a faint and much more diffuse band at about 1·5 A. For equal distances of specimen from film the breadth of a band when using copper $K\alpha$ is roughly twice that with molybdenum $K\alpha$, so that failure to detect the faint band with copper $K\alpha$ may have been due to this cause. We have tested out this point and have failed to obtain the second band using copper $K\alpha$ radiation with the distance from specimen to film reduced by more than half. It seems probable, therefore, that the faint band obtained with molybdenum $K\alpha$ radiation is spurious and that the only one on which reliance can be placed is that at 4·33 A. We have checked this spacing with those of standard substances obtained on the same apparatus and are unable to understand the value of 7·1 A. given by Parmelee and Clark. We hope shortly to publish these results elsewhere in greater detail.

J. T. Randall.
H. P. Rooksby.
B. S. Cooper.

Research Laboratories of the
General Electric Company, Ltd.,
Wembley, Mar. 1.

Scattering of Electrons and α-Particles.

Experiments by Rutherford show anomalies in the scattering of α-particles in a certain range of velocities for light elements. Similarly, the scattering of electrons by atoms shows anomalies for small velocities, as was discovered by Ramsauer. Both effects can be treated in a similar way by wave-mechanics considerations.

Let us first consider the corresponding one-dimensional problem. A particle is reflected (scattered) from a potential valley. When the valley has the simple form of a rectangle, the effect can be treated as the well-known phenomenon of interference from thin plates in optics. For certain velocities (frequencies) no particles (light) are reflected, for other velocities the coefficient of reflection has a maximum. This is not limited to a rectangular shape but occurs for very general potential valleys.

In the three-dimensional case, particles which are treated as a plane wave are scattered by an atom or by a nucleus, which is assumed to possess spherical symmetry. This plane wave may be enveloped into a series of spherical harmonics.[1] For each component one obtains a scattering coefficient, which is an oscillating function of the velocity of the incident particles.

In the first approximation the atom can be considered as a potential valley, which can be determined by the methods of Hartree. A nucleus should also be treated in this approximation as a potential valley, as was pointed out by Gamow in his theory of radioactive disintegration.

For electrons of sufficiently small velocities, only the zero order scattering is appreciable. The minimum of the zero order scattering explains the Ramsauer effect.[2] Something similar is true when an α-particle hits a nucleus with a velocity which is high enough so that it passes over the potential wall separating the inside of the nucleus from the outer space. For certain velocities of the incident particles the scattering coefficients of low order are affected a great deal by the presence of the potential valley. The resulting modification of the Rutherford scattering law has been calculated and reproduces the general type of experimental curves. Quantitative agreement cannot be expected until the shape of the potential valley of the nucleus is known in detail.

The detailed presentation will be given in an article to appear in the *Zeitschrift für Physik*.

G. Beck.

Institut f. theoretische Physik der Universität,
Leipzig.

[1] H. Faxén and J. Holtsmark, *Zeit. f. Physik*, vol. 45, p. 307; 1927.
[2] J. Holtsmark, *Zeit. f. Physik*, vol. 48, p. 231; 1928: vol. 52, p. 485; 1929.

Scattering of α-Particles by Light Atoms.

In a letter to NATURE of Feb. 1, and in greater detail in the *Philosophical Magazine*, vol. 9, No. 56, February 1930, Prof. A. C. Banerji has discussed some wave mechanical calculations on the scattering of α-particles by light atoms. I should like to make some remarks on this problem, which I have treated in a paper to appear in the *Zeitschrift für Physik*.

The first remark refers to the choice of nuclear model. While Prof. Banerji has assumed a central field of force consisting of a repulsion proportional to the inverse cube of the distance to be added to the Coulomb field due to the nuclear charge, I have taken a model corresponding to that used by Gamow to explain the radioactive decay; that is, for distances r larger than the 'radius' r_0 of the nucleus, the potential is supposed to be Coulombian and for $r<r_0$ a constant V_0. The scattering calculated by the mathematical method due to Born shows all the characteristic deviations from the normal Rutherford scattering, which have been traced experimentally by Bieler, Rutherford, and Chadwick.

We cannot expect that this very rough model should give quantitatively right results, but if we determine r_0 and V_0 so as to give the experimentally measured scattering for small angles, we obtain a first rough approximation to the potential in the nucleus. For aluminum we get for r_0 the value $2{\cdot}23 \times 10^{-13}$ cm., and for magnesium a somewhat smaller value, in agreement with the general increase of nuclear dimensions with atomic number. In contrast with this, Prof. Banerji, who also defines a 'radius' r_0, gets a larger value for magnesium than for aluminium. Besides, there is the difference that our r_0 does not depend on the velocity of the incident α-particle.

The above-mentioned scattering formulæ contains the velocity v of the α-particle and the scattering angle θ only in the connexion $v \sin \theta/2$; therefore if v and θ are varied so that $v \sin \theta/2$ is constant, the scattering will remain the same. This gives a very simple displacement rule, which allows us to calculate the scattering for every v and θ if the scattering is known for one value of v and all values of θ, or for one value of θ and all values of v.

It can be shown that this displacement rule, which seems to be in good agreement with experiments, holds for every nuclear potential of central symmetry if we confine ourselves to the first approximation of the Born method. That this is legitimate is not quite obvious, since the first approximation is not everywhere small compared with the zero approximation. For $r=0$ the two approximations are, for example, of the same order of magnitude. Also Prof. Banerji confines himself to the first approximation of the Born method, and for his potential this approximation is even infinite in the origin.

The next problem is how to improve the very rough assumptions about the potential within the nucleus. For this purpose I have considered the following unclear model. Let r_0, r_1, r_2,...r_n be a sequence of numbers so that $r_p > r_{p+1}$ ($p = 0, 1, 2,...n$). For $r>r_0$ the potential is again supposed to be Coulombian. Inside the shell $r_p > r > r_{p+1}$ it is supposed to have the constant value $V_p (p = 0, 1,...n)$. The Born method gives again a very simple expression for the scattering by this model. This expression contains the constants r_0, r_1,...r_n and V_0, V_1,...V_n. From the experimental scattering curves it will be easy to determine the constants V_p when the r_p's are arbitrarily given; that is, we have a general method from the experimental data to determine the potential in the nucleus with any desired accuracy. The performance of this work demands, however, more accurate measurements than are yet at hand.

It should also be remarked that according to our formulæ the sensitivity of such determination of the nuclear potential will decrease for decreasing distances from the centre. Indeed, the influence of a change of the potential on the scattering result will vanish for distances very small compared with the de Broglie wave-length of the incident α-particle.

Added in Proof.—In the issue of *Die Naturwissenschaften* of Mar. 14, Mr. Th. Sexl has treated the problem of the scattering of α-particles from a point of view similar to that of Prof. Banerji. In addition, he has also considered the case of an attractive force, which varies with the inverse fourth and fifth power of the distance. The last case corresponds with the idea proposed by Debye and Hardmeier, that the anomalous scattering should be sought in the polarisation of the nucleus produced by the α-particle. As the agreement with the experimental results in none of the cases investigated by him is quite satisfactory, Mr. Sexl infers that a nuclear polarisation is insufficient to explain the results, and that some other effect must be looked for.

CHRISTIAN MØLLER.

Institut for teoretisk Fysik, Copenhagen,
Feb. 21.

Electron Affinities of the Elements.

The various attempts to find experimentally the electron affinities of the chemical elements have met so far with little success. Since such a determination would probably help in shedding light on chemical reactions and the formation of molecules, it is obviously important. Accordingly, a method is here outlined which enables one to say approximately which elements have a positive electron affinity, and also to predict the approximate position of whatever lines of the electron affinity spectrum occur.

By definition, the electron affinity of an atom is the ionisation potential of its negative ion, or the difference in energy between the normal state of the atom and the normal state of the ion. From the work of Bowen and Millikan and others on stripped atoms, many of the higher ionisation potentials are known. In the iso-electronic sequence Be^{++}, Li^{+}, He, H^{-}, the ionisation potentials of the first three are known, and so we may extrapolate to get that of the fourth. This would be our method of estimating the electron affinity of the hydrogen atom. In this case, one must make a long extrapolation (from 24·47 volts), and so the attainable accuracy is not extremely high. Assuming that the square root of the ionisation potential is linear in Z, the atomic number, which gives reasonable agreement with the experimental values, one finds the electron affinity of H to be 1·4 volts. Other methods of extrapolation may yield somewhat lower values. This is in agreement with theoretical work of Bethe (*Zeits. f. Phys.*, **57**, 815; 1929), who concluded that the electron affinity was greater than 0·75 volts.

If we examine the first row of the periodic table, then it seems almost necessarily to follow from any reasonable extrapolation that the electron affinity will show the following behaviour. For helium, it will be negative, indicating that He^{-} is not stable. For lithium, it will be greater, perhaps positive, to decrease again with beryllium, increasing to carbon, decreasing to nitrogen, and increasing to fluorine, where the value is about 3·5 volts. The second row shows a similar behaviour, the increases in both cases being linear.

The first excited states of H^{-}, 2^1S and 2^3S, lie close below the normal state of H, and the states 2^1P and 2^3P both lie above, tending to show that no discrete

electron affinity spectrum for H^- is possible, as Bethe also concluded. The data used in the extrapolation are taken from the International Critical Tables, vol. 5, and from B. Edlén and A. Ericson (NATURE, **124**, 683; 1929).

If we consider the iso-electronic sequence Ca^{++}, K^+, A, Cl^-, using data from I. S. Bowen (*Phys. Rev.*, **31**, 457, 1919) and from K. W. Meissner (*Zeits. f. Phys.*, **40**, 839; 1929), then assuming the second differences to be approximately constant, one obtains 3 volts for the electron affinity of chlorine, but the first excited state of Cl^- lies above the normal state of the chlorine atom, so one would likewise expect no discrete electron affinity spectrum here.

A systematic investigation may possibly reveal elements which possess such a spectrum. The present note merely purposes to direct attention to a method which may perhaps be used with profit in the search for whatever lines may exist. Even the rough extrapolation used here would probably be helpful in estimating the position of 'polar' states of atoms at infinite separation, which information one needs in applying the Heitler and London method, as extended by Slater, to find the electronic energies of a diatomic molecule.

JAMES H. BARTLETT, Jun.
(Parker Travelling Fellow,
Harvard University).

Cambridge, Feb. 6.

Energy Losses of Electrons in Mercury Vapour.

A STUDY has recently been made by me of the effects of collisions with mercury atoms of electrons of energies of 8 volts, 18·4 volts, 34·6 volts, and 49 volts. The collisions of the electrons and mercury atoms took place in a field-free space from which those scattered at a definite angle passed into an analysing chamber

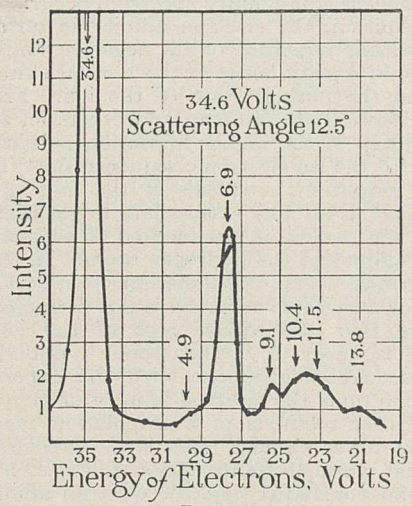

FIG. 1.

from which the mercury vapour had been removed. Here a velocity analysis was made by an electrostatic method instead of by the usual magnetic field. The paths of the electrons were bent by an electric field between two curved molybdenum plates. While the experiment was in progress, a paper appeared by G. P. Harnwell (*Phys. Rev.*, vol. 33, p. 559) in which the same method of analysis was used. Apparently, however, it failed to give results with electrons of energies less than about 40 volts and the resolution was somewhat low. Just recently, results of a similar experiment on energy losses in mercury have been published by Whitney (*Phys. Rev.*, vol. 34, p. 923), in which a magnetic analysis was used giving about the same resolving power as the method used by me.

The accompanying curves (Figs. 1 and 2) show typical curves. The main peak represents electrons which have suffered elastic collisions, the others electrons having lost various amounts of energy by inelastic collisions. Most peaks could be measured with an error of not more than 0·2 volt.

The inelastic peaks may be identified as follows:

(1) An energy loss of about 4·9 volts. This peak probably includes the 4·7 volt, 4·9 volt, and 5·4 volt energy levels, corresponding to the 1^3P_0, 1^3P_1, and

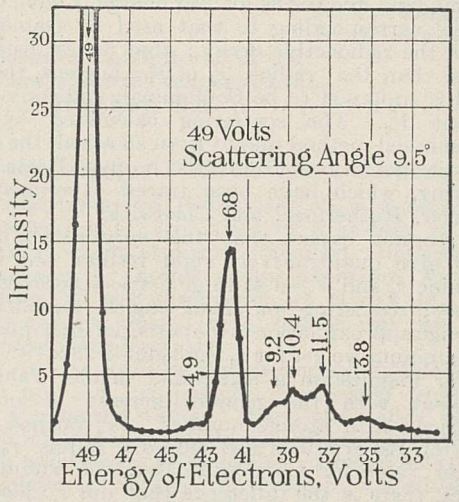

FIG. 2.

the 1^3P_2 levels. The resolving power was not sufficient to separate the 4·7 volt and 4·9 volt levels, and the 5·4 volt peak is too close to the 6·7 volt peak.

(2) An energy loss of 6·7 volts, the 1^1P_1 energy level. This peak is several times as intense as any other at all voltages studied except at 8 volts, where the 4·9 volt peak appeared a little more prominent.

(3) An energy loss of about 9·2 volts. This probably corresponds to some of the many energy levels near ionisation.

(4) An energy loss of 10·4 volts. This corresponds to ionisation of the mercury atom.

(5) An energy loss of 11·5 volts. This may be the result of two successive collisions, one losing 4·7 volts or 4·9 volts, and the other 6·7 volts. (See below.)

(6) Another peak occurs at 13·5 to 14 volts. It is not sharp enough to be located accurately. It probably represents two collisions, each resulting in the loss of 6·7 volts.

The first two peaks were also found to occur with about the same relative intensity by Whitney. He worked at sixteen different voltages between 5 and 41. He found a peak at 9·7 volts which probably corresponds to mine at 9·2. He suggests it may be due to two successive collisions of 4·9 volts loss each. He also gets a peak at 11·7 volts which without doubt corresponds to mine at 11·5. The exact position of this peak is a little uncertain in both experiments. In his experiments it seemed to be mixed up and inseparable from the ionisation peak. No doubt this is due to the fact that he worked at a pressure corresponding to a temperature of 94° C., while in my experiments the pressure was that corresponding to about 25° C.

The intensity of the 6·7 volt peak is very striking. The corresponding spectral line (λ1849) is very difficult to observe as it is so far in the ultra-violet. These experiments when carried further should prove

valuable in estimating the relative probability of excitation to the various levels which are difficult to observe spectroscopically. I think sufficient resolving power could be obtained to separate the 4·7 volts and 4·9 volt levels. The method has the great advantage that the collisions take place in a completely field-free space.

The intensity of the 11·5 volt peak is surprising. If it is the result of two successive collisions as explained above, it should be less intense than the 4·7 volt, 4·9 volt, and 5·4 volt peak. No satisfactory explanation of its intensity has been found. Foard, in an abstract (*Bull. Am. Phys. Soc.*, Dec. 13, 1929), has described some similar experiments using a magnetic analysis. He seems to have obtained slightly higher resolution. He finds a peak at 7·7 volts, the 1^3S_1 energy level. This peak does not occur either in my experiments or in those of Whitney. Otherwise the same peaks were found.

In the present experiment, the electron gun could be rotated to give an angular distribution of the scattered electrons and some results have been obtained. They are not very accurate, and agree in general with those of Arnot (*Proc. Roy. Soc.*, vol. 125, p. 660), so nothing further need be said about them.

These experiments were made possible by the kindness of Prof. A. M. Tyndall in placing the facilities of the Wills Physical Laboratory at the University of Bristol at my disposal. The work was done while I held an 1851 Exhibition Senior Studentship.

D. C. Rose.

Queen's University, Kingston,
Canada, Jan. 20.

Glancing Angle of Reflection from Calcite for Silver ($K\alpha_1$) X-Rays.

We have measured the first order glancing angle at which the $K\alpha_1$ line of silver is reflected from the cleavage planes of calcite by a method independent of any used by those who have obtained the most reliable results so far. The weighted mean value of fourteen independent observations reduced to 18° C. is 5° 17′ 13·81″ ± 0·06″.

This value was obtained from spectrograms taken on a new spectrometer specially designed to utilise the displacement method introduced by H. S. Uhler (*Phys. Rev.* [11], **11**, 1-20; 1918). A full description of the method, instrument, and results will be given later.

The value of the wave-length corresponding to the above glancing angle is 0·558238 A. ± 0·000002 A. obtained by using 3·02904 A. for the 'effective' grating space of calcite (Siegbahn, "Spectroscopy of X-Rays", 1924 edition).

The thermal coefficient of expansion at 18° C. for the grating space of calcite obtained from the most trustworthy sources, without approximations, is $0{\cdot}0000102_3$/° C. This value differs by about 2 per cent from the generally quoted value originally given by W. Stenström (Dissertation, Lund, 1919) as a sufficient approximation.

It is interesting to note that our value of the glancing angle is 1·4″ smaller than that given by G. Kellström (*Zeit. f. Phys.*, **41**, 516; 1927) for the first order of calcite, namely, 5° 17′ 15·2″. The probable error of the unweighted mean of Kellström's seven determinations for this order is ± $0{\cdot}04_5$″. The unweighted mean of his four second order determinations is also larger than ours and has relatively four times this probable error. With such a difference existing, one wonders if the grating spaces of the crystal specimens used were the same. We employed an unusually selective piece of calcite which was cleaved from an excellent specimen of Iceland spar contained in the Marsh collection of Yale University.

Our value is larger than those of K. Lang (*Ann. d. Physik*, **75**, 489; 1924), A. Leide (Dissertation, Lund, 1925), and A. P. Weber (*Zeit. f. Wiss. Photo.*, **23**, 149; 1925), although coming within 0·11″ of Lang's and 0·36″ of Leide's results when their probable errors are added to their respective mean values.

Charlton Dows Cooksey.
Donald Cooksey.

Sloane Physics Laboratory,
Yale University,
Feb. 11.

The Nuclear Moment of Lithium.

The fact that the hyperfine structures of spectral lines are so much narrower than the multiplets in the same spectrum is due principally to the fact that the latter are produced by the magnetic moment of the electrons, while the former originate from the magnetic moment of the nucleus, which is usually attributed to nuclear protons, and is, therefore, about 1840 times smaller.

The hyperfine structure of the Li^+ spectrum, discovered by Schüler (*Zeit. f. Phys.*, **42**, 487; 1927) is of the same order of magnitude, however, as the multiplet separations themselves. From this fact Heisenberg (*Zeit. f. Phys.*, **39**, 516; 1926) drew the conclusion that the magnetic moment of the lithium nucleus was of the same order of magnitude as that of an electron, and therefore caused by electrons in the nucleus and not by protons. The experiments of Taylor (*Zeit. f. Phys.*, **52**, 846; 1929) on the Stern-Gerlach effect with lithium atoms failed, however, to indicate the expected large magnetic moment for the nucleus.

In the following we will show that the nuclear magnetic moment is not very large, and that the wide hyperfine structure is caused by the presence of a single 1*s* electron in the configurations considered.

In a recent letter to Nature (**125**, 16; 1930), Fermi has given an expression for the interaction between the nuclear moment and the external electrons derived from quantum mechanics.[1] For an *s*-state in an hydrogenic atom the doublet separation (*s*-states have $j = 1/2$ and thus split into two levels) will be

$$\Delta\nu = \frac{8}{3} Ra^2 \frac{Z^3}{n^3} \cdot \frac{g(i)}{1840} \cdot (i + \tfrac{1}{2}).$$

In this expression we denote by $g(i)$ the ratio between the magnetic and mechanical moments of the nucleus, its Landé *g*-value, but in units 1840 times smaller than used for electrons, in order to obtain the magnetic moment of a spinning proton as unity. Since the mechanical moment of a spinning proton is 1/2 quantum unit, its $g(i)$ is thus 2. The mechanical moment of the nucleus is denoted by i.

Applied to doubly ionised lithium the lowest *s*-state would have a doublet separation of

$$\Delta\nu = 0{\cdot}228\ g(i) \,.\, (i + \tfrac{1}{2})\ \text{cm.}^{-1}.$$

For the 1*s* 2*s* and 1*s* 2*p* configurations of Li^+ we may assume that the hyperfine structure is mainly due to the presence of the 1*s* electron. The added electron will have some screening effect on the 1*s* electron, but as it is an outer electron this effect will be very small. Furthermore, the screening effect of the 1*s* electron upon the 2*s* or 2*p* electron will be large, and as these

[1] The same expressions were known to us before from unpublished material of H. Casimir, presented at a meeting in Copenhagen last April. For a general state in an hydrogenic atom Casimir obtains for the interaction energy:

$$\Delta E = Rhca^2Z^3/n^3(l+\tfrac{1}{2})j(j+1) \,.\, g(i)/1840 \,.\, ij \cos(i,j).$$

electrons have $n=2$ their interaction with the nucleus will be far smaller than that of the 1*s* electron, and will be neglected here.

To obtain finally the hyperfine structure for the 1*s* 2*s* ^3S and 1*s* 2*p* ^3P states of Li^+, use is made of the expressions derived by Goudsmit and Bacher (*Phys. Rev.*, **34**, 12; 1929). Assuming for simplicity $i=1/2$, which does not affect the order of magnitude of our results, we expect to a first approximation:

	Calc.	Obs.
$^3S_1$	$\Delta\nu=0{\cdot}17\ g(i)$	0·6 cm.$^{-1}$
$^3P_2$	$=0{\cdot}14\ g(i)$	0·3
$^3P_1$	$=0{\cdot}085\ g(i)$	0·3

The result is that the expected separations are not of an order of magnitude 1840 times smaller than the multiplet separation of ^3P, which is approximately 5 cm.$^{-1}$.

Recently Schüler and Brück (*Zeit. f. Phys.*, **58**, 735; 1929) have given a tentative analysis of the Li^+ hyperfine structure leading to $i=1/2$, and giving the separations mentioned as observed in the above table. With respect to the uncertainty in the screening effect and interpretation, their results indicate a $g(i)$-value of about 3 to 6. (It was hoped that this value would be approximately 2.) The application of these formulæ to hyperfine structure in other atoms, which can be done to a first approximation by replacing $(Z/n)^3$ by Zz^2/n_0^3, also seems to lead to rather large values for $g(i)$.

If the tentative interpretation of this hyperfine structure given by Schüler and Brück is correct, the hyperfine splitting is *inverted*. Another example where this is the case is the cadmium isotope with $i=1/2$ (Schüler and Brück, *Zeit. f. Phys.*, **58**, 737; 1929). This means that the magnetic moment of the nucleus is related to its mechanical moment as if it were due to *negatively* charged particles. However, it is possible, though improbable, to have a complicated configuration of positive particles for which the resultant magnetic moment is oppositely directed to the mechanical moment. Something similar occurs for the extra-nuclear electrons in certain complicated configurations which show a negative Landé *g*-value (for example, $^6F_{1/2}$, with $g=-2/3$).

S. Goudsmit.
L. A. Young.

Department of Physics,
University of Michigan,
Jan. 30.

Moment of Inertia of Hydrogen from Band Spectra.

The commonly accepted value of the moment of inertia of the hydrogen molecule, in the normal state, is due to Hori (*Zeit. f. Phys.*, **44**, 834; 1927). In deriving this value, Hori expressed the rotational energy as $E_m=B_v m^2+D_v m^4$, and calculated empirical values of D_v directly from the data. The term $D_v m^4$ is due to the swelling of the molecule with rotation, and it is now well established that the theoretical values of D_v hold accurately in the case of electronic levels for which there is no resultant electron momentum to complicate matters. This is the situation in the normal level of hydrogen ($^1\Sigma$). Hori's values of D_v are several times as small as those given by theory and, what is more important, are positive, whereas a *swelling* of the molecule with rotation requires that they be negative. Hori made note of this discrepancy in sign, but was unable to explain it. We find, however, in agreement with Schaafsma and Dieke (*Zeit. f. Phys.*, **55**, 164; 1929) that Hori's data, although relatively inaccurate and meagre, *do* indicate negative values of D_v, and we are unable to locate the origin of his published values. It should be pointed out, in addition, that Hori's data give probable errors for B_v (his A_v) and D_v (his β) ten to one hundred times as large as his published errors for these quantities.

There are now available much more extensive and accurate data for the normal state of hydrogen. Schaafsma and Dieke (*loc. cit.*) have published rotational energy data, based on H_2 plates obtained by Dieke and Hopfield (*Phys. Rev.*, **30**, 400; 1927) on the 50 cm. vacuum spectrograph at the University of California. One of us (see H. H. Hyman and R. T. Birge, Nature, **123**, 277; 1929) has recently obtained similar data from spectrograms taken with Prof. Hopfield's new 10-ft. vacuum spectrograph. Using all available data from these sources, and employing the various known theoretical relations, we have calculated values of B as a function of v, and find

$$B_v=60{\cdot}587-2{\cdot}7938(v+1/2)+1{\cdot}0500\times10^{-2}(v+1/2)^2-24{\cdot}058\times10^{-4}(v+1/2)^3.$$

In this equation, the actual vibrational energy levels are given by $v=0$, 1, 2, etc., and the available data run from $v=1$ to 12 inclusive. The equation is entirely satisfactory from $v=1$ to 9. The higher values of v lie close to dissociation and the observed values of B_v are smaller than those given by the equation.

The most important constant is of course B_0, corresponding to the lowest actual vibrational level ($v=0$). The absorption bands of the *B-A* system, observed and measured by Dieke and Hopfield (*loc. cit.*) lead directly to a value of B_0, but the probable error is quite large. On the other hand, only one emission band (observed by Witmer, *Phys. Rev.*, **28**, 1223; 1926) is available for this purpose, and the data in this case are very fragmentary. It is therefore necessary to evaluate B_0 by extrapolation, using the equation just given, with $v=0$. The extrapolation in this case is quite trustworthy *provided* the B_v curve is really smooth. The result is $B_0=59{\cdot}192$ cm.$^{-1}$. Using the new conversion factor $(27{\cdot}66\pm0{\cdot}04)\times10^{-40}$, given by Birge (*Phys. Rev.*, Supplement **1**, 1; 1929), one then obtains $I_0=0{\cdot}4673\times10^{-40}$ gm.cm.^{2}, and $r_0=0{\cdot}7500\times10^{-8}$ cm. Hori found $B_0=57{\cdot}77$, giving $I_0=0{\cdot}479\times10^{-40}$. This differs from our value by 2·2 per cent.

In this connexion we should like to emphasise that Hori's published $I=0{\cdot}467\times10^{-40}$ refers to the true state of zero vibration ($v=-1/2$) and would now be denoted I_e. Nearly everyone has quoted and used Hori's I_e value as though it were I_0. Our own value of B_e is given by the constant term in our equation (60·587), and this leads to $I_e=0{\cdot}4565\times10^{-40}$, $r_e=0{\cdot}7412\times10^{-8}$. It is interesting to note that Wang (*Phys. Rev.*, **31**, 579; 1928) obtained $I_e=0{\cdot}459\times10^{-40}$, from a theoretical wave mechanics calculation. We believe that the probable error in the values of B_1 to B_9, as given by the above equation, is 0·1 per cent, or less. So far as the uncertainty of the extrapolation is concerned, the probable error in B_0 and B_e is not more than 0·2 per cent. It is, however, shown in the following letter by Birge and Jeppensen that B_0 is definitely perturbed, so that our value is not correct. Whether B_e is correct cannot be tested, since this constant refers to a molecular state which does not exist.

This work has been carried out with the advice and assistance of Prof. R. T. Birge, to whom we wish to express our sincere thanks.

Hugh H. Hyman.
C. Rulon Jeppesen.

Union College, Schenectady, N.Y.,
and
University of California,
Berkeley, California,
Jan. 10.

Moment of Inertia of Hydrogen from Raman Effect.

F. Rasetti (*Phys. Rev.*, **34**, 367; 1929) has recently obtained accurate data on the Raman effect for gaseous hydrogen. From his data it is possible to calculate extremely precise values of B_0 and B_1. This is very fortunate, for it is now possible, from band spectra, to obtain an accurate value of B_0 only by extrapolation, as has been shown in the preceding letter by Hyman and Jeppesen. Because of the importance of this constant, it has seemed advisable to make a searching analysis of Rasetti's data, using all known theoretical relations.

We have expressed the rotational energy as $E_m = B_v m^2 + D_v m^4 + F_e m^6$, where m is a half-integer for the actual rotational levels. We have calculated values of D_v from the theoretical relations derived by Kemble. The only value of F which is known theoretically is F_e, but this can be used safely for F_v, when v is small. We have also paid scrupulous regard to the difference between derivatives and finite central differences. For most molecules the distinction can be ignored, but this is not at all the case for hydrogen. Rasetti, in his calculations, omitted the $F_e m^6$ term, although his data clearly require it. He also used D_v as constant, $= D_e$. Besides the rotational constants for $v = 0$ and 1, his data also evaluate $\omega_{1/2}$, the separation of these two vibrational levels, for zero rotation ($m = 0$). Using all of his data, we get $\omega_{1/2} = 4161{\cdot}70$ cm.$^{-1}$. Rasetti's value of 4161·8 is based on a single line.

This value of $\omega_{1/2}$ is most interesting, for it lies definitely *off* the smooth $\omega_v : v$ curve. Hyman's new data have not yet been analysed for ω_v values, but the older data lead to $\omega_{1/2} = 4146$ cm.$^{-1}$, with a probable error not greater than 2 cm.$^{-1}$, so far as the extrapolation is concerned. The discrepancy of 16 cm.$^{-1}$, or 0·38 per cent, is therefore real. Such a *vibrational* perturbation seems to be quite unprecedented, and obviously cannot be explained as due to the crossing of two sets of rotational levels. Such a crossing, in any case, affects only certain *lines* of a band, and not the entire band. Even the older data give 4159 cm.$^{-1}$ for $\omega_{1/2}$, as one of us noticed several years ago, but Rasetti's work is the first to establish definitely the existence of this irregularity. One disturbing consequence of the irregularity is that one cannot be certain of the value of ω_e, the frequency of vibration for infinitesimal amplitude. In calculating D_v values, we have used $\omega_e = 4371$, as derived from a *smooth* ω_v curve, ignoring $\omega_{1/2}$. The resulting uncertainty in D_v is negligible, in any case.

Our final calculated values of B_0 and B_1, from Rasetti's data, are 59·354 cm.$^{-1}$ and 56·4035 cm.$^{-1}$, respectively, as compared with Rasetti's published $59{\cdot}40 \pm 0{\cdot}03$, and 56·47. So far as the consistency of the data is concerned, our own calculated values have a probable error of less than 0·01 cm.$^{-1}$, but the real probable error is doubtless several times as large. Using all our derived constants, Rasetti's sixteen measured lines are represented with an average residual of 0·24 cm.$^{-1}$. His own average residual is 0·36 cm.$^{-1}$. The agreement with theory is remarkably close in every detail, and this is especially gratifying, since the hydrogen molecule provides the most severe test of any theory of band spectra.

The equation for B_v, derived by Hyman and Jeppesen from band spectra data *only*, gives $B_1 = 56{\cdot}4115$ cm.$^{-1}$. This agrees with our value from Raman effect to *one part in seven thousand*. It is the most accurate check between Raman effect and band spectra data that has yet been found, and is again a most satisfactory confirmation of theory. On the other hand, the Raman effect value of B_0 is 0·27 per cent greater than the *extrapolated* band spectrum value. The agreement of the B_1 values shows that the B_v equation given by Hyman and Jeppesen is entirely correct at $v = 1$, and hence its extrapolation to $v = 0$ is certainly correct to 0·1 per cent or less. We therefore have a *perturbation* in the moment of inertia of the *lowest* vibrational state of hydrogen. Since the separation of vibrational levels is assumed to measure an average value of the classical frequency of vibration in the two levels concerned, the conclusion seems almost inevitable that in the lowest vibrational level of hydrogen the frequency of vibration is *greater* and the moment of inertia *less* than the values to be expected from the constants for the other vibrational levels.

The essential correctness of the value of B_0, as derived from Raman effect, cannot be questioned. Hence the true I_0 for hydrogen is $0{\cdot}46602 \times 10^{-40}$ gm.cm.^{2}, $r_0 = 0{\cdot}74891 \times 10^{-8}$ cm. These constants are given to five significant figures, like B_0, but it should be remembered that the conversion factor has itself a probable error of one part in seven hundred. As noted by Hyman and Jeppesen, the value of B_e now becomes indefinite, due to the irregularity in B_0, but in the absence of contrary evidence, it seems best to use, for both B_e and ω_e, when calculating derived constants, the smooth extrapolated values already given.

Raymond T. Birge.
C. Rulon Jeppesen.

University of California,
Berkeley, California, Jan. 10.

Raman Spectra of Crystalline Powders.

In a recent communication (Nature, Nov. 2, 1929) Prof. R. Bär of Zurich has shown that it is possible in many cases to photograph the Raman effect with solids in a state of powder. The difficulty encountered by him, and also by Dr. A. C. Menzies (see Nature, Oct. 5, 1929), of the continuous background in the spectrum which overpowers all but the strongest Raman lines, is, however, serious, as it interferes with the general utility of the method. During the past two months I have been engaged in an attempt to overcome this difficulty, and have found that it may practically be avoided by running the mercury arc at a lower temperature, and, where necessary, also by interposing a suitable light filter between the arc and the illuminated substance. A concentrated solution of didymium chloride proved especially useful for this purpose. Thus, for example, all the four lines obtained by Schaefer with a large single crystal of sodium nitrate may, with equal success, be photographed in about half an hour by using an irregular aggregate of small crystals placed within a small triangular-shaped cell with mirrored walls.

Prof. Bär has found that in the case of naphthalene the Raman lines appear in the same position in the crystal powder as in the liquid. My results with benzophenone crystals and liquid show that a marked change in the position of some of the Raman lines occurs on fusion of this substance; this is best seen with the line usually attributed to the ketonic group, which gives a shift of 1657 wave numbers in the liquid and 1650 in the solid, and is also noticeably sharper in the latter. It is clear that a promising field of research offers itself in the comparative study of the Raman spectra in the liquid and solid states.

About eighteen inorganic nitrates have also been examined by this method, some anhydrous and the others as hydrates. It was noticed by Schaefer and by Bär that the inactive frequency of the NO_3 group in $NaNO_3$ crystals differed appreciably from the value in its aqueous solution. In the present investigation, the largest shifts corresponding to the inactive frequency were given by lithium, sodium, and mag-

nesium nitrates (1071, 1070, and 1060 wave numbers respectively). The values obtained with calcium, barium, and lead nitrates were not much different from the value for nitric acid (1045), while mercuric and bismuth nitrates showed smaller frequency shifts (1037 and 1040 wave numbers respectively). In some cases, for example, lithium, aluminium, and mercuric nitrates, the line was accompanied by a fainter component.

It is interesting to note that in nitrate crystals belonging to the cubic system the frequency shift is almost the same as for nitric acid in spite of the varying size of the metal atom (for example, calcium, barium, and lead nitrates). Of the other two frequencies, the 7 μ line appeared only in the case of lithium and sodium nitrates. The 13 μ line, however, was more persistent and appeared in the case of lithium, sodium, ammonium, potassium, barium, and lead nitrates. The Raman line corresponding to a remote infra-red frequency appeared prominently in lithium and mercurous nitrates (42·9 μ and 57·2 μ respectively), and was also noticeable with sodium, calcium, barium, zinc, silver, and mercuric nitrates.

P. KRISHNAMURTI.

Raman Effect in Liquefied Gases.

IN a recent investigation by Daure (*Trans. Faraday Soc.*, **25**, 825; 1929) on the Raman effect in liquefied gases, it was found that the spectrum of liquid ammonia includes three strong lines the displacements of which are 321, 330, and 338 mm.$^{-1}$ Two of these lines (321 and 330 mm.$^{-1}$) have already been observed by Dickinson, Dillon, and Rasetti (*Phys. Rev.*, **34**, 582; 1929), who found the line 330 to be very strong and the other slightly weaker. Now the Raman spectrum of ammonia vapour as reported by Wood (*Phil. Mag.*, **7**, 744; 1929) shows only the line 330 mm.$^{-1}$, hence Daure ascribes the two new lines to some complex such as $H_3N=NH_3$. It seems to me that this observation is significant and worthy of more consideration.

To begin with, it will be noted that the two new lines may be accounted for, within the limit of accuracy of Daure's measurements, by the expression 330 ± 8 mm.$^{-1}$ This is precisely the sort of expression which gives the displacements of the Raman effect in general, and it suggests that the outer lines represent a scattering of the light which gives the central line by complex or associated molecules. In other words, these lines may arise from a secondary Raman effect in the liquid. Unfortunately, Daure reports only the 'negative' lines (displaced towards the red), so that no check can be made on the structure of these lines on the 'positive' side.

The chance that this relation is mere coincidence is reduced by the data of Daure for liquid ethane, which exhibits in this region a similar triplet structure which may be represented by the expression 291 ± 4 mm. So far as I am aware, the Raman effect in ethane vapour has not been reported, but if the viewpoint outlined above is correct, it should contain only the line displaced 291 mm.$^{-1}$

One experiment which suggests itself as a confirmation of this interpretation is a determination of the polarisation of these lines. If the two liquid lines have the same polarisation, it would be strong evidence that they are related in the manner suggested.

If such an effect could be established, it would provide a valuable tool for investigating molecular complexes and associated liquids. A few inferences on this basis will serve to indicate its power. The frequency displacements of the liquid lines, ± 8 mm.$^{-1}$ and ± 4 mm.$^{-1}$ would indicate that the vibrations of the components of the complex are much smaller than those of the atoms in the molecules, which is to be expected. Moreover, the fact that both positive and negative lines are quite intense would point to the existence of a considerable portion of the complexes in an excited state, probably closely akin to Henri's conception of 'predissociation'. It is hoped that more data will shortly be available so that some of these questions may be settled.

J. B. AUSTIN.

Research Laboratory,
United States Steel Corporation,
Kearny, N.J.

Raman Lines of Mercury in Arc improbable.

A COMMUNICATION by Venkatesachar and Sibaiya appeared in NATURE for Nov. 30, 1929, in which the opinion was expressed that some of the faint nebulous lines of the mercury arc were in reality Raman lines of mercury excited by the more powerful radiations.

This did not seem to me very probable, and I have investigated the matter with a new 220-volt quartz arc provided with a window of polished optical quartz which permits end-on observation of the long narrow cylinder to which the discharge contracts when the arc operates on full load. The region surrounding this highly luminous cylinder is comparatively dark, and would seem to be the most promising field in which to search for Raman lines.

An end-on image of the discharge was focused on the slit of a large quartz spectrograph by means of a quartz fluorite objective. The image, a small circular disc of intense brilliancy, was blocked off with a strip of black paper, which was removed for half a second, at the end of the exposure. The spectrum of the irradiated vapour above and below that of the disc was comparable in density with that of the discharge. There was no relative enhancement of the lines indicated by Venkatesachar; if anything, they were a little stronger in the spectrum of the discharge than in the spectrum of the irradiated vapour.

R. W. WOOD.

Johns Hopkins University,
Baltimore, Feb. 15.

Raman Effect for Solutions of Sulphur Dioxide.

STUDIES of the Raman effect for hydrogen chloride and for ammonia as gases, as liquids, and in aqueous solution have been made by various investigators. With ammonia, the same modified line appears in all three cases. Hydrogen chloride reveals the same scattered line in the liquid and gaseous states, but, as is to be expected, not in aqueous solution.

We have investigated the scattering of sulphur dioxide in various solvents, such as water, benzene, and carbon tetrachloride, and intend to work with the pure liquid and the gas. In addition to the modified lines arising from the solvent, there occur, in each instance, lines characteristic of the sulphur dioxide molecule. The most prominent of these lines appear in all of the solvents at λ4588 and λ4238, excited, respectively, by λ4358 and λ4047 of the mercury arc. The shift indicates an infra-red wave-length of 8·8 μ. This is very close to the mean value of about 8·7 μ for the band from 8·4 μ to 9·0 μ, which is one of the most intense two of the six infra-red absorption bands found by Coblentz for this gas.

The replacement of the broad infra-red band by a Raman line may be due to the faintness of the *P* and *R* branches in the spectrum adjacent to this line, and the appearance of a *Q* branch in the Raman spectrum, as was found by Wood for hydrogen chloride.

WILLIAM D. HARKINS.
DAVID M. GANS.
HAROLD E. BOWERS.

University of Chicago, Jan. 6.

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Obituary.

DR. J. G. DE MAN.

THE Dutch zoologist Dr. Johannes Govertus de Man, who died at Middelburg on Jan. 19 last in his eightieth year, was well known as an authority on two very diverse groups of animals, the free-living Nematode worms and the Decapod Crustacea.

De Man was born in 1850 at Middelburg, where his father, Dr. J. C. de Man, was a physician well known throughout the Netherlands. He studied mathematics and natural science at the University of Leyden, where he received the degree of doctor in 1873 for a thesis, "Comparative Studies on the Myology and Neurology of Amphibia and Birds." He was appointed first assistant in the State museum of natural history in Leyden in 1872, and three years later was promoted to be conservator. He had studied under Leuckart at Leipzig in 1872, and in 1876 he spent some months at the recently established zoological station at Naples, where, however, his stay was cut short by a severe attack of typhoid. In 1881–82 he worked in Selenka's laboratory at Erlangen, studying the sipunculid worms collected by Semper on his expedition to the Philippine Islands.

In 1883 de Man had to resign his post at the museum at Leyden owing to prolonged ill-health and he retired to pursue his studies, first at his parents' home at Middelburg and later in a house which he built overlooking the Scheldt at Ierseke. Here he lived the quiet life of the student, working out collections from museums and expeditions all over the world, appealed to by the neighbouring fishermen when anything out of the common came to their nets, and explaining to the children the nature of the treasures gathered on their seaside rambles. Although he took no part in public life, his purse was ever open to appeals for charitable or useful purposes. None could have been more courteous and helpful to those who sought information by correspondence, and none more careful to give acknowledgment for any assistance he received.

The free-living nematodes are a group little studied in comparison with those species that, by reason of their parasitic habits, come into more direct relation with human affairs, and few zoologists have any suspicion of their abundance or their variety. In their study de Man was, after Bastian, one of the pioneers, and his work on them will not soon be surpassed for thoroughness and precision. On the Decapod Crustacea, his numerous memoirs and papers, full of the most careful and detailed description and beautifully illustrated by his own pencil, remain as a mine of information for all students of the group. An obituary notice in the *Nieuwe Rotterdamsche Courant* of Jan. 29 concludes with the words, "He leaves a blank, not only in the learned world, but also among the simple fisher-folk of Ierseke"; a fitting epitaph for the kindly old scholar.

W. T. C.

LIEUT. C. B. EIELSON.

THE loss of Lieut. Eielson removes one of the most experienced Arctic pilots and a pioneer in polar aviation. On Nov. 9 last year, he set out from Teller in Alaska on a second aeroplane journey to the ice-bound vessel *Nanuk*, off Cape North, Siberia. On his failure to arrive, search parties were sent out, and during the month of February discovered the bodies of Lieut. Eielson and his companion, Mr. E. Borland, near the wrecked machine about 90 miles south-east of Cape North.

Carl Ben Eielson was an American of Norwegian descent. In 1923 he was the first pilot to use an aeroplane in Alaska, and his success led to his being employed to carry mails during winter. In 1926 he joined Mr. (now Sir) Hubert Wilkins in his trial tests over the Arctic Ocean, which were continued in 1927 in preparation for a transpolar flight. In that year they flew more than five hundred miles to the north-west of Cape Barrow. On the return, a forced descent on the pack ice was followed, after a second start, by another descent, which entailed leaving the machine and marching 75 miles over the ice to land. This was done in two weeks, without any considerable difficulty.

In 1928, Eielson piloted Wilkins's machine from Point Barrow via northern Greenland to Spitsbergen. This was a flight of twenty hours and remarkable for its daring and skilful navigation. In the same year Eielson went to the Antarctic with Wilkins and was his pilot in his 1200-mile flight in December, which resulted in the discovery that Graham Land is a series of islands.

We regret to announce the following deaths:

The Rt. Hon. The Earl of Balfour, F.R.S., Chancellor of the University of Cambridge and of Edinburgh, on Mar. 19, aged eighty-one years.

Mr. T. A. Barns, a well-known Central African traveller and naturalist, on Mar. 4, aged forty-eight years.

Mr. R. Moir Clark, until last year lecturer in agricultural botany at the University of Aberdeen and secretary for many years of the Aberdeen Natural History Society, aged sixty-three years.

Mr. Edward Clodd, distinguished by his work and publications on folk-lore and anthropology, on Mar. 16, aged eighty-nine years.

Dr. A. T. Hadley, emeritus president of Yale University and a distinguished economist, aged seventy-three years.

Prof. Maurice R. J. Hayes, professor of materia medica and therapeutics, University College, Dublin, and first Director-General of the Irish Free State Army Medical Service, who was an authority on radiology, on Mar. 2, aged fifty-one years.

Dr. J. B. Hurry, formerly medical officer of Reading and author of a series of books on "Vicious Circles" which appeared in many languages, on Feb. 15, aged seventy-two years.

Dr. K. J. P. Orton, F.R.S., professor of chemistry, University College of North Wales, on Mar. 16, aged fifty-seven years.

News and Views.

FOR the centenary meeting of the British Association for the Advancement of Science, which will be held in London next year on Sept. 23–30, the Council has unanimously resolved to nominate Gen. the Right Hon. J. C. Smuts as president of the Association, and he has accepted the nomination. It was felt that, for the London meeting, the president should be a leading statesman or other representative of the British Empire with scientific interests instead of being distinguished for work in a particular branch of science. Usually, the presidents elected represent alternately the physical and the biological sciences, and little consideration is given to the appropriateness or otherwise of their special subjects to the place of meeting. If the Prince of Wales had not been president of the Oxford meeting in 1926, he would obviously have been of unique significance as president of the centenary meeting in London. His interests in South Africa suggest, however, that he would welcome the nomination of Gen. Smuts, who is so very highly respected in that country.

GEN. SMUTS has wide interests in many fields of practical life and intellectual activity, and has won distinction in all of them. He is a statesman with high principles and broad outlook, a naturalist who has done original field work in botany, and a philosopher who has correlated observations and conclusions into a coherent scheme. His work on "Holism and Evolution", published in 1926, was a wide and original survey of evolutionary philosophy of a universe vitalised by a great driving force. The great characteristic of the world of Nature is held to be the tendency to the development of 'wholes'. The work revealed Gen. Smuts as a scientific student and thinker of great knowledge and remarkable power of expression. His presentation of Darwin's principles and discussion of the work and conclusions of Mendel and Weismann and their disciples showed both just appreciation and sound judgment; and his general thesis was a valuable contribution towards the merging together of science and philosophy. Gen. Smuts was president of the South African Association for the Advancement of Science in 1925, and in his presidential address on "Science in South Africa", the main part of which was published in NATURE of Aug. 15, 1925, he presented a comprehensive survey of scientific problems of the southern hemisphere from the point of view of South Africa as the appropriate centre from which to correlate them. Whatever may be the subject of his address at the London meeting next year, we are sure that it will be dealt with in a masterly way and will command the attention of all interested in progressive life and thought.

PROF. BOHUSLAV BRAUNER, the eminent Czechoslovak man of science, distinguished for his investigations in the chemistry of the rare earth elements, has just attained the jubilee of his 'promotion' as doctor of philosophy at the Charles University of Prague. This event was celebrated according to the traditions of the University by a solemn renewal of his diploma on Feb. 28. Prof. Brauner has also recently been made an honorary member of the Polish Chemical Society, thus adding to the long list of foreign distinctions which have been conferred upon him in recognition of his researches in inorganic and analytical chemistry. Among his more important discoveries mention may be made of his independent isolation of fluorine, carried out at Manchester in the early 'eighties, the recognition of the complexity of didymium and its fractionation into praseodymium, neodymium, and samarium. He was among the first to realise the full significance of Mendeléeff's periodic classification of the elements and in support of it he undertook the redetermination of the atomic weights of many rare earth and other metals. He had deduced, so early as 1877, that beryllium must be bivalent and therefore has the atomic weight 9, thus bringing it into line with Mendeléeff's scheme. Prof. Brauner's interest in the classification of the elements brought him into close contact with the Russian savant, and their intimate friendship only terminated on Mendeléeff's death. Prof. Brauner shares his countrymen's talent for languages, and writes with equal facility in six or seven European languages. Many of his original researches have appeared in English journals, including NATURE. Mention must also be made of his influence in Central Europe, for he has established, at the Chemical Institute of the Charles University of Prague, a school of research which maintains the high traditions associated with his work.

IN the early part of the year 1830, Charles Lyell, F.R.S., foreign secretary of the Geological Society, published the first volume of the "Principles of Geology", and its centenary of issue and contemporaneous influence on scientific thought is worthy of recall. Four years afterwards, the Royal Society awarded Lyell (he was not knighted until 1848) a Royal medal, with apt expression: "For his work entitled 'Principles of Geology', in recognition of its comprehensive and philosophical spirit and dignity, and the important service rendered to science by specially directing the attention of geologists to effects produced by existing causes." As an exponent of the philosophy underlying geological study, and a historian of agencies in Nature he opened up new vistas for the men of his day. During a period of forty years Lyell continued to enlarge and improve his work, bringing out no fewer than eleven editions. "Which of us", asked Huxley, in his anniversary address to the Geological Society in 1869, "has not thumbed every page of the 'Principles of Geology'?" Lyell was born at Kinnordy, his father's seat near Kirriemuir, Forfarshire, on Nov. 14, 1797. Educated at a private school at Midhurst, he graduated at Exeter College, Oxford, studying later for the Bar, though he never practised, his tastes leading him to geological pursuits. Lyell was elected into the Royal Society in 1826, at the same time as Roderick Murchison. He was created a baronet in 1864. He died at his home in Harley Street, London, on Feb. 22, 1875, being then

in his seventy-eighth year, and was buried in Westminster Abbey.

ON Mar. 29 occurs the centenary of the death of Major James Rennell, one of the most eminent of British geographers. The son of an army officer, Rennell was born in 1742 at Chudleigh, Devonshire, and at the age of fourteen entered the Navy. After some service in home waters, he was sent to the East Indian station, where he saw active service and gained considerable experience in the practice of marine surveying. At the close of the Seven Years War he obtained his discharge from the Navy, entered the service of the East India Company, and in 1764 was appointed Surveyor-General of Bengal and given a commission in the Bengal Engineers. His labours were of great importance to Indian geography for, as the result of thirteen years' hard work, he was able to publish his Bengal Atlas, and in 1783 he published the first approximately correct map of India. By that time, as a result of the climate and wounds, he had been retired on a pension of £600 a year, and for more than fifty years afterwards he lived in London, devoting his whole time to geography. His house became the meeting ground of travellers and explorers, he was consulted by various bodies, and reports were sent to him from all over the world. His writings on Herodotus, Troy, Asia, and Africa attracted much attention, and his work on currents and winds is recalled to every navigator by the Rennell Current which flows northward from the coast of France towards the Scilly Islands. He was made a fellow of the Royal Society in 1781 and awarded the Copley Medal in 1791; he was also an associate of the Paris Academy of Sciences. At his death he was buried in the nave of Westminster Abbey, where his bust and a memorial tablet are to be seen.

AT the twenty-second annual meeting of the Institute of Metals, held on Mar. 12–13, Dr. Richard Seligman was inducted as president for the current year. Dr. Seligman was born in London in 1878, and educated at Harrow and (1895) at the Central Technical College (City and Guilds Institute), under Prof. H. E. Armstrong; he was awarded the College associateship in 1898. He then studied chemistry at the University of Heidelberg, and transferred to Zurich in 1900, being engaged in research work with Prof. Eugen Bamberger. Returning to Heidelberg he gained his doctorate in 1902. After a period in the Niagara Research Laboratories, N.Y., he became chief chemist to the United States Zinc Company of Pueblo, Colorado. In 1905 he commenced specialisation in his main work with his appointment as chief chemist to the British Aluminium Company, which appointment he relinquished in 1909 to form the Aluminium Plant and Vessel Co., Ltd., Wandsworth, London. The activities of this concern have been devoted to the development of aluminium in the service of industry, originally in the welding processes which enabled large-scale plant to be devised, and latterly in the associated technological work involved in its use in the foodstuffs, chemical, and other industries.

HIS MAJESTY THE KING has approved the award of the Royal Medals for 1930 of the Royal Geographical Society as follows: Founder's Medal to Mr. F. Kingdon Ward, for his geographical explorations and work on botanical distribution in south-west China and south-east Tibet; Patron's Medal to Mr. C. E. Borchgrevink, for his pioneer Antarctic expedition of 1898–1900, which was the first to winter in the Antarctic, to travel on the Ross Barrier, and to obtain proof of its recession. The Council of the Society has made the following awards: Victoria Medal to M. Emmanuel de Margerie, for his distinguished contributions to the science of land forms; Murchison Grant to Colonel H. Wood, for his surveys with the Tibet Mission and the De Filippi Expedition to Central Asia; Back Grant to Mrs. Gordon-Gallien, for her expedition to the Kalambo Falls; Cuthbert Peek Grant to Mr. Owen Lattimore for his travels in Mongolia and Chinese Turkistan; Gill Memorial to Lieut.-Col. Reginald Schomberg, for his explorations in the Tarim basin and the Tien Shan.

PROF. R. A. SAMPSON, Astronomer Royal for Scotland, described the purpose and design of the new equipment at the Royal Observatory, Edinburgh, in a paper read before the Optical Society on Mar. 13. The reasons which determined the form of the new telescope—a Cassegrain reflector of 36 inches aperture and 54 feet focal length, serving a spectrograph of one, two, or three prisms—were discussed, and the problems to which the instrument is to be applied were indicated. Speaking generally, the main problem is the intensity of stellar light for different parts of the spectrum. It was pointed out that even an empiric treatment of this question led Adams to a method that has doubled our knowledge of stellar distances. A theoretical treatment, comprising a discussion of the behaviour of the photographic plate, led to fixing the temperature sequence. A slit spectrograph is required in order to deal with the lines. The state of the lines, combined with that of the continuous spectrum, conveys all the information that reaches us of the star's constitution and atmosphere. Subsidiary but highly interesting questions are those of selective absorption of light by the atmosphere of the earth. Behind these is the theoretical and laboratory investigation of the relation between intensity of light and the density of silver deposit on the photographic plate. The whole presents an attractive field. Mr. C. Young, of Messrs. Sir Howard Grubb and Parsons, Ltd., described the reflector, and Mr. J. H. Dowell, of Messrs. Adam Hilger, Ltd., the spectrographic equipment.

NEARLY a year ago a sub-committee of the Committee of Civil Research was appointed, under the chairmanship of Mr. E. R. Peacock, "to examine and report on the economic aspects of proposals for the construction of a Channel tunnel or other new form of cross-Channel communication". A report has now been issued (Cmd. 3513. London: H.M. Stationery Office, 1930. 3*s*. net), signed by all the members of the committee, subject to a 'minute of dissent' by Lord Ebbisham. It appears that only two schemes

were put before the committee, one of which is dismissed as impracticable and prohibitive in cost, while the other, due to the Channel Tunnel Co., is reviewed in detail. The proposal is for two independent traffic tunnels each of 18 ft. 6 in. diameter and a pilot tunnel of 10 ft. diameter for drainage and ventilation. The tunnel approaches would be about 12 miles long and 24 miles would be under the Straits of Dover. The cost of the pilot tunnel is estimated at £5,000,000 and the remainder of the workings at £25,000,000; the pilot tunnel would take about 2½ years to drive, and the whole scheme might be completed in 6½ years. It will be remembered that the geological evidence on the possibility of constructing a Channel tunnel was discussed by Mr. John Pringle in an article in NATURE of April 20, 1929, p. 608, wherein it was shown that, geologically, such a tunnel is practicable. The committee of inquiry concurs with this view, but suggests that the final decision should await the completion of the pilot tunnel. It is concluded that a Channel tunnel should be built and maintained by private enterprise and that it would be of economic advantage to Great Britain. Lord Ebbisham, in his 'minute of dissent', opposes the scheme on economic grounds.

IN a lecture by Sir Harry Haward, the vice-chairman of the Electricity Commission, to the Surveyors' Institution on Mar. 10, a clear and interesting account was given of recent developments in the electricity supply of Great Britain. Since 1920, the amount of plant installed in generating stations has been trebled and the cost of a unit to the consumer has been nearly halved. To the non-technical reader, the working of the scheme may be described as follows. The merging of the general sources of a district provides a regional pool of electrical energy. This pool is fed from selected stations operating under a definite control. The more efficient stations work three shifts and take what is termed the constant load. The less efficient stations work on a two or even a one shift basis. Contributions to the pool are also derived from energy produced by waste heat from industrial works and other sources. The central board purchases the whole of the output of selected stations and the owners buy back the amount required for their own use. The rest of the energy is exported to those undertakers whose generating stations have been shut down. For this purpose the grid, which is at 132,000 volts, is tapped at certain points where the voltage is reduced usually to 33,000 volts and from which lines radiate throughout the district. The tapping of the grid is an expensive matter, costing at least £40,000, and cannot therefore be done merely to give supplies to individuals. A breakdown at any station or an exceptional demand can at once be met by the resources of the pool. The difficulties in the way of progress are connected with wayleaves, obtaining consents to the erection of overhead wires from local authorities and from the Council for the Preservation of Rural England. Cases arise where the question of amenities has to be weighed against economic and utilitarian considerations. The question is whether the boon of an electric supply will outweigh a limited interference with local amenities.

SOME interesting suggestions for the development of the resources of the British Empire have been put forward by Sir Robert A. Hadfield in a pamphlet entitled, "Organised Empire Development", and in an article in *Canada* on "Making Empire Development a Business Proposition". As is well known, Sir Robert Hadfield advocates the formation of an Empire Development Board, non-political and non-fiscal in character, which would investigate opportunities for trade and industrial development throughout the Empire. This Board would be a permanent organisation, meeting more frequently than the Imperial Conference, and would consist of representatives from all parts of the Empire, devoting their whole time and energies to its work. Meetings would be held in Great Britain and the various Dominions in rotation, and by this means the members would obtain first-hand knowledge and experience of the conditions, requirements, and possibilities of the different parts of the Empire.

IN conjunction with the proposed Empire Development Board, Sir Robert Hadfield suggests that a large Imperial Development Fund should be raised which would be utilised by arrangement with the various governments to develop the productive capacities of the constituent parts of the Empire. Among the first aims of the Board should be the promotion of the development of more efficient transport; the foundation of new industries; the initiation of hydro-electric power schemes; the encouragement of agriculture and the control of forestry. Attention should also be especially devoted to the economic development of the Crown Colonies, since in these areas raw materials in abundance can be obtained. Another interesting suggestion put forward by Sir Robert Hadfield is that Empire settlers should be given opportunities to revisit the home country periodically. This, he holds, would do a great deal to cement the ties of Empire.

IT is well to remind ourselves occasionally that there are technical colleges in Great Britain which are doing higher and more valuable work than teaching 'engineering arithmetic' or 'commercial English' to pupils who have left school without having acquired sufficient knowledge of arithmetic or English to do a simple calculation correctly or to write an intelligible letter, and who can only be tempted to further study by a title suggesting that a very little of an educational subject is sufficient for industrial or commercial life. The January issue of the *Journal of the Royal Technical College*, Glasgow, gives ample evidence of the value for science and industry of the work which is being done at this institution. It consists of more than 200 pages of research work carried out in the College by the staff and senior students and communicated to the *Journal* during the last six months of 1929. More than 80 pages emanate from the mechanical laboratory, 50 from the bacteriological, and the rest from the mathematical, chemical, physical, and pharmaceutical laboratories. One cannot read these papers without realising the importance of the work which is being done in institutions of the type of the

Royal Technical College in the supervision and direction of present research and in training men for the research of the future.

THE value of joint effort in scientific work is well illustrated by the success of the Southern-Eastern Union of Scientific Societies. The Union now consists of sixty-four societies interested in antiquities, architecture, botany, geology, natural science, photography, and the less circumscribed pursuits of field and rambling clubs, and in these it embraces more than sixteen thousand members. It is probably not too much to say that few of these societies, standing by themselves, would accomplish much original work, but under the stimulus and organisation of union they have succeeded in doing well for the investigation of the south-east of England. The thirty-third annual report, which appears for the first time with the title of the *South-Eastern Naturalist and Antiquary*, contains the papers read at the Brighton Congress of 1929—Sir Arthur Keith's presidential address on "The Pre-Roman Inhabitants of Southern England", and the addresses of the presidents of sections. But it also shows that the botanical section is compiling a complete flora of Sussex, and that the geological and archæological sections are alive to the need for collecting and recording local information and the discovery of objects of scientific interest. This year's Congress is to be held at Portsmouth under the presidency of Mr. O. G. S. Crawford.

AN interesting and important piece of evidence for the existence of the creature popularly called the 'sea-serpent' has recently come to hand in the shape of a letter in which Capt. F. W. Dean, R.N. (retired) describes a creature seen by himself and several of the officers and men of H.M.S. *Hilary* in May 1917. He relates the incident as follows: "About 9 A.M. on approx. 22/5/17, H.M.S. *Hilary* was some 70 miles S.E. of the S.E. part of Iceland, the day very fine and clear, the Iceland mountains in sight, flat, calm, and smooth sea. An object was observed on starboard quarter. The ship was turned round and steered straight for the object. When we were about a cable (200 yards) from it the creature quietly moved out of our way and we passed it on our starboard side at a distance of about 30 yards, getting a very good view of it. . . . As we passed close to the creature it lifted its head once or twice as if looking at us. The head was in appearance black and glossy, with no protrusions such as ears, etc., in shape about that of a cow . . . the top edge of the neck was just awash, and it curved to almost a semicircle as the creature moved its head as if to follow us with its eyes. The dorsal fin was a black equilateral triangle which rose at times till the peak was estimated to be four feet above the water."

THREE independent estimates made on board the *Hilary* gave the length of the neck of the 'sea-serpent' (head to dorsal fin) as 15 feet or more, 20 feet, and 28 feet. The head appeared to have a patch of whitish flesh in front, "like that around a cow's nostrils". The dorsal fin was thin and flexible, occasionally curving over at the top. The *Hilary* being on patrol at the time, the unfortunate creature was used as a target for anti-submarine practice with the 6-pounders, at about 1200 yards range. A direct hit having apparently been scored, it disappeared, no trace remaining. A few days later (May 25, 1917), the ship was torpedoed and sunk, taking with her all logs, journals, etc., recording the 'sea-serpent' incident. As described, the creature seems to have borne a most striking resemblance to that seen off the Brazilian coast, in December 1905, from the Earl of Crawford's yacht *Valhalla* (see NATURE, June 28, 1906, p. 202). This, also, exhibited a dorsal fin rising some four feet out of water, and a long, snake-like neck, terminating in a head described as resembling that of a turtle. In this case, the head and part of the neck were lifted well clear of the water, and not merely floating awash. In both cases there seems no doubt that the observers saw a single living sea-creature of unknown species.

THE Journal of the American Museum of Natural History, New York, entitled *Natural History*, is the most successful popular museum magazine with which we are familiar, from the point of view alike of its matter and of its circulation. The half-dozen parts which form the volume for 1929 are remarkable for the variety of their interest, for the skill of the contributors in composing articles containing much new information expressed in easy language, and for the excellence and lavishness of the illustrations. Where so much is excellent it is difficult to particularise, but one of the series most interesting to naturalists must be the descriptions and restorations of prehistoric animals recently discovered in America or in other parts of the world by the Museums' expeditions. The final number for 1929, for example, contains an account, with photographs of the actual skeletons and of a restoration model, of a herd of Miocene camels (*Stenomylus hitchcocki*), discovered entombed near Agate Springs in Western Nebraska. The cost of running so sumptuous a museum journal must be enormous, but the return, represented by interest taken in the Museum and its doings, must also be great, and much can be done with a membership numbering more than eleven thousand.

SOME interesting data emerge in a study of the statistics of cancer in England and Wales, which have been published by M. Pittard in the *Bull. et Mém. de la Société d'Anthropologie de Paris*, Ser. 7, T. 9, Fasc. 4-5-6. This study is supplementary to an appendix in the Report of the Cancer Commission of the League of Nations and revises certain of the figures of distribution in that appendix. Its chief interest, however, lies in the fact that M. Pittard has here endeavoured to correlate the data of cancer and race. He finds that the highest death-rate from cancer for ages above forty-five occurs in two groups of counties, (1) Montgomery and Merioneth in Wales, and (2) Rutland, Peterborough (Lincoln), Isle of Ely, Suffolk, Lincoln (parts of Holland), and Huntingdon. On turning to the anthropological data, he finds that a high cancer rate is found with the higher figures for stature, and with the more pronounced dolichocephaly, but that in the case of pigmentation the figures are

contradictory, though certain of the data point to a coincidence of a high rate of cancer mortality and a high degree of nigrescence. These conclusions are interesting for what they are worth. M. Pittard is well aware how far they fall short of a scientific standard. The anthropological data upon which his conclusions are based are utterly inadequate. In the case of pigmentation, there are whole areas for which he could obtain no data for his purpose, and he points out how completely Great Britain falls behind Germany, for example, in a knowledge of the physical type of its population. Cancer, however, is but one of the more important of the numerous problems of which the scientific study is handicapped by the fact that no complete anthropometric survey of the British population has ever been made.

AT the annual general meeting of the Society of Public Analysts, held on Mar. 5, the following officers were elected: *President*, Dr. J. T. Dunn; *Hon. Treasurer*, Mr. E. B. Hughes; *Hon. Secretary*, Mr. F. W. F. Arnaud.

THE eleventh International Congress of Zoologists will be held at Padua on Sept. 4–11 next, under the presidency of Prof. Paolo Enriques. It will be followed by two or three days' excursion to the valleys of Comacchio, Ferrara, Bologna, and Ravenna. The office is at Padova, Via Loredan 6.

ENGINEER-VICE-ADMIRAL SIR ROBERT DIXON, president of the Institute of Marine Engineers, and Dr. H. J. Weld, organiser of the Weld-Ashmolean Expedition to Kish, have been elected members of the Athenæum Club under the provisions of Rule II. of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature, the arts, or for public service.

DR. IRVING LANGMUIR, associate director of the General Electric Company's research laboratory at Schenectady, has been awarded the Willard Gibbs gold medal of the Chicago section of the American Chemical Society, "for fundamental work on atomic hydrogen and on surface relations and also on electrical discharge phenomena. Also for his contributions of great importance to nearly all branches of physical chemistry, including high vacuum technique, electronics, thermochemistry, and catalysis. And lastly, for his presentation of a theory of atomic structure."

IN 1932 it will be a hundred years since the death of Goethe and fifty years since that of Darwin. Goethe, it will be remembered, was a native of Frankfurt a/M., and Prof. Fritz Drevermann proposes to arrange in the Senckenberg Museum there, of which he is director, an exhibition in commemoration of these two great men. He would be glad to borrow for that purpose any objects personally connected with Charles Darwin, especially a page of his handwriting, and he urges that as a means of inducing friendship between the nations this last would have more value than "a scrap of paper".

EARLY this year it was announced in the daily Press that Prof. A. A. Michelson, the distinguished physicist of the University of Chicago, had died, and we were glad to be able to contradict this report promptly and authoritatively. Congratulations are now due to Prof. Michelson on the recent award to him by the Council of the Physical Society of London of the Duddell Medal for 1930. This award, it will be remembered, is made annually to some one who has contributed to the advancement of knowledge by the invention or design of scientific instruments or by the discovery of material used in their construction. Scientific workers generally will agree that this new tribute to Prof. Michelson's genius has come at a particularly happy time.

THE Report of the Haffkine Institute, Bombay, for 1928 records that nearly two million doses of anti-plague vaccine were issued, and 276,095 rats were examined for plague infection, of which 2222 were found to be infected. At the anti-rabic department, 718 persons were treated, of whom 6 died, a mortality of 0·83 per cent.

BY arrangement with the proprietors of *The Quarterly Journal of Mathematics* and *The Messenger of Mathematics*, the Oxford University Press will, after Mar. 31, continue both journals by a single successor in new format, to be called *The Quarterly Journal of Mathematics* (*Oxford Series*), and to appear quarterly, commencing in April next.

UNDER the Local Government Act, 1929, the functions relating to public vaccination in England and Wales hitherto discharged by Boards of Guardians will, from the appointed day (April 1, 1930), be transferred to other bodies. The Ministry of Health has, therefore, issued an explanatory leaflet (*Circular* 1067) to guardians of unions extending into more than one area, and to the county and other councils who will assume the functions of the guardians, a statement of the main statutory provisions governing the vaccination service (*Memorandum*, L.G.A. 33, 2d.). The Minister of Health has also issued an Order (Order No. 73,990. Statutory Rules and Orders, 1930, No. 2. 9*d*. net) consolidating and amending the orders made from time to time under the Vaccination Acts, 1867 to 1907 with a covering circular (*Circular* 1068). All these publications are issued by H.M. Stationery Office.

THE latest catalogue (No. 341) of Messrs. W. Heffer and Sons, Ltd., Cambridge, to reach us contains particulars of some 2500 second-hand works, mainly relating to the classics and classical archæology, from the libraries of the late H. V. Macnaghten and R. D. Hicks.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant master, graduate in engineering, at the Ashton-under-Lyne Junior Technical School—G. W. Handforth, Education Offices, 8 Warrington Street, Ashton-under-Lyne (Mar. 29). A sanitation officer for Barbados—The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, Whitehall, S.W.1. An assistant radiologist at London Hospital—The House Governor, London Hospital, E.1 (Mar. 29). An organic chemist as research assistant

at the East London College—Dr. A. Robertson, East London College, E.1 (Mar. 30). Scientific officers and junior scientific officers under the Directorate of Scientific Research of the Air Ministry — The Chief Superintendent, R.A.E., South Farnborough, Hants (April 5). An assistant in the Jodrell Laboratory at the Royal Botanic Gardens, Kew — The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (April 7). An assistant lecturer in mathematics at the University College of Hull—The Secretary, University College, Hull (April 14). Professors of botany, and geography and anthropology, at the University College of Wales, Aberystwyth—The Secretary, University College of Wales, Aberystwyth (April 23). A lecturer in palæontology and stratigraphy, two lecturers in geography, and a demonstrator in inorganic and physical chemistry, at Bedford College for Women—The Secretary, Bedford College for Women, Regent's Park, N.W.1 (April 24). Three assistant inspectors of ancient monuments under the Commissioners of His Majesty's Works and Public Buildings—The Establishment Officer, H.M. Office of Works, Westminster, S.W.1 (May 16). A radiologist at the Wellington General Hospital, New Zealand—The Secretary, Wellington General Hospital, Wellington, New Zealand (May 20). Two assistant physicists, one a woman, under the Research Association of British Paint, Colour, and Varnish Manufacturers — The Director, Paint Research Association, Waldegrave Road, Teddington. A sanitary inspector under the Sudan Medical Service—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1. A radiologist at the Mount Vernon Hospital — The Secretary, Mount Vernon Hospital, 7 Fitzroy Square, W.1. A woman assistant under the Air Ministry, Kidbrooke, for Aeronautical Inspection Directorate Test House—Secretary, I.E.2, Air Ministry, W.C.2.

Our Astronomical Column.

New Comet, 1930 *b*.—The second cometary discovery of the year was made at Hamburg on Mar. 11 by Mr. Beyer; the magnitude was given as $10\frac{1}{2}$, but as the object was seen in bright moonlight it may have been brighter than this. Subsequent search of plates exposed by Dr. Prager at Neubabelsberg, Berlin, revealed images. The following positions are from telegrams from the I.A.U. Bureau, Copenhagen:

U.T.	R.A.	N. Decl.	Observer.	Place.
Mar. 2d 21h 59·0m	6h 8m 12·86s	28° 3′ 5″	Prager	Berlin
3 21 11·0	6 7 40·53	28 32 2	,,	,,
11 20 30·5	6 5 20	32 22	Beyer	Hamburg
13 18 49·9	6 5 11·33	33 14 2	Bianchi	Milan

The comet is well placed in the evening sky, and should be within reach of moderate instruments.

M. Ebell has computed the following orbit and ephemeris of Beyer's comet; they have been telegraphed from the I.A.U. Bureau:

T	1930 April 22·212 U.T.
ω	26° 41′
Ω	116 26
i	71 28
log q	0·31385

EPHEMERIS FOR 0h.

	R.A.	N. Decl.
Mar. 21	6h 5m 56s	36° 13′
25	6 7 12	37 45
29	6 9 8	39 11

There does not appear to be any sensible deviation from a parabola in the orbit of comet 1929 *d* (Wilk). Mr. F. E. Seagrave deduced an orbit from observations extending over five weeks, which indicated a period of 20,000 years.

Mars in 1926.—Prof. W. H. Pickering has for many years published in *Popular Astronomy* reports on the successive apparitions of Mars. His report on the 1926 apparition appeared in December last. Thirty-six drawings by eight different observers are reproduced. These are arranged in groups some 60° apart in longitude, so that drawings of the same region are grouped together. While there are large differences in style, the drawings of the separate observers to a large extent corroborate each other; some differences are due to real changes on the planet, produced by clouds, or precipitation from them. The great majority of the canals on the drawings are confirmed by different observers, though some draw them much narrower than others. The total number of canals drawn was 189, of which 139 were confirmed by other observers. The lakes seem less certain; 110 were drawn, but only 69 confirmed. Prof. Pickering notes that the apparition of 1928 was probably the worst observed one in modern times; still he exhorts observers to send him such drawings as they were able to make, as it is undesirable in the interests of continuity that it should pass unrecorded.

The Zodiacal Light.—Two interesting notes about the appearance of this phenomenon have come to hand. In *Astr. Nach.*, 5684, Mr. I. Yamamoto reports the observations of two Japanese astronomers, K. Araki and T. Kamei, on the morning of Nov. 3, 1929; the former noted that at 76° from the sun its width exceeded 40° and its brightness was twice that of the galaxy in Auriga. The latter noted that at 80° from the sun the width was 23°, and the brightness five times that of the galaxy in Monoceros. Nearer the sun it appeared to be narrower and fainter; that may be due to lower altitude. Twilight had not begun at either station. The axis of the light lay very near the ecliptic according to Mr. Araki; Mr. Kamei noted that the base was on the ecliptic, but the apex some 6° to the south of it.

In a letter to the Editor, Mr. C. T. Jacob, stationed at Tuticorin, South India, states that about local midnight on the night of Jan. 30–31, 1930, the zodiacal light was visible simultaneously in the east and in the west; the appearance was that of two nebulous triangles, the apices of which pointed to the zenith; the western triangle was brighter and better defined than the other. The sky was so clear that the Milky Way could be traced right down to the horizon in the south. Mr. Jacob notes that there are no powerful artificial lights in his neighbourhood that could have given rise to the glows that he describes.

The late Mr. E. W. Maunder, in his account of the eclipse expedition of January 1898, noted that the zodiacal light was frequently very conspicuous in India.

Research Items.

The Earliest Bantu.—The problems of the Bantu languages and the light they throw upon the earliest culture of the Bantu-speaking peoples are discussed by Dr. N. J. v. Warmele in *Africa*, vol. 3, No. 1. The Bantu languages constitute a group of exceptional uniformity both in grammar and vocabulary, which indicates that they are derived from one clearly distinct form of speech. From the comparative study of living Bantu dialects, philologists have reconstructed archaic or Ur-Bantu. From this may be deduced a knowledge of the ideas and the culture, and perhaps the place of origin of the ancient Bantu. The roots now accepted as belonging to the Ur-Bantu tongue number nearly a thousand. These indicate that the original home of the early Bantu was by a lake (root *yangja* ; for example, Nyassa, Nyanza). Neither the names of animals nor plants are helpful, as they are too widely distributed throughout the whole continent ; but the roots for the names of animals exclusively African are widely spread, so that the Ur-Bantu were familiar with them from an early date. If, therefore, they came from Asia, it must have been before their language began to split up, and the infancy of Ur-Bantu may safely be laid in Africa. As regards the nature of their culture, the root *Yombe*, meaning cattle, is of wide distribution, and cattle must therefore have been known long ago. But in South Africa the root for cattle, *Komo*, is related to the Hottentot *goma-b*, *kumamb*. Further, it is only in the South African languages that the root for sheep occurs to any extent, suggesting that the Bantu obtained their sheep from the Hottentot. The widely distributed terms for breeding or rearing apply only to cattle. On the other hand, the Bantu were not cattle breeders simply, and a similar examination of the roots indicates that agriculture also played a part in the economic life of the people. The grain with which they have been longest acquainted is millet, and their agricultural implement the hoe. The evidence would also point to the fundamental religious conception as being taboo. Although *tûla*, 'to forge iron', is common, there is no term for iron, and the word *tûmbi* in use in South Africa also means cowrie, so that apparently iron was not known to the early Bantu, and when introduced was used through barter, and primarily served the purpose of currency and ornament only.

Vocational Guidance in Schools.—In the *Journal of the National Institute of Industrial Psychology*, vol. 5, No. 1, there is a suggested scheme for the organisation of vocational guidance in schools. It is no longer necessary to defend vocational guidance as such ; its value in numbers of cases has been well established. There is, however, the very practical problem of providing assistance in the selection of a career for large numbers. The article suggests that in every school there should be one person whose recognised duties should include the vocational guidance of the children. He should work in consultation with his colleagues, the parents, and the school medical officers. As, however, no one person could obtain all the necessary information about all possible careers and industrial facilities, his work should be supplemented by that of a visiting vocational adviser, who should be responsible for the vocational guidance work in all the schools in his district. He should be the originator of new lines of inquiry, of experimentation with new tests. The suggestions put forward in the article are worthy of serious consideration.

Inheritance of Natural Immunity.—The literature on natural immunity in animals and its inheritance has been summarised by Mr. A. W. Kozelka (*Jour. of Heredity*, vol. 20, No. 11), who points out that immunity to a particular disease may be characteristic of a species, a race, or an individual. Many curious cases of specific and racial immunity are cited. The immunity of the frog to anthrax is at least partly due to the phagocytic activity of its leucocytes, while the blood serum of animals often has a bactericidal effect. The alligator is immune to tetanus because of a natural antitoxin in its blood. Such human diseases as diphtheria, typhoid, scarlet fever, measles, and yellow fever are not found in animals. Larvæ of the rhinoceros beetle were found by Metchnikoff to be susceptible to cholera but immune to anthrax and diphtheria, while crickets are readily susceptible to anthrax. Among related species, *Anopheles maculipennis* carries malaria, while *A. punctipennis* is immune. Negroes are relatively immune to yellow fever, and Japanese to scarlet fever. Negroes are very susceptible, and urban Russians, Poles, and Jews much more resistant to tuberculosis. Measles is a fatal disease among various native races. Such racial differences have probably resulted from natural selection through long exposure to the disease. Among domestic animals, the Algerian sheep is the only breed not susceptible to anthrax. Zebu cattle are apparently unaffected by foot-and-mouth disease, anthrax, and Texas fever, and the immunity is transmitted in some degree in hybrids with ordinary cattle. The Japanese waltzing mice are susceptible to implanted tumours, while the degree of resistance in house mice varies greatly in different localities. Many rats are immune to plague. Some 50 per cent of human beings and 30 per cent of horses are naturally immune to diphtheria. By selection, strains of mice resistant to mouse typhoid can be produced, or of guinea-pigs resistant to tuberculosis. In many of these cases several Mendelian inheritance factors appear to be involved.

Fishes of the North Atlantic.—The International Council for the Exploration of the Sea, at the Copenhagen meeting in June 1928, decided to undertake the publication of an illustrated ichthyological fauna of the North Atlantic. Parts 1 and 2 of this work have now appeared ("Faune ichthyologique de l'Atlantique Nord". Conseil Permanent International pour l'Exploration de la Mer (Publiée sous la direction de M. le Professeur Joubin). N.p. : n.d.). It is published in the form of loose cards made up in sets of 24. Each set or part is enclosed in a folder, and the entire work is expected to run to about 15 parts. One card is devoted to each species and contains, in addition to one or more illustrations, a clear and precise description of the fish, its geographical distribution, synonymy, and a short bibliography. The legend is written—in English, German, or French—by specialists on the group or family concerned, and each card is signed by the author. Some of the illustrations are original, others are reproduced from standard works. It seems unfortunate, however, that more original illustrations are not being produced, especially when some of those copied from elsewhere could be replaced by better illustrations.

Mammals of Buru, Moluccas.—For the first time a list of the mammals of Buru has been published, and it reveals a fauna of unusual interest (Dr. K. W.

Dammerman in *Treubia*, Buitenzorg, vol. 7, Suppl., December 1929). Of the 27 species recorded, 16 are bats, and of the four rats and mice, three are recorded for the first time from the island. The most interesting species are undoubtedly the Moluccan deer (*Cervus hippelaphus moluccensis*) and the Babirussa. Buru is the type locality of the former, although the race seems now to be very rare there, and may have been imported in former days. Dr. Dammerman regards Buru as the type locality also of the Babirussa, for although Linnaeus described the species as from Borneo, the older Dutch authors do not mention its presence there, and the Dutch name Boeroe for Buru may have led to confusion. It is curious that, in spite of the frequency with which skulls of this species may be found in museums, the skin of the beast itself is so rare. Even the museum at Buitenzorg has only an old and badly stuffed specimen from Celebes and a recent damaged skin from Buru. The unexpected and localised distribution of the species on the island and the fact that it has no native name suggests that at one time it may have been introduced from Celebes, for Quoy and Gaimard stated that in former times the rajahs there kept and bred the babirussa in order to make presents of it. The shortness of the skull and less straight profile of the Buru race may be, as in domestic pigs, indications of domestication.

A New Japanese Oyster.—Dr. Haruo Seki has discovered a new species of *Ostrea* from Japan which he has named *Ostrea futamiensis* ("Description of a New Species of Oyster from Japan", *Proc. Imp. Acad. Sci.*, Tokyo, vol. 5, No. 10, 1929). This oyster is to be found with *Ostrea denselamellosa*, and has hitherto been regarded as a dwarf form of that species. The new oyster, bearing the Japanese name of *Kurohimegaki*, has a much larger egg than *O. denselamellosa*, although the shell in the adult is much smaller. The spat is either uniformly black or striped with yellow. The developmental stages take place within the mantle cavity until the free-swimming straight-hinge larval stage is reached, the larvæ when freed being found near the shore in the deeper water layers. So far as has been observed, each individual spawns twice or thrice at intervals of from ten to twenty days during the spawning season, which lasts from the middle of June to the end of September.

Taxonomy of Bryophyta.—In "Honduran Mosses collected by Paul C. Standley" (Field Museum of Natural History, Chicago; Pub. 267 Bot. Series, vol. 4, No. 9, 1929), Edwin B. Bartram describes 178 mosses, representing 79 species and including four new to science, *Campylopus hondurensis*, *Bryum Standleyi*, *Bryum bursiforme*, and *Rhynchostegium patulum*, which are figured and described. The data are too meagre for a discussion of geographic distribution, but Mr. Bartram considers the evidence points to affinity with Mexico and the Antilles rather than with the types of Costa Rica and Panama. It is suggested that *Isopterygium scalpellifolium* (C.M.) Broth. should be restored to *Microthamnium*.

Hybridism in the Forests of New Zealand.—In no country is the knowledge of hybridism in the native flora so advanced or the recognition of its all-important bearing upon floristic and ecological botany so fully appreciated as in New Zealand, where Dr. Cockayne's researches have done so much towards a proper understanding of its taxonomic significance. In a recent paper (*Acta Forestalia Fennica*, 34, 1929), he gives details concerning the forest and semi-forest hybrids, more than a hundred groups of which have been recognised. Cogent reasons are advanced for accepting the hybrids as valid, and in several cases hybrids have been synthesised which match those occurring in the field. With one exception, so far as is known, all the hybrids are fertile, and the constant crossing and segregation which takes place results in the hybrid groups all occurring as big polymorphic swarms of individuals which have previously been either aggregated into so-called 'variable' species, or segregated into inconstant varieties. The rôle of the hybrids in the forest is discussed with reference to the number and relative abundance in the community of the hybrid groups and the life-forms of the hybrid individuals which are present.

Development of the Inflorescence in Cereals.—Very valuable data on this subject are provided by Yakichi Noguchi for Japanese cereals in a paper in the *Journal of the College of Agriculture*, University of Tokyo, 10, 247-303; 1929. Detailed measurements of the inflorescences at various stages are supplied, together with details of morphological development for six spring-sown and four winter-sown cereal types under Japanese conditions. A study of the rice plant's development under various conditions of cultivation shows that the developmental characteristics vary very little, which adds force to the general conclusion that spring and winter-sown types show very different types of development. In all the cereals the initials of the reproductive organs are already to be detected in the embryo in the mature grain. In the spring-sown types, a very slow growth of the panicle initial occurs for the first 40-50 days, and during this time the morphological changes in the growing point are negligible. Growth and differentiation then start suddenly and proceed very rapidly until the panicle emerges from the bud. In the winter-sown types, on the contrary, shortly after sowing, floral parts begin to differentiate in the panicle initial, although growth is slow for the first 120-150 days. Then rapid growth begins and proceeds for some 65 days longer, when the panicle emerges from the bud. No correlation was found between the vigour and period of vegetative development, and the processes of floral differentiation and development; on the other hand, a large grain showed correlation with a large embryo and a large embryo with the degree of differentiation of the floral rudiments within it. On the basis of a comparison of the growth and development of their floral organs, Noguchi would put rice, sorghum, panicum, and setaria into one group; wheat, rye, barley, and oats in another, with maize yet another distinct type. The data supplied in this paper are very full and valuable, and will well repay close study.

Salinity Investigations in the South African Seas.—Mr. Marchand has shown (*Fisheries and Marine Biological Survey*. Report No. 6. For the Year 1927–28. Special Report No. 4. Pp. 1-21) that water samples can be analysed within three months without any appreciable inaccuracy in the results, and confirms Dr. Gilchrist's statement that "the Mozambique Current, which has been subjected to the evaporation of the equatorial regions, contains a greater percentage of salt than the Antarctic waters" which is known as the Benguela Current on the west coast. This difference in salinity has not been observed to have a direct effect on life in South African seas, but the existence of waters of different temperature and salinity side by side forms an effective barrier to some animals.

Echo Sounding and Depths.—In an article on echo sounding in the *Hydrographic Review*, vol. 6, No. 2, Dr. H. Maurer raises a practical issue of much import-

ance. In order to calculate the true echo distance, obtained by a sonic sounder, the mean velocity of sound between the ship and the bottom must be known. The velocity varies with temperature, salinity, and pressure. Tables for conversion of echo distances to depths are issued by the Admiralty (H. D. 282), and comparisons made by the German vessel *Meteor* in recent work in the South Atlantic showed that the use of these tables gives fairly accurate results in cases where the depths was ascertained by both echo and wire. Yet out of 245 comparisons of depths of more than 2000 metres, 36 gave a difference exceeding 100 metres and the maximum difference was 650 metres. The echo gives, of course, the distance to the nearest point on the bottom, and not necessarily the vertical depth. Since depths are frequently important in finding position, Dr. Maurer suggests that the echo-distances should be entered on the chart. The crude echo distances, converted on a single constant velocity, are the most useful to the seaman and also for scientific purposes since it is then possible to convert them by the latest data available. Results of echo-sounding given in depths without any indication of the velocity on which the depths are based or of attempts to rectify oblique distances are practically useless and may be misleading.

A New Lamp.—The February issue of the *General Electric Review* contains a description of a new form of electric lamp, in which an arc and filament are operated together. The arc passes between terminals of tungsten in an atmosphere of mercury vapour and pure argon, and the filament, a V-shaped spiral of tungsten, is connected internally in the same bulb between the electrodes of the arc. In the lamp for which details are given, about two-thirds of the light emitted comes from the tungsten electrodes, and one-quarter from the arc, the remainder being presumably from the filament. The colour temperature of the light is greater than 3500° absolute. The tube passes a current of about 30 amperes at 11 volts, and is self-starting. Ultra-violet light of physiological value has been conserved by making the bulb of a special iron-free glass, which is partially transparent down to a wave-length of 2800 A.

The Charge of an Electron.—Prof. A. S. Eddington's derivation of the amended number 137 for the atomic constant $hc/2\pi e^2$ is given in a paper entitled: "The Interaction of Electric Charges" in the March number of the *Proceedings of the Royal Society*. As he indicated in his letter to NATURE on this problem (Nov. 30, 1929, p. 840), the mistake in his earlier theory (see NATURE, Jan. 26, p. 138, and Feb. 2, p. 174, 1929) consisted not so much in overlooking that degree of freedom of a pair of electrons which has no counterpart in the theory of a single electron—alteration of the proper distance between the two—as in not recognising its distinctness from the others. Whether or not the best *experimental* value of the constant is 137 is still perhaps an open question. In addition, by making definite assumptions as to the physical significance of certain transformations and results of quantum theory, Prof. Eddington has traced down the distinction between space and time to properties of matrices; the matrix theory predicts that one dimension of the world will be related to the other three by Lorentz transformations instead of by rotations. Still another tentative line of argument points to an origin of the loss of mass which occurs in such cases as the formation of the nuclei of atoms, in the loss of a degree of freedom when charges link up to form a *perfectly rigid* system. Prof. Eddington's aim in this paper has been to substitute a more satisfactory geometrical basis for the appeals to the analogies of classical dynamics which occurred in his earlier theory, but he expresses the opinion that finality has yet to be attained.

Iridescent Colours in Nature.—The discourse on iridescent colours given by Lord Rayleigh at the recent exhibition of the Physical and Optical Societies at the Imperial College of Science has been published in full—apart from the illustrations—in the February number of the *Journal of Scientific Instruments*. The objects dealt with were chiefly butterfly wings, beetles, and the eye of a peacock feather. That the colours of butterflies are partly due to absorption and partly due to interference is well established, but the origin of the colours of an iridescent beetle has been a matter of controversy. The facts presented by Lord Rayleigh seem to establish that they are due to interference in a laminated structure, and not to surface reflection, for quite apart from the variation of the colour with the angle at which the beetle is viewed, the characteristics of the banded spectrum of light transmitted by a specimen are those of an interference spectrum. All the observations mentioned by Lord Rayleigh are not yet completely explained, however; in particular, the bleaching of what are apparently interference colours by exposure to ultra-violet light, or even to sunlight, calls for further investigation, and especially the complicated behaviour of the peacock's feather, in which, under such treatment, certain zones have their reflecting power for red light *increased*.

Origin of Protoactinium.—The January number of the *Journal of the American Chemical Society* contains an important paper by J. E. Wildish on the separation of tantalum from different uranium ores, this element being the nearest homologue of protoactinium. The uranium and protoactinium contents of five uranium ores from widely separated localities were determined and the atom for atom relation between uranium and protoactinium computed in each case. The results show that the ratio in different ores is very different, and consequently lend support to the hypothesis that the actinium series originates from some other source than uranium-II.

Ignition of Hydrocarbons in Oxygen.—It is now generally recognised that paraffin hydrocarbons react readily with oxygen at comparatively low temperatures. In the January number of the *Journal of the Chemical Society*, J. S. Lewis describes some experiments in which mixtures of hydrocarbon vapour and oxygen were heated in glass bulbs until explosion occurred. It was found that in dilute mixtures explosion could not be produced, but extensive oxidation had occurred at about 235°, and the rate of heating was also important. The minimum percentage for ignition increased with the instability of the hydrocarbon towards oxygen. With rich mixtures the explosion was not so violent: the violence increased with reduction in hydrocarbon content until a maximum was reached when the ratio approaches that for complete combustion. A more rapid rate of heating tends to raise the ignition temperature, a result not found with olefines. In presence of powdered charcoal the ignition temperature of paraffin is raised, that of amylene considerably lowered. In presence of lead tetraethyl the ignition temperature was raised, sometimes as much as 40°. It is concluded that the explosion of hydrocarbons takes place in two stages: the explosion of the products of autoxidation (peroxides or chain reactions) followed by the combustion of the products in the excess of oxygen to oxides of carbon and water.

The Articulation of a Telephone Circuit.

THE best method of testing telephone circuits and apparatus is a problem to which a great deal of attention has been devoted of recent years. Speech is carried over a telephone circuit by means of certain frequency components produced by the voice of the speaker at the sending end and received by the listener at the receiving end. If the components arriving at the listener's ear are exactly the same as when they left the speaker's mouth, the circuit would have a hundred per cent efficiency. There are two principal reasons, however, why the components arriving at the listener's ear are not the same as those leaving the speaker's mouth. In passing along the circuit the amplitude of the waves is attenuated ; they thus become weaker. The amount of the attenuation also varies with the frequency, and hence the waves become distorted. Again, components which were not originally present are produced in the circuit. These are due either to noise or to the overloading of some part of the circuit. Their effect is to raise the threshold values at which the ear can hear different notes. In *Electrical Communication* for January, J. Collard gives a method by means of which the effect of given noises on the ' articulation ' of a telephone circuit can be computed much more quickly than by the ordinary methods.

In the usual method of testing, a series of syllables chosen at random are spoken into the telephone, the listener writing down what he imagines he hears. The ratio of the number of syllables correctly received to the total number of syllables sent gives an indication of the quality of the circuit. Unfortunately, the value thus obtained depends not only on attenuation and distortion, which are produced by the circuit, but also on faulty pronunciation by the speaker and faulty hearing by the listener. The value, therefore, varies with the speakers and the listeners ; a great number of tests have to be taken before we can tell what is the approximate mean value.

The author gives empirical formulæ by means of which the ideal sound articulation can be approximately computed. It is not affected by careless pronunciation by the speaker or inattentive hearing by the listener. Once a circuit has been set up, articulation tests can be made on it and the value of the articulation obtained, but there are many cases in which it is desired to know before installing a given circuit or before inserting a given piece of apparatus in the circuit what the articulation will be, and this can be found in a few minutes by the author's method.

It has been calculated that to obtain a value of the articulation with a probable error of one per cent, it is necessary to speak 5000 syllables into the circuit. If there are ten pieces of apparatus to be tested, this would mean that 50,000 syllables would have to be called. The usual rate of calling is 20 per minute. Taking into account also the time required for calibrating the experimenters, the total time will be about 50 hours. The saving effected, therefore, by using the new empirical formulæ is a substantial one. In a previous paper published in *Electrical Communication* for January of last year, the author showed that articulation has much the same value whether English, French, German, or Italian be used. It appears, therefore, that his method is applicable to other languages with little, if any, modification.

Whaling and Fishing in the North Atlantic.[1]

IN the autumn of 1923 the Norwegian Government appointed a whaling committee, under the chairmanship of Dr Johan Hjort, to carry out a scientific study of whaling and of the various factors in the sea which govern the life and migrations of whales. This committee at once approached the British Discovery Committee with a proposal that the two bodies should co-operate in this work. As a result of the negotiations which followed, it was agreed that, at any rate to begin with, the best arrangement would be for the *Discovery* to operate on the Antarctic whaling grounds, especially those worked from the Falkland Islands Dependencies, while the Norwegian investigators concentrated upon work in the North Atlantic.

In accordance with this agreement, a number of investigations have been carried out in northern seas during the years 1924–1928 under the administrative direction of the Norwegian whaling committee, the results of which have now been published in a very full report of some 550 pages. This report, although entitled " Whales and Plankton in the North Atlantic ", deals not only with the occurrence and distribution of whales and their food but also with the occurrence and habits of the various species of fish of economic importance.

The two great sea areas lying west of Greenland (Davis Strait) and to the eastward of it (Norwegian Sea) have been studied in detail. Reference is made at the outset to two cruises made by Jensen during the summers of 1908 and 1909 in the brig *Tjalfe*, when that indefatigable investigator prospected for fish along the entire western seaboard of Greenland, including fjords, inshore waters, banks, and deep sea —a vast tract extending from 60° N. to 71° N. Along this enormous distance the distribution and biology of all the more important edible fishes were investigated, and the fact established that the very limited fishery of this region is due not to the absence of marketable fish but to the primitive equipment of its fishermen and their difficulty in disposing of their catch. There is an abundance of good fish, including common cod, fjord cod, halibut, Greenland or black halibut, the long rough dab, and two species of catfish.

During the years 1924–28 fishing expeditions to Davis Strait, financed by Messrs. I. O. and O. S. Hellyer of Hull and led by Mr. Engvald Baldersheim of Bergen, have proved extraordinarily successful, and form striking examples of what can be done to solve the difficult problems of organisation involved in fishing in very distant seas. To this region Hjort proceeded in the research vessel *Michael Sars* in 1924 and there carried out exhaustive fishing and hydrographical investigations.

The course of modern whaling is traced from the time of its initiation by Svend Foyn in Finland about the year 1870 until the present day, when its operations extend to almost all the waters of the globe. In a section written by Andr. Ingebrigtsen, himself a practical whaler of more than thirty years' experience, it is shown that with few exceptions the commercial pursuit of the whale sooner or later reduced the stock so greatly that whaling had to be abandoned either temporarily or permanently as unremunerative. Convincing details of the growth and decline of many whale fisheries are given. From about the year 1880 onwards, a number of whaling stations were established along the coast of Finmark and the number of boats rapidly increased from four in 1880

[1] Whales and Plankton in the North Atlantic (a contribution to the work of the Whaling Committee and of the North-Eastern Area Committee). Conseil Permanent International pour l'Exploration de la Mer. *Rapports et Procès-Verbaux des Réunions*, Volume 56. Pp. 551. (Copenhague: Andr. Fred. Høst et Fils, 1929.) 21·50 Kr.

to thirty-four in 1885. The fatal result of this increase in the intensity of the fishery was soon apparent, for after about the year 1900 whaling at most of the Finmark stations ceased to pay and steadily declined. In 1905 most of the companies transferred their headquarters to Bear Island and Spitsbergen, but there too the industry was not of long duration. Too many boats destroyed the fishery, and by 1910 fishing in these waters was entirely abandoned. Subsequent attempts to revive the industry at Spitsbergen in 1920 and 1925–26 proved ruinous to the companies concerned.

Whale fishing off Iceland commenced about the year 1890 with eight whaling vessels. The catch at first was good and the number of boats increased to thirty in 1902. Thereafter there followed a steady decline in the catches. One station after another had to close, and Iceland whaling ceased altogether in 1915. The history of the whale fishing at the Faroes is in many ways similar to that of Finmark and Iceland. As the number of boats increased the catch per boat greatly decreased, and many stations ceased to operate. But during the War whaling stopped to a large extent. This proved good for the stock, and post-War catches off the Faroes, with fewer boats as compared with the number employed before the War, have yielded reasonable profits.

The same tale of rapid initial growth and subsequent decline is told of whaling in the Straits of Gibraltar, off South Africa, and on the west coast of America, and in a final sentence Ingebrigtsen states his firm conviction that the great modern extension of whaling in the Antarctic will undoubtedly, in spite of its vast tracts of ocean and apparently enormous numbers of whales, produce in the course of some years the same results as in all other waters—namely, a decreasing stock of whales from year to year. G. A. S.

University and Educational Intelligence.

CAMBRIDGE.—At King's College the following have been elected to Fellowships: Mr. A. E. Ingham, reader in mathematics at the University of Leeds; and Mr. R. F. Kahn, Wrenbury Scholar (1928) and Adam Smith prizeman (1929).

CARDIFF.—H.R.H. the Prince of Wales will visit Cardiff on May 21 to open the new chemistry and physics wing of the University College, and the Department of Public Health of the Welsh National School of Medicine.

Mr. H. J. Phelps has been appointed as assistant lecturer and demonstrator in physiology.

EDINBURGH.—On the recommendation of the Faculty of Medicine, the Cameron Prize for 1930 has been awarded to Dr. George R. Minot, physician-in-chief, Collis P. Huntingdon Memorial Hospital of Harvard, Boston, Mass., and Dr. William P. Murphy, assistant physician, Peter Bent Brigham Hospital, Boston, Mass., conjointly, for their work on the liver treatment of pernicious anæmia.

The Senatus has resolved to offer the honorary degree of doctor of laws to the following, among others: Sir Thomas Barlow, Physician-Extraordinary to H.M. the King; Sir Otto Beit, trustee of the Rhodes Trust and founder of the Beit Memorial Fellowships for Medical Research; Sir William Hardy, director of food investigation, Department of Scientific and Industrial Research; Sir David Wallace, consulting surgeon to the Royal Infirmary, Edinburgh; Prof. W. W. Watts, professor of geology, Imperial College of Science, South Kensington; Prof. K. F. Wenckebach, emeritus professor of medicine, University of Vienna.

Historic Natural Events.

Mar. 23, 1233. Thunderstorm and Floods.—There was a great and terrible tempest of thunder, and after followed a marvellous wet summer with many floods.

Mar. 23, 1913. Electrical Storm.—An usually severe electrical storm occurred in the western part of Kansas, U.S.A. High winds were blowing from south-west or west, and the air was warm, very dry, and filled with dust; there was no rain. Windmills, especially steel mills mounted on wooden supports, became so highly charged with static electricity that anyone touching them received a distinct, sometimes a severe shock. At Tribune, sparks two or three inches long were drawn from a wire running to a windmill. Telephone and telegraph wires and wire fences also became charged, and in Scott County, where the disturbance was most severe, a prairie fire is thought to have been started by sparks at a break in a wire fence, as in several places distinct sparks were noted on holding the broken ends of wire fences together. In Thomas County all green vegetation was killed, and in Sheridan County the wheat turned brown. The sky was obscured by a leaden or copper-coloured haze, and most people experienced nervous depression.

Mar. 24, 1878. *Eurydice* Squall.—A V-shaped trough of low pressure crossed England from north-west to south-east, and with its passage the wind changed from a moderate westerly breeze to a north-westerly gale. The wind velocity was not especially great, but there were some violent north-westerly squalls with sleet or snow, during one of which the training ship H.M.S. *Eurydice* foundered with all hands off Dunnose Head, near Ventnor. The loss of life was about 300.

Mar. 24, 1895. Gale.—This was described as the worst gale of the nineteenth century in the English Midlands. At 8 A.M., a well-marked depression was centred over the Shetland Isles, and during the afternoon a small but intense secondary depression traversed England and Wales with a velocity of 58 miles per hour. The greatest destruction was caused by a south-westerly gale along a narrow belt (only 30-50 miles in width) to the right or south-east of the track followed by the centre of the secondary. Very great damage was done to property, many churches were injured and thousands of trees uprooted, and several lives were lost. In the observatory at Birmingham the oscillation of the building stopped the clock.

Mar. 25, 1241. Drought.—It is recorded in Matthew Paris's Chronicle that "From the Annuciation to SS. Simon and Jude (Mar. 25–Oct. 28), continued drought and intolerable heat dried up deep lakes and extensive marshes, drained many rivers, parched up the warrens, and suspended the working of mills; hence the pastures withered away, herbage died, and consequently the flocks and herds pined away with hunger and died".

Mar. 26, 1812. Earthquake in Venezuela.—The town of Caracas was utterly ruined by an earthquake felt throughout Venezuela and as far as Carthagena (600 miles). The shock occurred shortly after 4 P.M. As it was Ascension Day, large crowds had collected in the churches before the processions through the streets began, and three or four thousand persons were killed by the fall of the roofs. Throughout Venezuela, more than 20,000 persons perished. On April 24, the first eruption of the Soufrière of St. Vincent since 1718 began. The noise from it was heard at Caracas (nearly 400 miles).

Mar. 27, 1606. Great Storm in Belgium.—At 8 A.M. began a great tempest of wind which continued

until 2 or 3 P.M., and especially from 9 A.M. to 1 P.M., during which time the great force of the storm threw down chimneys and very great trees, and unroofed almost all the churches and a great part of the houses. It blew with such fury that one expected every minute to perish, and it surpassed the storm of Mar. 27, 1524.

Mar. 28, 1916. Gale and Snowstorm in England.—Great numbers of elm trees in the southern and midland counties were uprooted, railway traffic was dislocated in the midlands on the Midland, L.N.W.R., and G.W.R. lines in consequence of snowdrifts and wrecked telegraph wires. The snowfall was general throughout England and Wales, and greatest in the hill districts, where many villages were isolated, and farms and sheep buried beneath gigantic drifts, in some cases 40 feet deep. In the Black Mountains the snow was 10 feet deep.

Societies and Academies.

LONDON.

Royal Society, Mar. 13.—**V. B. Wigglesworth**: A theory of tracheal respiration in insects. The theory provides for the increased demands for oxygen which arise locally in active tissues. If it be assumed that the terminal portions of the tracheal tubes are bounded by a semi-permeable membrane, then liquid will be drawn up the tubes by capillarity until further progress is checked by osmotic pressure of the tissue fluids. During activity lactic acid will be produced, osmotic pressure will rise, liquid will be absorbed, and air will extend down the tubes towards the active tissues. The theory is supported by experiments on mosquito larvæ (see NATURE, Dec. 28, 1929, p. 986). Some observations are recorded on the effects of certain poisonous gases and of oil on the tracheal system.—**H. Raistrick** and others: Studies in the biochemistry of the lower fungi. A résumé of the main results of investigations presented in eighteen papers communicated to the Society.

Geological Society, Feb. 5.—**E. J. Garwood**: The Tuedian Beds of northern Cumberland and Roxburghshire east of the Liddelwater. The series consists of sandstones, mudstones, shales, and impure limestones laid down mainly under lagoon conditions. An interesting feature is the important algal development in the middle of the series. The beds are intermediate in character between the freshwater facies of the Tweed district and the more marine facies of Westmorland. The succession is described under three districts: Northern Cumberland (Bewcastle district), Roxburghshire (Newcastleton district), Western Northumberland (Rothbury). In northern Cumberland the structure is that of a denuded anticline having a general north-north-easterly trend. This area may be divided into two districts separated by the 'central' fault. The Bewcastle district in the east is taken as the type, and the succession has been determined there. The algal episode enters first in the Bewcastle Beds; but the conditions were unfavourable, and it is not until the Main Algal Series is reached that algal growths become important as rockbuilders. In Roxburghshire east of the Liddelwater, the algal series is again well developed. In Northumberland, the chief feature of interest is the rich development of *Mitcheldeania* and *Ortonella* near the summit of the Cementstone Group, the latter genus being especially characteristic of the highest two limestones in the neighbourhood of Rothbury.—**Sir Douglas Mawson** and **C. T. Madigan**: Pre-Ordovician Rocks of the McDonnell Ranges (Central Australia). This paper concerns the age and stratigraphical relations of a great series of quartzites, slates, and limestones forming the southern front of the McDonnell Ranges. These beds, dipping at a steep angle off the older Pre-Cambrian basement (Arunta Complex) of the Ranges, extend in an east-and-west direction with wonderful regularity for a length of at least 150 miles. This great series of rocks lies stratigraphically between the undoubted Ordovician rocks (Larapintine formation) and the Arunta Pre-Cambrian Complex. They form a Pre-Ordovician series, upon which rests unconformably the Larapintine Formation with its basal members formed of conglomerates and breccias. Horizons rich in Cryptozoa and *Girvanella*-like algal growths characterise the series.

Institute of Metals, Mar. 12 (Annual Meeting).—**T. A. Rickard**: The early use of the metals. The industrial history of mankind is divisible into two major epochs—a stone age and a metal age. The melting of copper probably preceded its extraction from minerals by some centuries, and the production of bronze or hardened copper was a later stage in metal culture. The critical event in the industrial history of man was the first melting of metal out of stone, and this appears to have occurred about 3500 B.C. Metal articles fashioned at earlier periods were made from native gold, silver, or copper, or from meteoric iron.—**D. Stockdale**: The composition of eutectics. A very sensitive apparatus for the taking of cooling curves is described, and a new method for the determination of the liquids from such curves is given. The eutectic systems examined were as follows: aluminium-copper, antimony-silver, cadmium-tin, cadmium-zinc, copper-silver, and lead-tin.—**N. P. Allen**: Experiments on the influence of gases on the soundness of copper ingots. The unsoundness in commercial ingots is not due to hydrogen alone, but to hydrogen and cuprous oxide together, which react in the solidifying metal to evolve steam. Those elements which, when added to copper, endow it with the ability to cast soundly, do so by reducing the cuprous oxide present. Carbon monoxide, carbon dioxide, and nitrogen are inert, so far as the formation of blowholes is concerned.—**W. E. Prytherch**: Gases in copper and their removal. Experiments on the effect of oxygen, hydrogen, and sulphur dioxide on the soundness of copper. Dissolved gases may be partially removed by: (1) Slow solidification followed by remelting of the copper; (2) passing an inert gas, such as nitrogen, into the molten metal; (3) melting *in vacuo*. Experiments to determine whether oxygen would remove hydrogen showed that the rate of oxidation was so slow as to make the method unpractical.—**E. J. Daniels**: Unsoundness in bronze castings. The effects of some pure gases on the soundness of bronze, and of casting in sand moulds of metal subjected to various melting treatments, are described. Nitrogen, carbon dioxide, and carbon monoxide are neutral towards bronze. Hydrogen is capable, at certain rates of solidification, of causing unsoundness which can be suppressed by treatment with neutral gases. Improvement in density of sand-castings can be obtained by melting in a pot-furnace with a thin fuel bed and good draught. Degasification with nitrogen, deoxidisers, and pre-solidification gave negative results so far as improvement in density is concerned, but pre-solidification appears to increase the strength.—**R. Genders**: Macrostructure of cast alloys. Effect of turbulence due to gases. When an alloy is cast in a mould prepared by a coating of volatile material, the macrostructure of the resulting ingot may be considerably modified by the turbulence resulting from the evolution of gases by the mould coating.

DUBLIN.

Royal Irish Academy, Feb. 24. — Joseph Algar and Mary Boylan: Azo dyes derived from diacetoresorcinol. The preparation of some azo derivatives of diacetoresorcinol and of dichalkones is described. Diazonium salts couple readily with diacetoresorcinol in alkaline solution forming compounds with tinctorial properties. The latter condense with aromatic aldehydes under the influence of alcoholic hydrochloric acid or piperidine with the production of dichalkones containing an azo group, for example, phenyl-azo-dianisylidene-diacetoresorcinol. All the compounds described function as dyestuffs and give yellow to brown shades on mordanted wool.—Joseph Algar and A. V. Flaegel: The action of Grignard reagents on phthalide. By the carefully regulated addition of *o*-methoxyphenyl magnesium bromide to phthalide and decomposition of the resulting addition compound, the substance produced is α-hydroxy-α (2-methoxyphenyl)-β, β'-benzo-α, α'-dihydrofurane (I.), a compound which very readily loses water with the production of complex dehydration products. Reduction of I. with sodium amalgam gives 2-methylol-2′-methoxy-diphenyl-carbinol (II.). The addition of phthalide to an excess of the above Grignard reagent gives 2-methylol-2′, 2″-dimethoxy-triphenyl-carbinol (III.). Dehydration of III. with hydrochloric acid gas gives α-di-(*o*-methoxyphenyl)-β, β'-benzo-α, α'-dihydrofurane (IV.). The latter, in benzene solution, exhibits a beautiful blue fluorescence.

PARIS.

Academy of Sciences, Feb. 10.—Serge Bernstein: The limitation of derivatives of polynomials.—Louis Roy: The propagation of waves on elastic surfaces with six parameters.—Bertrand Gambier: Configurations.—Paul Delens: The representations of circles.—N. Lusin: The problem of J. Hadamard on the uniformisation of ensembles.—L. Kantorovitch and E. Livenson: The δs-functions of Hausdorff.—Henri Cartan: Functions of two complex variables and the encircled domains of Carathéodory.—Miloch Radoïtchitch: The fundamental domains of meromorph functions.—Lucien Féraud: The extension to the case of any number of degrees of freedom of a property relative to Pfaffian systems.—N. Cetajev: The reciprocal of Lagrange's theorem.—Jean Courrègelongue: The formation of eddying movements behind immersed solids.—G. Mouret: The conditions of passage through a section of a permanent current (of fluid), open, uniform, or gradually varied.—Henri Mineur: The movement of the double stars under the action of the field of gravitation of the galaxy.—G. Ribaud: The calculation of the temperature of flames and their proportion of atomic hydrogen. A calculation of the influence of the dissociation of hydrogen into atomic hydrogen on the temperature of flame. The cases of hydrogen and oxygen and acetylene and oxygen are considered.—E. Darmois: The action of boric acid and borates on the rotatory power of tartaric acid. Boric acid has no action on ethyl tartrate, but borax at 40° C. has a clear action. The author agrees with the views of Lowry as to the constitution of these complex compounds.—Mlle. Stéphanie Maracineanu: Remarks on a note by MM. Fabry and Dureuil entitled: "On a supposed transformation of lead". Reply to criticism, maintaining the accuracy of the original results.—G. Reboul: A method of activation of matter. The activation of metals described in an earlier note by treatment with high voltages has been proved by further experiments to be independent of the nature of the metal and of the conditions of working, and the origin of the activity appears to be in the air.—A. Astruc, M. Mousseron, and Mlle. N. Bouissou: A new method for the micro-estimation of the calcium ion. The method, which is applicable for the determination of quantities of calcium between 0·1 mgm. and 1·5 mgm., is based on the precipitation of the metal as the tungstate, reduction of the latter by titanous chloride, followed by comparison of the colour produced with a known standard.—Lespieau and Bourguel: A new ethylenic erythrite. The new erythrite is

$CH_2(OH) . CH(OH) . CH = CH . CH(OH) . CH_2(OH)$

and is obtained by the reduction of the corresponding acetylene compound with hydrogen in the presence of colloidal palladium.—Louis Glangeaud: The age of the strata containing Orbitolines at the north of the province of Algiers.—Henri Termier: The vertical extension of the genus *Spiriferina* in Morocco. From the evidence adduced it is concluded that this genus persisted in Morocco for a much longer period than in the north-east of Europe.—Raymond Furon: The presence of copper in the French western Sudan.—Guilliermond: The formation of zoosporangia and the germination of the spores in *Saprolegnia*, in cultures on nutritive media containing neutral red. Neutral red is a colouring matter which is almost non-toxic and is of great value for the study of vacuoles.—M. Bridel and C. Charaux: Oroboside, a new glucoside hydrolysed by emulsin, extracted from *Orobus tuberosus*, and its products of hydrolysis, glucose and orobol. The products of the hydrolysis of oroboside by emulsin are glucose and a substance, orobol, described in detail. It appears to be a tetrahydroxyflavone: further work is in progress with the view of determining its exact constitution.—H. Lagatu and L. Maume: Observation, by leaf diagnosis, of the phenomenon of mutual physiological replacement of two bases, lime and gotash.—Lenglen and Durier: Appreciation of the value of powdered limestones used in agriculture. The solubility of a limestone in a solution of carbon dioxide in water under fixed conditions depends largely on its physical structure as well as on its state of division. The correlation between carbonic acid solubility and neutralising action on the soil has been proved.—Charles Pérez: Visceral asymmetry and dimorphism of the spermatophores in some pagurians.—Mlle. Simone Mouchet: The comparative morphology of the excretory canals of some pagurians.—P. Portier and Mlle. de Rorthays: The mode of flight of insects and the wing load per unit of surface. There is a striking concordance between the modes of flight of various insects and their anatomo-physiological characteristics.—H. Simonnet and G. Tanret: The toxicity for laboratory animals of large doses of irradiated ergosterol. The toxic action of irradiated ergosterol on rabbits was found to be associated with a calcification of the arterial system, but the venous system and the pulmonary artery remained free from calcification. Owing to the varying toxic action on different animals, no conclusion can be drawn as to the action on human beings.—F. Labrousse and Mlle. S. Philippon: Phenomena of oxido-reduction observed in the course of the development of some fungi.—H. Bierry: Proteid sugar and mannose in mammals.

CRACOW.

Polish Academy of Science and Letters, Dec. 2.—K. Kordylewski: The variable stars Orionis 47.1929 and 49.1929.—Mlle. H. Grünbaum: New resonance of selenium.—P. Swings: The structure of the groups of resonance lines of sulphur vapour.—L. Marchlewski and A. Boryniec: The absorption of ultra-violet radiations by the methoxybenzoic acids. The absorption in the ultra-violet by *p*-methoxybenzoic acid

is much more intense (about six times) than that given by the meta isomer.—K. Dziewonski, J. Auerbach, and J. Moszew: 1,8-Benzyl-benzoyl-naphthalene and some of its derivatives.—M. Thomaschewski: The pollen analysis of the peat bogs of Sztengwald and of Zaskoczyn (Free Town of Dantzig). The results obtained are analogous with those found for southern Sweden.—S. Skowron: Researches on spermatogenesis *in vitro*.—A. Wierzejski: The freshwater sponges.—T. Marchlewski: Genetic researches on the domestic dog.

Official Publications Received.

BRITISH.

Empire Cotton Growing Corporation. Reports received from Experment Stations, 1928–1929. Pp. xi+268. (London.) 2*s*. 6*d*.

Home Office. Welfare Pamphlet No. 7: Lighting in Factories and Workshops. Third edition. Pp. 25. (London: H.M. Stationery Office.) 4*d*. net.

The Scientific Proceedings of the Royal Dublin Society. Vol. 19 (N.S.), No. 29: Studies on Peat. Part 3: Low Temperature Carbonization of Peat. By James T. Donnelly and Joseph Reilly. Pp. 365-376. 1*s*. Vol. 19 (N.S.), No. 30: The Nitration of substituted Phenylbenzylamine Derivatives. By J. Reilly, T. V. Creedon and P. J. Drumm. Pp. 377-379. 6*d*. Vol. 19 (N.S.), No. 31: A Study of Two New Species of Bacteria belonging to the Genus Chromobacterium. By Dr. M. Grimes. Pp. 381-384. 6*d*. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

City and County of Bristol: The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee for the Year ending 30th September 1929. Pp. 24+4 plates. (Bristol.)

National Joint Industrial Council for the Flour-Milling Industry. Technical Education Series, Pamphlet No. 5: Pests in Wheat and its Products. By Sebert Humphries. Pp. 36. (London.) 6*d*. net.

The Imperial College of Tropical Agriculture. Prospectus for 1930–31, also Principal's Report for 1928–29 and Register. Pp. 47+3 plates. (St. Augustine, Trinidad; London.)

The Carnegie Trust for the Universities of Scotland. Twenty-eighth Annual Report (for the Year 1928–29) submitted by the Executive Committee to the Trustees on 12th February 1930. Pp. iv+78. (Dunfermline.)

John Murray, 50 Albemarle Street, 1768–1930. Pp. 14. (London.)

Journal of the Indian Institute of Science. Vol. 12A, Part 17: i. Contributions to the Study of Spike-Disease of Sandal (*Santalum album*, Linn.). Part 7: Factors influencing Diastatic Activity, by B. N. Sastri and M. Sreenivasaya; ii. Part 8: Chemical Composition of Tissue Fluids from the Leaf, by M. Sreenivasaya and B. N. Sastri; iii. Part 9: Chemical Composition of Tissue Fluids from the Stem, by M. Sreenivasaya and B. N. Sastri; iv. Note on the Starch-Liquefying Action of Sandal Leaf Extracts, by B. N. Sastri. Pp. 233-252. 1.4 rupees. Vol. 12A, Part 18: Studies on Soil *Actinomyces*. Part 3: Standardisation of a Plate Method of counting Soil *Actinomyces*. By M. Ganesho Rao and V. Subrahmanyan. Pp. 253-273. 1.4 rupees. Vol. 12A, Part 19: i. Biological Oxidation of Sulphur. Part 2: Effect on the Microflora of Activated Sludge. By C. V. Ramaswami Ayyar and Roland V. Norris. Pp. 275-294. 1.4 rupees. Vol. 12A, Part 20: Contributions to the Study of Spike-Disease of Sandal (*Santalum album*, Linn.). Part 10: Seasonal Studies on Healthy and partially Spiked Trees. By A. V. Varadaraja Iyengar. Pp. 295-305. 12 annas. (Bangalore.)

Melbourne Astrographic Catalogue, 1900·0. Vol. 3: Zones −69° and −70°. Rectangular Co-ordinates and Diameters of Star Images, from Photographs taken and measured under the direction of R. L. J. Ellery and Pietro Baracchi. Revised and prepared for publication under the supervision of Dr. J. M. Baldwin. Pp. xi+254. (Melbourne: H. J. Green.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 68, No. 398, February. Pp. 205-316+xxxvi. (London: E. and F. N. Spon, Ltd.) 10*s*. 6*d*.

The Indian Forest Records. Vol. 14, Part 4: Immature Stages of Indian Coleoptera (6). By J. C. M. Gardner. Pp. 30+6 plates. (Calcutta: Government of India Central Publication Branch.) 1.2 rupees; 2*s*.

Journal of the Society of Glass Technology. Edited by Prof. W. E. S. Turner. Vol. 13, No. 52, December 1929. Pp. xii+79·430+x+xxviii. (Sheffield.) 10*s*. 6*d*.

Far Eastern Association of Tropical Medicine. Transactions of the Seventh Congress held in British India, December 1927. Edited by Lieut.-Col. J. Cunningham. Vol. 3. Pp. xv+761+38 plates. (Calcutta: Thacker's Press and Directories, Ltd.)

FOREIGN.

U.S. Department of Agriculture. Technical Bulletin No. 170: A Pipette Method of Mechanical Analysis of Soils based on Improved Dispersion Procedure. By L. B. Olmstead, Lyle T. Alexander and H. E. Middleton. Pp. 23. (Washington, D.C.: Government Printing Office.) 5 cents.

Smithsonian Miscellaneous Collections. Vol. 82, No. 2: The Thoracic Mechanism of a Grasshopper, and its Antecedents. By R. E. Snodgrass. (Publication 3027.) Pp. 111. (Washington, D.C.: Smithsonian Institution.)

Field Museum of Natural History. Geology Leaflet 11: Neanderthal (Mousterian) Man. By Oliver C. Farrington and Henry Field. Pp. 14+9 plates. 25 cents. Geology Leaflet 12: Cement. By Henry W. Nichols. Pp. 15+4 plates. 25 cents. Anthropology Leaflet 28: The Field Museum-Oxford University Expedition to Kish, Mesopotamia, 1923–1929. By Henry Field. Pp. 34+14 plates. 50 cents. (Chicago.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procès-verbaux des réunions. Vol. 64: Current Measurements, Direct and Indirect; Reports of the Proceedings of a Special Meeting held on April 13th, 1929, in London. Pp. 77. 3.75 kr. Vol. 65: Fluctuations in the Abundance of the various Year-Classes of Food Fishes; Reports of the Proceedings of a Special Meeting held on April 12th, 1929, in London. Pp. 188. 7.25 kr. (Copenhague: Andr. Fred. Høst et fils.)

Agricultural Experiment Station, Michigan State College of Agriculture and Applied Science. Circular Bulletin No. 127: Pruning Young Fruit Trees. By Roy E. Marshall, H. A. Cardinell and H. D. Hootman. Pp. 32. Circular Bulletin No. 128: Undulant Fever in Man and Abortion Disease in Cattle; some Facts that the Consumer and Producer of Milk and the Breeder of Cattle should Know. By E. T. Hallman and E. L. Anthony. Pp. 4. (East Lansing, Mich.)

Scientific Papers of the Institute of Physical and Chemical Research. No. 220: Researches on the Cutting Force. Report 1: New Designs of Tool Dynamometer. By Makoto Ōkoshi. Pp. 167-192. Tōkyō: Iwanami Shoten.) 40 sen.

Field Museum of Natural History. Publication 258: i. Supplement to the Flora of Barro Colorado Island, Panama, by Leslie A. Kenoyer and Paul C. Standley; ii. Two new Species of Chara from Tropical America, by M. A. Howe. (Botanical Series, Vol. 4, No. 6.) Pp. 141-161+plates 11-16. Publication 259: Spermatophytes, mostly Peruvian. By J. Francis Macbride. (Botanical Series, Vol. 4, No. 7.) Pp. 163-193. Publication 260: The Mineral Composition of some Sands from Quebec, Labrador and Greenland. By James H. C. Martens. (Results of the Rawson-Macmillan Sub-Arctic Expedition of 1926.) (Geological Series, Vol. 5, No. 2.) Pp. 15-31+plates 7-9. Publication 261: A New Rodent from the Galapagos Islands. By Wilfred H. Osgood. (Zoological Series, Vol. 17, No. 2.) Pp. 19-24. Publication 262: Contents and Index to Volume 12, Numbers 1 to 19. (Zoological Series, Vol. 12, No. 19.) Pp. ix+503-526. Publication 263: Birds of the James Simpson-Roosevelts Asiatic Expedition. By Charles E. Hellmayr. (Zoological Series, Vol. 17, No. 3.) Pp. 25-144. Publication 264: Studies of American Plants–I, by Paul C. Standley; Studies of American Plants–II, by Paul C. Standley. (Botanical Series, Vol. 4, No. 8.) Pp. 195-345. Publication 265: The Land Mammals of Uruguay. By Colin Campbell Sanborn. (Zoological Series, Vol. 17, No. 4.) Pp. 145-165. Publication 266: Catalogue of Birds of the Americas and the Adjacent Islands in Field Museum of Natural History, including all Species and Subspecies known to occur in Northern America, Mexico, Central America, South America, the West Indies and Islands of the Caribbean Sea, the Galapagos Archipelago and other Islands which may be included on account of their Faunal Affinities. By Charles E. Hellmayr. Part 6: Oxyruncidae, Pipridae, Cotingidae, Rupicolidae, Phytotomidae. (Zoological Series, Vol. 13.) Pp. v+258. Publication 267: Honduran Mosses collected by Paul C. Standley. By Edwin B. Bartram. (Botanical Series, Vol. 4, No. 9.) Pp. 347-364+plates 17-19. (Chicago.)

Smithsonian Miscellaneous Collections. Vol. 82, No. 4: The Characters of the Genus *Ge capromys* Chapman. By Gerrit S. Miller, Jr. (Publication 3029.) Pp. 3+1 plate. Vol. 82, No. 5: Mammals eaten by Indians, Owls and Spaniards in the Coast Region of the Dominican Republic. By Gerrit S. Miller, Jr. (Publication 3030.) Pp. 16+2 plates. (Washington, D.C.: Smithsonian Institution.)

CATALOGUES.

A Catalogue of Miscellaneous Books. (No. 449.) Pp. 40. (Cambridge: Bowes and Bowes.)

S.U.P. 36 in the Treatment of Influenza. Pp. 8. (London: The British Drug Houses, Ltd.)

Diary of Societies.

FRIDAY, MARCH 21.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botany Lecture Room, Imperial College of Science and Technology), at 2.30.—The Nutrition of Fruit Trees:—T. Wallace: Some Effects of Deficiencies of Essential Elements on Fruit Trees.—R. G. Hatton: Response of Apple Trees on known Rootstocks to Applications of a Complete Fertiliser.—N. H. Grubb: The Reaction to Potash Fertilisers of Apple Trees in the Field.—Dr. T. Swarbrick: Some Observations upon the Growth and Seasonal Cycle of Food Reserves in Apple Trees.

DIESEL ENGINE USERS' ASSOCIATION (at Caxton Hall), at 3.30.—H. R. Ricardo: The High-Speed Diesel Engine.

IMPERIAL COLLEGE CHEMICAL SOCIETY (at Royal College of Science), at 5.—Prof. I. M. Heilbron: The Fat Soluble Vitamins A and D (Lecture).

LONDON SOCIETY (at Royal Society of Arts), at 5.—Dr. R. Unwin: The Decentralisation of Industry.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.—Dr. C. W. Buckley and others: Discussion on The Influence of Sunlight and other Climatic Factors in Health and Rheumatic Diseases.

BRITISH INSTITUTE OF RADIOLOGY (Medical Section), at 5.—Discussion on Radiology in Chest Diseases.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Frank Colyer: Demonstration of Specimens illustrating Dento-alveolar Abscess and Dental Cyst.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—W. Nithsdale: The Design and Results of a 600 lb. per sq. in. Boiler Installation.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Mining Institute, Newcastle-upon-Tyne), at 6.—Sir Westcott Abell: Direct Flooding Calculations.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—Annual General Meeting.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at St. Thomas' Café, Swansea), at 7.—Annual General Meeting.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section) (at 36 George Street, Manchester), at 7.—A. J. Hall: The Effect of Swelling Agents on the Creasing of Artificial Silks.—J. R. Hannay: The Preparation of Artificial Silk and Cotton Unions for Printing.—Eva Hibbert: On the Action of Certain Acids on Cellulose.—J. H. Preston: The Mounting of Textile Fibre Sections.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section) (Informal Meeting), at 7.—A. J. Gibbons and others: To Meter or not to Meter.—W. Lawson and others: Whether or not Meters should be Stamped and Sealed.—E. Fawssett and others: The Use of 1-amp. Secondaries in Current Transformers as against 5-amp. Secondaries.—C. B. Green and others: Whether or not Prepayment Meters should be Earthed.—G. F. Shotter and others: Formula for the Merit-factor of a Meter.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group—Informal Meeting), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Students' Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.15.—J. Bennett and O. A. Chrisp: A Survey of Switch and Control Arrangements with Examples of Modern Practice.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—M. V. Hurst: Surface Combustion.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Dr. J. E. Hughes: A Case of Hydatidiform Mole with Multiple Syncytial Infarction of the Lungs.—Dr. A. E. Gyles: The Influence of Hysteropexy on Subsequent Pregnancy, and of Pregnancy on a Previous Hysteropexy.—Prof. W. F. Shaw: The Treatment of Prolapsus Uteri.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. J. M. W. Morison: Diaphragmatic Hernia.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Seton Gordon: Sea Birds and Seals.

PAPER MAKERS' ASSOCIATION (Technical Section, Northern Division) (at Engineers' Club, Manchester).—N. L. Matthews: The Application of Dyestuffs to Paper.

SATURDAY, MARCH 22.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District) (jointly with North-Western District) (at Town Hall, Halifax), at 2.45.—F. Marsden: Borough and County Borough Extensions in the Light of the Local Government Act, 1929.

MATHEMATICAL ASSOCIATION (London Branch) (at Bedford College), at 3.—C. L. Beaven and others: Discussion: Are we satisfied with the Present Syllabus in Mathematics for the General School Certificate?

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Nuclei and their Structure.

MONDAY, MARCH 24.

KING'S COLLEGE ENGINEERING SOCIETY (Anniversary Meeting), at 5.30.—Brig.-Genl. M. Mowat: A Brief Review of Mechanical Engineering Progress in the Past Thirty-four Years.

BRITISH PSYCHOLOGICAL SOCIETY (Joint Meeting of Industrial and Education Sections) (at National Institute of Industrial Psychology), at 6.—The Relation of Raising the School Leaving Age to Problems of Vocational Guidance and Selection:—Miss Sheila Bevington: (from point of view of Vocational Guidance); T. Tibbey: (from point of view of Education).

SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (Annual General Meeting) (at Great Northern Station Hotel, Leeds), at 7.—Dr. N. K. Adam and others: Discussion on The Fundamentals of Lubrication.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—H. A. Humphrey, D. M. Buist, and J. W. Bansall: The Imperial Chemical Industries Limited's Steam and Electric Power Plant at Billingham.

ROYAL SOCIETY OF ARTS, at 8.—Comdr. F. G. Cooper: Aids to Navigation (Cantor Lecture) (1).

MEDICAL SOCIETY OF LONDON, at 8.—Sir Thomas Horder, K. Walker, and others: Discussion on Coliform Infections of the Genito-uninary Tract.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Sir William Willcox: Dental Sepsis—a Retrospect.—F. Coleman: Buried Mandibular Teeth with Crowns in Occlusion

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Dr. E. Trinkler: Exploration in the Karakoram and Kun-lun.

TUESDAY, MARCH 25.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Meeting), at 4.30.—O. J. R. Howarth: The Work of the British Association in Relation to the Empire.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. F. Coombs: Syphilis of the Heart and Great Vessels (Lumleian Lectures) (2).

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.—Prof. E. Leschke, Dr. J. Parkinson, Dr. J. Cowan, Dr. T. F. Cotton, and others: Discussion on Syphilitic Aortitis.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. C. Singer: The Passage from Mediæval to Modern Science (3): On the Inductive Philosophy and some of its Instruments.

INSTITUTION OF CIVIL ENGINEERS, at 6.—D. Anderson: Tyne Bridge, Newcastle.—G. L. Groves: The New Wearmouth Bridge, Sunderland.

BRITISH PSYCHOLOGICAL SOCIETY (Industrial Section) (jointly with Education Section), at 6.—Discussion on Vocational Guidance and Selection in Relation to the Raising of the School-leaving Age, with papers dealing with the question from the point of view of: (*a*) Education; (*b*) Vocational Guidance and Selection; (*c*) Industry.

ROYAL AERONAUTICAL SOCIETY (at 7 Albemarle Street), at 6.30.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Loughborough College), at 6.45.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—H. A. Humphrey, D. M. Buist, and J. W. Bansall: The Imperial Chemical Industries Limited's Steam and Electric Power Plant at Billingham.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—W. Clark: The Characteristics of Sound Recording Emulsions.—W. Clough: The Pantone Process of Reproduction.

ILLUMINATING ENGINEERING SOCIETY (at Home Office Industrial Museum, Horseferry Road, S.W.1), at 7.—S. Anderson: Textile Lighting.

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7.30.—F. W. Rowe: Common Defects in Steel for Gear Manufacture.

WEDNESDAY, MARCH 26.

CHEMICAL SOCIETY (at Salters' Hall, E.C.), at 5.30.—Prof. G. von Hevesy: The Chemistry and Geochemistry of the Titanium Group (Hugo Muller Lecture).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—W. Campbell Smith: A Classification of some Rhyolites, Trachytes, and Phonolites from Part of Kenya Colony, with a Note on some Associated Basaltic Rocks.—Dr. T. N. George: *Ambocœlia* Hall and certain similar British Spiriferidæ.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at 17 Fleet Street), at 5.30.—A. Titley: Winding Engines of Richard Trevithick.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.30.—P. J. Pollock: Nomography as Applied to Engineering.

INSTITUTION OF AUTOMOBILE ENGINEERS (Manchester Centre) (at Engineers' Club, Manchester), at 7.—Capt. J. S. Irving: Problems Encountered in the Design of the *Golden Arrow*.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—E. G. Lowes: The Development of Auxiliary Machinery as applied to Ships.

HALIFAX TEXTILE SOCIETY (at Halifax), at 7.30.—Discussion on Education.

ROYAL SOCIETY OF ARTS, at 8.—H. Robertson: Architecture of To-day and To-morrow.

EUGENICS SOCIETY (at Royal Society), at 8.30.—Dr. J. A. Ryle: Constitution as a Factor in Morbidity.

THURSDAY, MARCH 27.

CHEMICAL SOCIETY (Annual General Meeting), at 4.—Prof. J. F. Thorpe: Presidential Address.

ROYAL SOCIETY, at 4.30.—Discussion on Geological Climates, opened by Dr. G. C. Simpson, followed by Prof. A. C. Seward, Prof. J. W. Gregory, Sir Peter Mitchell, C. E. P. Brooks, and Dr. C. Tate Regan.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. F. Coombs: Syphilis of the Heart and Great Vessels (Lumleian Lectures) (3).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—J. B. S. Haldane: Some Problems of Genetics.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—H. H. Harrison: Developments in Machine Telegraph Systems and Methods of Operation.

BATLEY AND DISTRICT TEXTILE SOCIETY (Annual General Meeting) (at Batley Technical College), at 7.30.—H. R. Hirst: Faults in Yarns and Cloths, their Detection and Prevention.

MEDICO-LEGAL SOCIETY (at 11 Chandos Street, W.1), at 8.30.—Prof. J. S. Haldane: Carbon Monoxide Poisoning and its Medico-Legal Aspects.

ROYAL AERONAUTICAL SOCIETY (Yeovil Branch).—Aircraft Accessories.

INSTITUTE OF RUBBER TECHNOLOGISTS (at Manchester Café, Ltd., Manchester).—H. Riding: Some Notes on Ebonite.

FRIDAY, MARCH 28.

ROYAL SOCIETY FOR THE PROTECTION OF BIRDS (at Middlesex Guildhall, Westminster), at 3.—Annual Meeting.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section) (at King's College Hospital), at 4.30.—Clinical Meeting.

PHYSICAL SOCIETY (Annual General Meeting) (at Imperial College of Science), at 5.—Presentation of the Duddell Medal to Prof. A. A. Michelson.—At 5.45 (at City and Guilds Engineering College).—Exhibition of Research Work now in Progress.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre, jointly with Manchester Association of Engineers) (at Manchester), at 7.15.—J. Calderwood: Marine Diesel Installations, with particular reference to Auxiliary Machinery.

JUNIOR INSTITUTION OF ENGINEERS (at Royal Society of Arts), at 7.30.—G. S. Taylor: Industrial Accidents; their Cause and Prevention (Gustave Canet Memorial Lecture).

ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Dr. W. Fletcher: Typhus-like Diseases of Unknown Ætiology.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Ernest Rutherford: The Transmutation of Matter.

INSTITUTION OF ELECTRICAL ENGINEERS (West Wales (Swansea) Sub-Centre).

SATURDAY, MARCH 29.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Nuclei and their Structure (4).

PUBLIC LECTURES.

SATURDAY, MARCH 22.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—M. A. Phillips: Pond Life.

SATURDAY, MARCH 29.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—J. E. Dallas: June Flowers in Alpine France.

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