THURSDAY, JULY 17, 1913.

ARISTARCHUS OF SAMOS.

Aristarchus of Samos: The Ancient Copernicus. A History of Greek Astronomy to Aristarchus together with Aristarchus's Treatise on the Sizes and Distances of the Sun and Moon. A New Greek Text with Translation and Notes. By Sir Thomas Heath, K.C.B., F.R.S. Pp. viii+425. (Oxford: Clarendon Press, 1913.) Price 18*s.* net.

ARISTARCHUS, who flourished in the first half of the third century B.C., is chiefly known as the only philosopher or astronomer of antiquity who taught that the earth moves round the sun. This doctrine is, however, not mentioned in the only writing of his which has been preserved, and the little we know about it is derived from allusions to it made by subsequent writers. All the same, his little book, "On the Sizes and Distances of the Sun and Moon," is of great importance, and Sir Thomas Heath's new and critical edition, accompanied by a translation, commentary, and notes, is therefore a most welcome addition to the literature of astronomical history.

Considering that the idea of the earth being in the centre of the universe reigned undisturbed until less than four hundred years ago, it is one of the most surprising facts in the history of astronomy that its motion round the sun should have been proposed more than 1700 years before the time of Copernicus, and that it should only have been accepted by one single philosopher, Seleukus, as to whom it is not even certain that he went the whole way and did not merely accept the daily rotation of the earth. The editor of this new edition of Aristarchus, therefore, thought it desirable to prepare a lengthy introduction to the work, giving an account of the progress of astronomy in Greece from the time of Thales to and including that of Aristarchus. Though this is not the first time that an English writer has dealt with this subject, Sir Thomas Heath has done good work by preparing this introductory memoir, which fills more than three hundred pages, as he possesses special qualifications for writing the history of Greek science, and there are various controversial matters which cannot be too much discussed—provided it is done by writers who are as competent to do so as he is. The author gives full references to the very copious literature on the subject; indeed, he even notices some statements which he might well have ignored, such as the comically exaggerated picture drawn by Gomperz, of how Demokritus seems to have anticipated out of his inner consciousness many modern discoveries. The passages in the works of ancient writers from which our knowledge of early Greek astronomy is derived are always given at full length in translation, which many readers who may not have access to the originals will find very convenient.

The chapters on the pre-Socratic philosophers, the Pythagoreans, Plato, Eudoxus, and Aristotle, do not call for special notice. They deal very fully and fairly with all the questions about which a good deal of controversy raged fifty or sixty years ago, but which may now be considered finally settled. Nobody now believes that Plato taught the daily rotation of the earth, or that he, in his old age, was inclined to think that the sun was at the centre of the universe. The debatable question is now, how astronomy can have advanced so much during the sixty or seventy years after the promulgation of the system of concentric spheres of Eudoxus as to lead Aristarchus to announce that the earth moved round the sun in a year.

The dominating figure of this period (as regards the progress of astronomy) is not Aristotle, but Herakleides of Pontus. Of him we know with certainty that he taught the rotation of the earth and the motion of Mercury and Venus round the sun. But much greater honours were claimed for him by Schiaparelli, who, in a memoir published in 1898, tried to show that Herakleides not only must have extended his theory from the inferior to the superior planets, thus enunciating the Tychonic system, but that he must also have taken the next step in favour of the heliocentric system. He should thus have anticipated Aristarchus. The only alleged proof of this is a passage in a lost book by Geminus (who lived 250 years after Herakleides) quoted by Simplicius. That this very peculiarly worded passage is corrupt is beyond a doubt; Sir Thomas Heath shows clearly that the name of Herakleides occurring in it is a later interpolation, and he suggests that Geminus may simply have been alluding to the doctrine of Aristarchus. But in any case it is impossible to get over the express statement of Simplicius that Herakleides assumed the earth to be in the middle, while Aëtius (the compiler of the "Placita Philosophorum") distinctly says that Herakleides let the earth move, "not progressively, but in a turning manner." That is to say, it stood still, but it rotated on its axis.

There is therefore no reason to believe that Aristarchus had any predecessor in developing first the so-called system of movable excentrics, and then, by a bold step, the heliocentric system. That

this met with no acceptance was doubtless due to the improved knowledge of the motions of the planets in the third century, when it was found that there were other irregularities which could not be accounted for by assuming the earth to be in motion.

The book of Aristarchus, now for the first time translated into English, is of great interest to the mathematician because the ratios of the sizes and distances which he calculates are really trigonometrical ratios, sines, cosines, &c., although at the time when the book was written trigonometry had not been invented, and no close approximation to the value of π was known. Aristarchus therefore endeavours to find upper and lower limits for those ratios by assuming propositions comparing the ratio between a greater and a smaller angle in a figure with the ratio between two straight lines in the figure. These propositions were afterwards proved by Ptolemy. To the astronomer the book is particularly interesting by the attempt made by Aristarchus to determine the ratio of the distances of sun and moon by observing their angular distance at the time when the moon was half illuminated. The very erroneous result found (19 : 1), corresponding to a solar parallax of 3′, continued to be accepted from the time of Ptolemy to that of Kepler.

J. L. E. D.

THE APOTHEOSIS OF THE POTATO.

(1) *The Potato: A Compilation of Information from Every Available Source.* By E. H. Grubb and W. S. Guilford. Pp. vii + 545. (London: Constable and Co., Ltd., 1913.) Price 8*s.* 6*d.* net.

(2) *Commercial Gardening: A Practical and Scientific Treatise for Market Gardeners, Market Growers, Fruit, Flower and Vegetable Growers, Nurserymen, &c.* By many practical Specialists, under the Editorship of John Weathers. In four volumes. Vol. i., pp. xiii + 239 + plates; vol. ii., pp. xii + 235 + plates; vol. iii., pp. xii + 240 + plates; vol. iv., pp. xii + 244 + plates. (London: The Gresham Publishing Co., 1913.) Price 36*s.* net, the four volumes.

(1) THERE are men who, having attained to wealth and fame by the agency of some humble instrument, basely repudiate and kick over the ladder by which they have risen. Not so the authors of the first book on our list. The potato has "made" them, and in return they proceed to "make" the potato. A large number of men have at times written about this vegetable, and extracts from their books and papers occupy a very large proportion of the volume. The food value, methods of propagating, cultivating, harvesting, and selling, all receive attention, but the authors are so evidently enthusiastic, and discourse so eloquently on the merits of their subject, that we are carried along with them, and forget that, after all, they are only talking about potatoes, and not about alpine plants or roses.

The book makes one realise, as nothing else we know has quite done, how manifold are the aspects from which a simple natural object can be regarded. Successive chapters give long quotations from the writings of chemists, botanists, zoologists, entomologists, mycologists, agriculturists, engineers, economists, legislators, business men, doctors, historians, geographers, all dealing with problems directly and closely connected with the potato. And the senior author shows us enough of his personality to let us see how entirely enthusiastic the plant-fancier may become over this plant. There is nothing critical about the book, and the student of science may not find much of direct value to him. Perhaps its main interest to the general reader is that it deals with one of the humblest products of the garden in the same enthusiastic and affectionate spirit as Dean Hole wrote about roses, or Farrar about "alpines."

(2) The four volumes on commercial gardening represent a somewhat ambitious attempt to put into one work the rather wide knowledge that the successful grower ought to have of crops, manures, markets, &c.; they are frankly intended for the commercial man only. Had they been confined to practical matters we should have found little fault with them, but the scope has been widened, and chapters on "science" have been inserted. It might be argued that sound science could not fail to be useful to the grower; on the other hand, it might also be argued that the busy grower has no time to concern himself with the reasons for things, but simply wants specific, trustworthy information on his problems. Either plan might have been adopted and justified. But we do not see any justification for the third plan that has been followed of putting in poor science. While a first-hand knowledge seems to have been expected of the writers on practical subjects, no such qualification seems to have been deemed necessary in the case of science. We are not referring, of course, to Mr. Massie's and Mr. Theobald's contributions, or to some of the botanical work, which is also good, but the large sections on science are in the main distinctly poor. Some of the errors are ludicrous, and could have been corrected by any good student at an agricultural college. The distinction between

aërobic and anaërobic decompositions proved entirely too much for the author:—

"Curiously enough, he says, "some scientists say that if air is admitted to the soil nitrogen is set free from the organic matter; and, on the other hand, if air is excluded, nitrogen is set free from the nitrates; and in both cases it is lost. These views would appear to be mutually destructive."

The chemist is still worse: when appealed to by growers to help in checking plant-diseases, "the chemist, like a sensible man of business, immediately proceeded to compound his nostrums and to talk learnedly about the fungoid and other diseases, at the same time not forgetting to take the fees to recompense him for his learning and skill."

But perhaps the most severe treatment is reserved for Rothamsted.

"The cultivation seems to be of the poorest description; in fact, it can hardly be described as cultivation at all. . . . One can imagine the condition of the soil . . . it must be almost as hard as rock, and impervious to rain, air, or roots. . . . Farming on the Rothamsted principle would appear to be a very precarious business."

As all this occurs in a science section, first-hand information was apparently deemed superfluous; nevertheless, a visit to Rothamsted first of all might not have been a bad idea. After this we are quite prepared for the author's scheme for making the wheat crop yield a profit of more than 7*ol.* per acre, instead of 4*l.* or less as at present. The experimental basis consists of a trial made at Ealing in 1910 with 400 seeds; the results are multiplied up till they can be expressed in terms of one acre; and this in turn is multiplied up till the author foresees that "thousands of men would be kept on the land at better wages, and our wheat crops would be increased enormously. Agriculturists would do well to consider the above figures before smiling too broadly at them." Unfortunately, agriculturists have had these paper schemes presented to them fairly often for at least 250 years past, and now they require facts. Enough has been said, however, to show the sort of "science" that is considered good enough for growers.

E. J. RUSSELL.

TEXT-BOOKS OF PHYSICS.

(1) *Experimental Mechanics and Physics.* By A. H. E. Norris. Pp. viii+176. (London: Mills and Boon, Ltd., n.d.) Price 1*s.* 6*d.*

(2) *Elementary Physical Optics.* By W. E. Cross. Pp. 312. (Oxford: Clarendon Press, 1913.) Price 3*s.* 6*d.*

(3) *Heat: A Manual for Technical and Industrial Students.* By J. A. Randall. Pp. xiv+331. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1913.) Price 6*s.* 6*d.* net.

(4) *A Synopsis of the Elementary Theory of Heat and Heat Engines.* By J. Case. Pp. iii+65. (Cambridge: W. Heffer and Sons, Ltd., 1913.) Price 2*s.* 6*d.* net.

(5) *Elementary Principles of Electricity and Magnetism for Students in Engineering.* By Dr. R. H. Hough and Dr. W. M. Boehm. Pp. vii+233. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1913.) Price 6*s.*

(6) *Transport de Force.* Calculs Techniques et Economiques des Lignes de Transport et de Distribution d'Energie Electrique. By C. Le Roy. Deuxième Partie. Pp. 143. (Paris: A Hermann et Fils, 1913.) Price 6 francs.

(7) *First Year Course in General Science: A Combined Text-book and Note-book.* By E. A. Gardiner. Pp. vi+113. (London: W. Heinemann, n.d.) Price 2*s.* 6*d.* net.

(1) THE title of this little book is rather misleading. The use of the word "physics" suggests that the contents of the book comprise the various branches of physics, and not merely—as is actually the case—heat and a meagre treatment of a few of the properties of matter. These subjects occupy only one quarter of the volume, the remainder being devoted to mechanics. The treatment is very simple and is suitable as an introductory course. In this respect the book will no doubt serve its purpose as efficiently as many others of its class, although it exhibits no noteworthy advances in the mode of presentation of the subject. The frequent change of type is rather an unfortunate feature, and some of the diagrams are very badly drawn, notably a cube used to represent the measurement of volume, the perspective of which is in exactly the wrong sense.

(2) This book has several very good points. The subject is treated in a straightforward and lucid manner. The author has endeavoured to develop the theory of optics upon both "ray" and "wave" bases simultaneously, and we think he has succeeded. There is much to be said for both methods of treatment, and neither should be ignored. As is natural in an elementary treatise, no very difficult problems are considered, but it is rather surprising to find practically no reference to diffraction and interference, especially as some stress is laid on the wave theory. There are many simple experiments in this connection which, far from confusing a junior student, would undoubtedly interest him. One of the most notable

features of the book is the series of diagrams, which are well drawn, and often a whole page is devoted to a single figure, with the result that a very clear representation is secured.

(3) One is inclined to think that too much is being done nowadays in the matter of adapting branches of study to the special needs of various classes of students. Text-books of physics, and presumably of other subjects also, are written from the point of view of subsequent work, and the result is often detrimental to the students themselves. It is scarcely possible to avoid a certain looseness of language and an inexactness of expression when the subject is submitted to the special mode of treatment in question. The present book is quite a good one in many ways, and no doubt contains a great deal of useful information with regard to heat and heat engines. It is good to find the subject introduced from the point of view of energy, although the discussion of the meaning of energy is evidently handicapped by the knowledge on the part of the author of the very limited training in mechanics possessed by the students for whom the book is written. To each chapter the author appends a summary in heavy type of the important conclusions therein, together with a number of problems based on the work. Apart from the limitations imposed by the mode of treatment referred to, this book is a straightforward and lucid presentation of the subject.

(4) This pamphlet is frankly published for "cramming" purposes. It is intended as a synopsis for students reading for the Mechanical Sciences Tripos, and especially for the "A" paper in Heat. In order to make this perfectly plain the author leads off with some forty lines of doggerel, which, if committed to memory, apparently ensures success in the examination. To those students who regard their study of physics from this point of view, the book will prove useful in proportion to what they remember of its contents; to the serious student it can scarcely be recommended. For so small a volume the table of "errata" is too long; indeed, it rather looks as though this handbook has been hurriedly prepared.

(5) There is room for doubt as to whether it is desirable in a book on electricity and magnetism to avoid almost entirely references to the physical, as distinct from the mathematical, side of the subject. This is the only fault we have to find with this treatise, which is otherwise quite excellent. And even this objection disappears if it can be guaranteed that the book will be read concurrently with attendance at experimental lectures and laboratory work. Most teachers find that students of physics experience much more difficulty with the mathematics it involves than with the experimental principles upon which it is based. To those students this book should prove a boon. Here they will find presented in logical order and in a simple manner an extensive series of deductions from, and applications of, the fundamental laws of electrostatics, magnetism, and electromagnetics. Numerous numerical examples are appended to the various chapters, and at the end of the book the more important formulæ developed in it are compiled in a list. The use of this list, of course, involves the adoption of a particular notation in the memory of the student, and this, perhaps, is a little inexpedient at a time like the present, when notation varies so much; but it is not easy to see how to overcome the difficulty.

(6) To those interested, both theoretically and practically, in the transmission of electrical power this volume should prove of great interest and use. The author has carried out a large number of calculations of the various electrical data required in this connection, with numerical examples. Graphical methods are frequently resorted to, and the treatment of the whole subject appears to be very complete.

(7) The chief objection to this type of book is that it is very liable to become very dirty in the hands of a slovenly boy, and very unsightly, owing to numerous corrections, when written up by a boy who, though clean, is not brilliant. The instructions for the experiments are given clearly and neatly, and it seems rather a pity to spoil their appearance. The course comprises three parts, arranged more or less in order of difficulty, and a considerable number of simple experiments in mechanics, heat, and the physical and chemical properties of water and air are dealt with. At the end of each lesson a number of questions, intended for homework, are set. Presumably the answers to these are to be recorded in a separate notebook. Why not the experimental results also?

OUR BOOKSHELF.

Vegetation of the Peak District. By Dr. C. E. Moss. Pp. x+235+plates. (Cambridge University Press, 1913.) Price 12*s.* net.

QUICKLY following on Elgee's "Eastern Moorlands of Yorkshire," we have Moss's book on the vegetation of the Peak district, especially in its relations to geology and the chemical nature of the soil. Faunistic relations, so ably discussed by Elgee, are not considered by Moss. As the author remarks, the Peak district has no definite geographical boundaries, but his maps of the plant formations include the area lying between Mossley and Penistone to the north, and, approximately,

Congleton and Matlock to the south, embracing portions of five counties, and sources of several head-streams of the Mersey, Dee, Trent, and Yorkshire Ouse.

There are several elevations of a little more than 2000 feet, and a large proportion of the district consists of unenclosed moorland and grassland. The maps are coloured to show the plant formations of acidic peat, siliceous soil, calcareous soil, sandy soil, and of cultivated land. The plant formations are subdivided into associations. For example, the formation of acidic peat exhibits associations in which *Vaccinium Myrtillus*, *Eriophorum vaginatum*, *Calluna vulgaris* respectively dominate, and others in which two of these units are more or less equally dominant.

Following an introduction, dealing, among other things, with rainfall, temperature, and winds, are chapters on woodland, scrub, grassland, moorland, rocks and screes, marsh, and aquatic and cultivated land associations. Summaries of the plant communities (these include formations and associations) of the Peak district and of Britain conclude a most interesting book, the illustrations and maps of which are excellent. W. B. H.

Outlines of Stationery Testing. A Practical Manual. By H. A. Bromley. Pp. 74. (London: C. Griffin and Co., Ltd., 1913.) Price 2*s.* 6*d.* net.

THIS little manual deals chiefly with the technical examination of paper, though other articles of stationery are included in its scope. It avoids theoretical considerations, and gives in simple language concise instructions for the practical testing of paper, physically, microscopically, and chemically. Under the first heading come questions of colour, nature of the paper, surface or "finish," texture, opacity, ink-bearing properties, and strength. Short notes are supplied explaining these terms as applied to paper, and the methods of testing the properties indicated by them.

Few words are wasted in the chapter devoted to explaining the microscopic examination of paper. The author has managed to condense the description of the examination into five small pages, whilst another five are allotted to plates showing the microscopic characters of the principal fibres.

Under the head of chemical examination, directions are given for determining the nature and amount of the mineral matter used as "loading," and of the organic substances, such as gelatine, rosin, casein, and starch, employed in the "sizing" of paper. Methods are also propounded for discriminating the colouring ingredients and detecting chemically certain fibres and impurities. In all cases, the author claims, the chemical processes described are those which require the simplest possible apparatus. The characteristics of special kinds of paper are indicated briefly, and the book concludes with short sections on the testing of ink, gum, sealing-wax, and other miscellaneous articles included in the term "stationery." Within its limits—those of a collection of notes for use in practically examining stationery—the book will be found useful.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Pianoforte Touch.

I CAN fully endorse Dr. Heaviside's opinions as to the possibilities of the piano-player, and could only wish that there were some reasonable prospect of this instrument being used to save a great portion of the uninteresting drudgery of the usual school music-lesson. At the present time a considerable amount of school time is wasted in attempting to learn an instrument which is so difficult to play that few succeed in obtaining any satisfactory results. This system does not succeed in producing musicians any better than the ordinary school algebra lesson succeeds in producing mathematicians.

On the other hand, my recent experiments in connection with this "patent" control have led me carefully to test the existing commercial piano-players, and I can fully endorse Mr. Wheatley's complaints as to their lack of responsiveness and their persistent assertion of their mechanical individuality in opposition to the most strenuous efforts of the performer controlling them. The methods of varying expression by means of punch-holes, or by damping down all the notes on one side or other of a hard and fast dividing line, produce a very pleasing impression at first, but one soon tires of their very limited capabilities.

In these circumstances I would strongly recommend Mr. Wheatley and any other readers of NATURE who are interested in the subject to experiment with the methods of control claimed in my patent specifications. Even a rough and ready device rigged up with sticks, strings, and kitchen weights produces such a great improvement in the range of effects and flexibility of the instrument that after experimenting with such an arrangement I found it impossible to obtain any satisfaction without it. I think it may be safely said that the mechanical self-assertiveness of the instrument can be reduced to a small quantity of the second order, and can be further reduced by a method of successive approximation. So soon as dynamical considerations are introduced the possibility of accenting notes in *chords* (*i.e. proper chords*, not the miserable arpeggios which are so often substituted for them in recently cut music rolls) becomes evident, and the production of variations of tone quality by differences of touch is probably much easier when effected this way than when the keys are played by hand. All this appears less difficult to learn than the control of the speed regulator, which must always remain a difficulty.

The absence of these capabilities constitutes the great defect of the commercial player. But the ordinary "practical man" cannot understand anything based on the principles of dynamics and physics, consequently he treats the pressure as if it were constant instead of a very variable function of the time, and the result is an instrument which is mechanical and little else, and can only be played with an unnecessary expenditure of energy.

I have heard a professional pianist perform a very delicate *pianissimo* passage in which the accented notes rang out clearly and brilliantly above the background without being played any louder. It was simply a difference of tone quality produced by a corresponding difference of touch. My dynamically-controlled piano-player is quite capable of giving a

very approximate reproduction of this effect, whereas I have heard an expert break down hopelessly over a similar passage at an exhibition recital of a commercial machine.

With regard to the connection between tone quality and touch, I do not think Dr. F. J. Allen's explanation meets the case. Unless there is distinct experimental evidence to the contrary, I do not think we ought to exclude the *possibility* of a double or multiple impact between the hammer and string; indeed, some of my experiences favour this hypothesis. But I am inclining more and more to the belief that the differences may be largely due to the elasticity and inertia of the stem of the hammer. The introduction of these elements converts the hammer into a dynamical system capable of independent vibration. The method of normal coordinates then enables us to represent this system by a simpler system having the same vibration periods; for example, a system of two or more particles connected by elastic springs and moving in a straight line. It is clear that the duration of contact of a pair of such particles with the wire will depend largely on the state of compression between them and their relative velocity at the instant of impact. The interval between the release of the hammer and its striking the wire is probably short compared with the time of a free oscillation of the hammer itself, and certainly short compared with the time in which such an oscillation would die out. On setting the hammers of the horizontal piano low down, the variations of tone quality entirely disappear, as one would expect.

I find another favourable condition by developing Kaufmann's method in connection with the problem of a single inelastic particle striking a wire near one end. The duration of contact is determined by the vanishing of a function which has one or more minimum values before it actually vanishes, some of these being small. A very small difference in the assumed conditions might therefore convert one of these minimum values into a negative value. Remembering that such assumed conditions are probably not even approximately satisfied in practice, we still have a result indicating that the pianoforte hammer and string may be highly susceptible to any cause which tends to vary their duration of contact.

I am specially pleased to receive Dr. Heaviside's views on this subject, and to find that he has been long interested in these difficult problems.

Since writing this I have read Prof. Morton's letter, and am very glad to receive his references to previous work on the subject. With regard to his own experiments, I think something more is necessary for my purpose than what he mentions in NATURE, namely a comparison of the striking velocities of pianoforte hammers in *different* parts of the scale. I notice Prof. Morton does not mention what particular notes were struck in his observations. It would also be important to compare the striking velocities for two notes, one in the treble and one in the bass, when simultaneously excited by a common pneumatic impulse of long or short duration, such as can be produced in these piano-player experiments with properly cut chords. With regard to the other question, I think it is unfortunate that authors like Matthay have used the terms "good" and "bad" touch in this connection. I freely admit that the heavy, inelastic impacts produced by the inexperienced performer produce such a harsh effect as to be very objectionable (and possibly this may be due to Dr. Allen's so-called "xylophone" effect); on the other hand, any playing sounds to me mechanical which does not involve considerable variation of tone quality. This appears to me to be particularly necessary in studying piano arrangements of orchestral music, where the sharp, metallic tones of the brass instruments have to be brought out in contrast to the softer tones of the strings. Possibly when fingers are used the pianist usually has too many other matters requiring his attention. But whether a metallic effect is "good" or "bad" must depend on how and when it is used, and personally I should think a constant tone quality the worst effect of all. Prof. Morton's letter, however, raises a number of other questions which would take a long time to answer, and may have to be explained in subsequent correspondence.

G. H. BRYAN.

Plâs Gwyn, Bangor, North Wales.

Mackerel and Calanus.

WE all believe that most of our common food-fishes at some stage of life feed upon plankton, but those who have looked into sea-fisheries questions know that there is a great want of actual observations connecting the occurrence of some planktonic organism in quantity with the presence of a particular fish. Consequently the following record may be of interest to both marine biologists and fisheries experts.

We are out on a scientific fisheries cruise, and in addition to members of my own family, two well-known naturalists, Prof. Newstead and Mr. Alfred O. Walker are with us on the yacht, and we have just had what we regard as a satisfactory demonstration of the connection between a large shoal of mackerel and the occurrence of *Calanus finmarchicus* in unusual quantity.

On arriving in this bay last night we found that the local boats had been catching abundance of mackerel close to. We bought some for supper (good fish for a halfpenny each), and on dissection found that the stomachs of all of them were crammed full of fresh-looking Calanus (the individual Copepods being for the most part distinct and perfect), along with a few immature Nyctiphanes and larval Decapods. Prof. Newstead and my daughter then noticed, while fishing over the side of the yacht, about 8 p.m., that the gulls in the bay were feeding in groups around patches of agitated water evidently caused by shoals of fish. On rowing out to these we saw distinctly the mackerel, large and small, darting about in great numbers in the clear water, and we also noticed every here and there on the smooth surface of the water—it was a beautifully calm evening—innumerable small whirls or circular marks which, on looking closely, I found to be caused by large Copepoda close to the surface.

About twenty years ago I sent a note to NATURE, from the yacht *Argo*, in regard to large Copepoda (I think it was Anomalocera on that occasion, and the locality was further north, off Skye) splashing on the surface so as to give the appearance of fine rain; and this present occurrence at once reminded me of the former occasion, but here the Copepod was *Calanus finmarchicus* of large size and in extraordinary abundance. They could be clearly seen with the eye on leaning over the side of the boat, a small glass collecting jar dipped at random into the water brought out twenty to thirty specimens at each dip, and a coarse grit-gauge tow-net of about 34 cm. in diameter caught about 20 cubic centimetres of the Copepoda in five minutes. The mackerel were obviously darting about, occasionally leaping to the surface (which gave the gulls their opportunity) where the whirls caused by the Copepoda were thickest, and an examination of the stomach-contents of the fish on the yacht afterwards showed us that the amount in one mackerel was about the same quantity as that caught by the tow-net in five minutes. Prof. Newstead and I have made a count of 8 c.c. of the tow-net gathering, and estimate that it contains about 2400 specimens of

Calanus. This would give about 6000 Copepods in the stomach of an average mackerel, or in a five minutes' haul of the tow-net, on this occasion.

It may be added that these mackerel were evidently not being nourished in accordance with the views of Pütter, and were clearly able to fill their stomachs from the plankton around them.

W. A. HERDMAN.

S.y. *Runa*, Tobermory, N.B., July 12.

Helium and Neon.

THE experiments communicated to the Chemical Society recently by Prof. Collie and Mr. Patterson, the lectures delivered by Sir J. J. Thomson, and the discussions which have taken place in NATURE, on the possible synthesis of the chemical elements have aroused great interest outside England. So far as I can ascertain, opinion is much divided. For my own part I may perhaps be permitted to say that I have always entertained the idea of a possible formation of elements of the helium group from other gases by *integration*, just as these are formed from other elements by disintegration (see *Chemical News*, 1896, and *Berichte*, 1899). When I put forward this view objection was taken that 4H is greater than He, 4·032 instead of 3·99, and the same kind of objection may be raised to-day that He+O, or 3·9+16, is less than Ne, 20·2 (unless Ne is a mixture of gases).

In order that the above question might be solved definitely, I would beg to suggest that experiments should be conducted in Röntgen-tubes from the electrodes of which every trace of the gases "occluded" or firmly held by them would be first removed by continued bombardment with kathode rays.

As regards the question put forward by Sir J. J. Thomson, whether the new gas X_3, discovered by him, may be a new element that fills the vacant space in VII. group, 1 series (VII–1), in Mendeléeff's periodic system, I may be allowed to remark that Mendeléeff's prediction of the properties of the elements Sc, Ga, Ge, could be successful, because it was an *interpolation*; whereas the prediction of the properties of the element X=3 includes an *extrapolation*, which is always rather uncertain; besides, the gases of the helium group were unknown at the time of the prediction. Its properties may be derived from the following equations:—(1) Ne : F=He : X; (2) Li : F=H : X; (3) Li : H=F : X; but also (4) Fe : He=Mn : X, and (5) Cu : H=Br : X, showing how uncertain the prediction of its properties becomes, so that it is indeed probable that it will be more negative than fluorine, but not necessary that the gas should combine with the silicon of the glass.

The delicacy of Sir J. J. Thomson's new method has superseded our old methods of investigation in a way similar to that based upon radio-activity, and the results of the study of the new gases discovered by this new method are awaited by chemists with the greatest interest.

BOHUSLAV BRAUNER.

Bohemian University, Prague, July 6.

Red Water and Brine Shrimps.

BY the kindness of Mr. A. W. Sheppard and Prof. A. Dendy, F.R.S., I have been enabled to examine specimens of the brine shrimps from Geelong mentioned by Mr. Whitteron in his letter (NATURE, June 12, p. 372). They belong to the species *Parartemia zietziana*, described by the late Mr. O. A. Sayce in 1903 (Proc. Roy. Soc. Victoria, xv., part ii., p. 232). In Parartemia the unpaired uterine sac is produced into two large dorso-lateral lobes lying on either side of the "tail," and appearing, as Mr. Whitteron says, "like the egg sacs of Cyclops." Mr. Sayce's specimens were obtained from a "brackish-water swamp near Lake Alexandrina, South Australia." It is interesting to learn that the species is able also to live in the brine of salt-pans.

The flagellate described by Mr. Whitteron is probably allied to, and perhaps identical with, *Dunaliella salina*, which has long been known to cause a red coloration in the brine of salt-pans in Europe and Algeria. A detailed account of this form and references to the somewhat extensive earlier literature of the subject are given by Clara Hamburger ("Zur Kenntnis der *Dunaliella salina*," *Arch. Protistenk.*, vi., 1905, p. 111).

W. T. CALMAN.

British Museum (Natural History),
Cromwell Road, London, S.W., July 12.

The Maximum Density of Water.

PHYSIOGRAPHERS lead us to believe that the earth is defended from a profound glaciation, cumulative from year to year, by the law that water is heaviest at a temperature of four degrees above centigrade zero. If the main cause lies here, it is desirable that this measure should have its peculiar power set forth with more precision than has been customary.

The matter usually presents itself to students rather differently. The predominant fact is the floating power of ice. Hereby the water is screened from further attacks of the cold air, and dispersal is provided in the puzzling conditions of ground or anchor ice. Next perhaps in importance is the slow conduction of cold by water. Then comes the large value of the latent heat of water. It is not obvious why there should be disastrous results if the maximum density of water were at 0° C. The four units may be viewed as a helpful margin of safety rather than as an essential; but they would appear to be negligible in comparison with the 79 units of latent heat. Water at 0° C. is by no means unstable; each gram weight as it passes into ice throws out amongst its neighbours an amount of heat which is an effective safeguard against sudden and extensive solidifying.

W. B. CROFT.

The College, Winchester, July 5.

Radio-activity and the Age of the Earth.

I AM gratified to learn from Dr. Fermor's letter in NATURE for July 10 that there is a scientific possibility of conceiving how the interior of the earth may be devoid of radio-activity. But if "high pressure and temperature" can inhibit the dissociation of "potentially radio-active" substances, will they not do so also in the interior of the stars? If so, radio-activity will no longer be available to prolong their radiation of energy, and we shall be back in the old difficulty about the age of the sun. Indeed, it will be aggravated, because we now have positive evidence for a high antiquity of the earth, while still unable to explain that of the sun.

F. C. S. SCHILLER.

Corpus Christi College, Oxford, July 11.

THE GENERAL MAGNETIC FIELD OF THE SUN.[1]

THOSE who are familiar with Prof. Hale's brilliant discovery of magnetic fields in sunspots, and are aware of the difficulties connected with that investigation, will greatly admire his courage in seeking to establish the much weaker general magnetic field of the sun itself. The following condensed account of the method adopted and results obtained is given, to some

[1] Based upon an advance proof of a paper by Prof. G. E. Hale which is to appear in *The Astrophysical Journal*.

extent, in Prof. Hale's own words. As a general problem of physics, Schuster's suggestion that every rapidly rotating body may produce a magnetic field is of fundamental importance. A direct test by laboratory experiments cannot be made because of the limitations of size and rotational velocity, but advantage may be taken of the heavenly bodies where these limitations do not obtain. The most promising object for such an investigation is the sun. It is here that the direct method of determining the magnetic field by observation of the Zeeman effect is most readily employed, since the sun is bright enough to permit the use of the very high dispersion required. Further, it is possible to observe at a great number of points on the surface, and since observations may be made in both hemispheres the most perfect test of the Zeeman effect can be applied by looking for a reversal of the sign of the displacement with the polarity. The present minimum of solar activity has furnished a particularly favourable opportunity for the investigation, in consequence of the general absence of local strong fields due to spots and other disturbances.

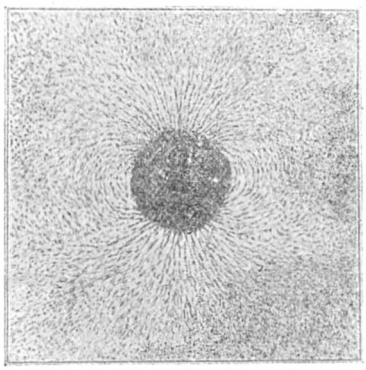

FIG. 1.—Lines of force of a magnetised sphere.

Assuming the sun's magnetic field to be similar to that of a magnetised sphere, with magnetic poles coincident with the poles of rotation, the lines of force would appear as in Fig. 1, the angle δ between them and the solar surface being given by $\tan \delta = 2 \tan \phi$, where ϕ is the heliocentric latitude. If the field were strong enough, and if the observer could look along the sun's axis and form an image of one of the poles on the slit of a spectroscope, certain solar lines would appear as doublets with components circularly polarised in opposite directions. If a Nicol prism were placed in front of the slit, with its long axis parallel to the slit, in combination with a quarter-wave plate set with its principal section at an angle of 45°, one of the components would be extinguished, while the other would be transmitted by the Nicol. Assuming the red component to be transmitted, a rotation of the quarter-wave plate through 90° would cause this to be extinguished and the violet component to be transmitted. If from the same place of observation the slit were directed to a point in 45° lat., the effect would still be clearly observable, though the transformation of the circularly polarised light of the components into elliptically polarised light would result in less complete extinction by the Nicol.

In the actual case the terrestrial observer is close to the plane of the sun's equator and must look in a direction nearly at right angles to the lines of force at the sun's poles.[2] He therefore cannot take full advantage of the fact that the total intensity of the sun's magnetisation is twice as great at the poles as at the equator. The angle between the lines of force and the line of sight, however, is reduced to zero at 35° north and south latitude; but the most favourable position for observation is 45° lat., where the effect of the ellipticity of the light is overcome by increased strength of the field.

On account of the weakness of the sun's magnetic field, complete separation into doublets is not to be expected, and the investigation must, therefore, depend upon the possibility of detecting very slight displacements of lines to red or violet, according to the position of the quarter-wave plate, with reversal of the sign of the displacements in passing from the northern to the southern hemisphere.

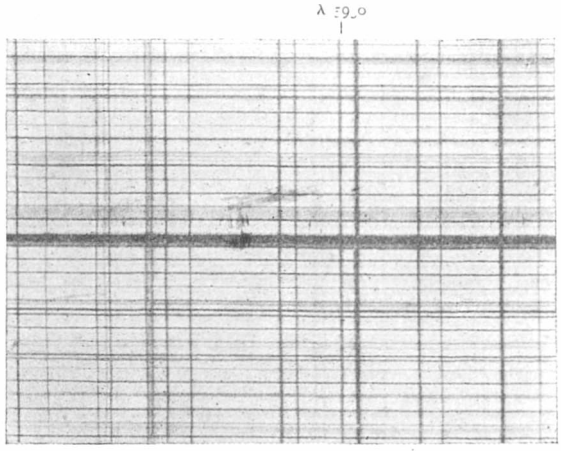

FIG. 2.—Region of λ5930 photographed in the third order with the 75-ft. spectrograph showing the division of the spectrum into 2 mm. strips by the compound quarter-wave plate. The heavy horizontal line marks the junction of two sections of the Nicol. The fifth stripe below is the "marked strip" used for reference purposes.

The first attempts to detect the solar magnetic field were made in 1908 with the 60-ft. tower telescope at Mt. Wilson, but it was not until the new 164-ft. tower telescope and 75-ft. spectrograph became available, in 1912, that definite results were obtained. With the latter instrument the sun's image is about 16 in. in diameter, and about λ5900 in the third order spectrum, where much of the work was done, the linear dispersion is 1 Ångström = 4·9 mm.; on this scale the distance between the D lines is 29 mm. For determination of focus and investigation of resolving power the extremely fine lines in the absorption spectrum of iodine were employed with advantage, and lines as close as 0·025 A.U. were found to be just resolved.

The polarising apparatus consists of a Nicol prism 18 mm. wide, built up of four sections, each 32·5 mm. long, so as to give a total length of 130 mm. The impossibility of rotating it is easily

[2] The triplets produced by light from the poles would, of course, be too narrow for observation as such, and the use of a Nicol in different positions would not affect the symmetry of the lines.

overcome by the use of a half-wave plate, as a rotation of this through a given angle is equivalent to a rotation of the Nicol through twice the angle.

The quarter-wave plate was built up of strips of mica, 2 mm. wide, mounted so that the principal sections of successive strips make an angle of 45° with the slit and 90° with each other; the Nicol would thus transmit, say, the red components of the doublets for the odd strips and the violet components for the even strips. In a photograph of the spectrum the lines would thus have a dentated appearance (Fig. 2), the magnitude of the separation of the components shown in successive strips varying directly with the strength of the field.

Every conceivable precaution appears to have been taken in setting the desired portion of the sun's image on the slit of the spectrograph, and in securing full illumination of the grating in any exposure. A valuable check on the observations was obtained by making duplicate exposures with the quarter-wave plate in the normal and inverted positions, which should give displacements of opposite sign if they are caused by a magnetic field. As a further check, at least one atmospheric line was measured on most of the plates of the first series, but afterwards they were only occasionally measured, as they were invariably found to give no shifts exceeding the errors of measurement. Possible effects of polarisation produced in the spectrograph have also been carefully considered.

The region of the spectrum selected, λ5800 to λ6000, was determined by the consideration that the magnetic separation varies directly as the square of the wave-length; too great a wave-length, however, being undesirable since the average sharpness of the solar lines decreases as the wave-length increases. Numerous difficulties arising from distortion of the cœlostat mirrors of the tower telescope and other causes were successfully overcome, and 280 photographs were obtained. For purposes of discussion the photographs and measures have been divided into four series.

For the preliminary observations it was decided to obtain a large number of measures of a few lines rather than a smaller number of measures of many lines. Three lines, showing the largest displacements, were accordingly selected for systematic investigation, namely, λ5812·139 (Fe,0), λ5828·097 (−,0), λ5929·898 (Fe,2).

The measurement of the minute displacements, amounting only to a few thousandths of a millimetre, presented great difficulties, largely arising from the natural diffuseness of the solar lines. Full details of the individual measures are given in the paper, and discordances appear to have been as faithfully recorded as the measures on which the final conclusions are based.

The tables and curves show a marked grouping of positive displacements in the northern and of negative displacements in the southern hemisphere, with values decreasing, on the average, from middle latitudes towards the equator or poles. It is

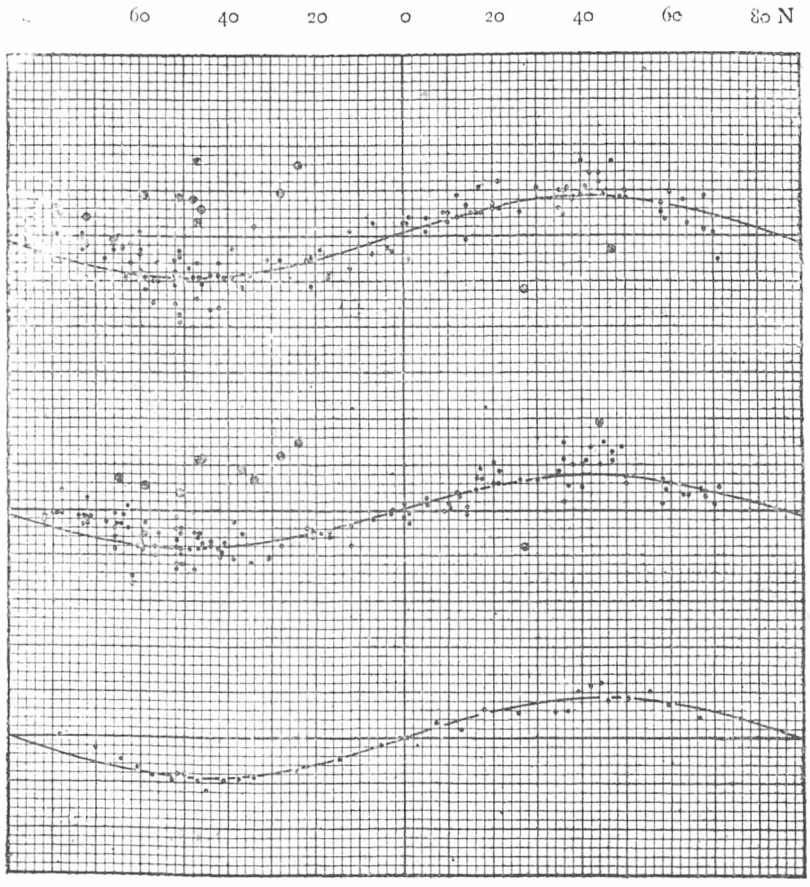

FIG. 3.—Displacements observed in different latitudes, fourth series. *a*, λ5812; *b*, λ5828; *c*, Mean curve of displacements including λ5930 from first and third series and λλ5812 and 5828 from fourth series. Vertical Scale: 1 division=0·001 mm.

also shown that the displacements were reversed in direction by turning the half-wave plate through 45° (equivalent to a rotation of the Nicol through 90°), or by inversion of the compound quarter-wave plate. Hence it is concluded that the light from the red and violet sides of the solar lines in question is circularly or elliptically polarised in opposite directions. In the northern hemisphere the light of the violet component is circularly polarised in the right-handed direction.

Some of the evidence for the systematic shifts is reproduced in the appended table, giving the mean displacements for λ5930 in the first and third

series, and λλ5812 and 5828 in the fourth series, as measured by Mr. Van Maanen:—

Lat.	Δ (unit= 0·001 mm.)	No. of observations	Lat.	Δ (unit= 0·001 mm.)	No. of observations
N. 68°.8	+2·2	15	S. 5°·1	−0·8	15
59·4	+3·6	15	14·3	−2·4	15
55·4	+5·1	16	24·2	−3·6	15
50·3	+4·4	15	34·1	−4·3	15
46·1	+4·1	15	37·7	−4·6	15
44·5	+6·0	15	41·0	−4·7	15
41·9	+5·7	15	45·1	−5·8	16
39·3	+5·1	15	47·1	−4·7	15
36·7	+3·0	15	49·9	−4·1	15
33·9	+2·9	15	51·7	−4·1	15
25·7	+2·7	15	52·8	−4·7	15
18·0	+3·1	16	57·3	−4·1	15
12·7	+0·8	15	60·5	−3·5	15
7·3	+1·6	15	64·5	−2·5	15
0·5	0·0	15	70·9	−1·1	15
			78·1	+0·1	15

A graphical representation of the results of this series of measures is given in Fig. 3, in which the horizontal scale is that of solar latitude, and the vertical scale that of displacements. The agreement of the data of the foregoing table with the theoretical curve derived from the average of the ordinates at 45° is shown in Fig. 3*c*.

It is considered that within the limits of precision the observations agree satisfactorily with the displacements calculated for lines originating in a source on the surface of a magnetised sphere, and observed from a point in or near the plane of the equator. On the assumption that the field is due to the rotation of a charged body, or of a body composed of neutral molecules which act as though they carried a charge, it is concluded that the sign of the dominant solar charge is negative, and that the north magnetic pole of the sun lies at or near the north pole of rotation.

The determination of the strength of the sun's field has presented some difficulty because the lines measured are so weak in the arc or spark that their separations in a magnetic field can only be determined experimentally with the greatest difficulty, or not at all. In the case of 5929·898, the procedure has been to observe the separation of the line in a sun-spot the strength of field of which was determined from other lines; as indicated by this line, the field strength of the sun at its pole is 28 gausses. The line 5812 and a nickel line 5831·821 (not yet fully discussed), by comparison with laboratory observations, lead to the values 48 and 29 gausses, but for comparison with the foregoing determination these should be increased by about 60 per cent. on account of systematic differences between the measurers. The general result is to indicate that the field strength at the sun's pole is of the order of 50 gausses. Various higher level lines, which show large Zeeman effects in the laboratory, have hitherto failed to show the effect of the sun's field, and it is therefore concluded that the intensity of the general field falls off very rapidly in passing upward through the reversing layer, more rapidly than in the case of spots.

Prof. Hale gives a careful discussion of the question as to whether the magnetic fields indicated by the observations are due to local phenomena or to the magnetic effect of a rotating sphere. In the case of spots, the Zeeman effect frequently extends beyond the penumbra, and the structure of the Hα flocculi sometimes suggests that local magnetic fields may also be caused by invisible spots, or by whirls in which no umbræ or penumbræ have appeared. There is also some evidence that the pores which occur in all parts of the sun may be small vortices which develop into spots under favourable conditions. Reasons are given for believing that the line displacements in question are not due to any of these causes. Right and left-handed whirls about spots are equally common in the northern and southern hemispheres, and there is no reason to suppose that they could produce the systematic displacements, of opposite sign in the two hemispheres, which have been observed. In fact, in the majority of the observations no spots whatever and very few calcium flocculi were visible on the sun. If the pores are electric vortices, like the spots, there is no reason to suppose that pores of one polarity preponderate in the northern hemisphere and those of opposite polarity in the southern, unless local differences in rotational velocity are sufficient to account for such small vortices as the pores may represent; this possibility, says Prof. Hale, deserves more careful consideration than he has yet been able to give it, but even if there were a clear preponderance of pores of opposite sign north and south, it would be difficult to account for the curve of observed displacements.

Serious objections having been urged against all theories of terrestrial magnetism, it can scarcely be hoped that any one of them can be applied without modification to the sun, especially in view of its high temperature, low density, and gaseous condition. In the case of spots, neutral molecules cannot produce the observed fields unless an improbable degree of separation of the positive and negative electrons is assumed. Harker's experiments,[3] however, have led Prof. Hale to suppose that in a spot there must be a flow of negative electrons from surrounding regions into the cooler umbra, and that the whirling of these in the vortex may account for the strong magnetic fields observed.

An extension of Dr. Harker's work made at Pasadena by Mr. King has further shown that although the ionisation current decreases as the pressure increases, it is still appreciable at pressures up to twenty atmospheres. On account of the greater mobility of the negative electrons, their tendency to flow towards regions of lower temperature, and the evidence afforded by Mr. King's experiments that solar ionisation is not limited to the region above the photosphere, it is evident that the electrical and magnetic phenomena of the interior of the sun must differ radically from those of the earth. But since the negative electrons will tend, on the average, to lie farther from the

[3] NATURE, July 18, 1912, p. 517.

sun's centre than the positive, the polarity of any general field that may thus result from the solar rotation should correspond with that of the earth's field.

There is reason to believe that in the solar atmosphere the negative electrons lie farther from the photosphere, on the average, than the positive electrons. The rotation of the atmosphere with the sun would thus tend to set up a magnetic field of the same polarity as that of the earth. At the base of the atmosphere this field would oppose the field due to the rotation of the body of the sun. Hence, assuming a suitable distribution of the positive and negative electrons, it may be possible to account in this way for the observed decrease in the strength of the general field at increasing distances from the photosphere. Prof. Hale thinks that it may even turn out that the Zeeman effect observed is due to the rotation of the solar atmosphere, and not to the rotation of the body of the sun.

Further work will be necessary before such questions as these can be fully discussed, and an extended series of observations, including lines representing a wide range of level, is contemplated.

The space at our disposal is too restricted to permit full justice to be done to this fine piece of work. It will be sufficiently evident, however, that Prof Hale has conducted the investigation with his accustomed skill and with due regard to the numerous possible sources of error.

THE BIRMINGHAM MEETING OF THE BRITISH ASSOCIATION.

THE arrangements for the Birmingham meeting (September 10–17) are almost completed. In order to avoid the competition for places at the various functions, which so often causes inconvenience to visitors, the local secretaries intend to obtain beforehand from members an indication of their wishes with regard to the general meetings, lectures, entertainments, and excursions; and a circular for that purpose will be issued shortly.

A new arrangement has been made for the convenience of the delegates of corresponding societies. Thanks to the council of the Birmingham Natural History and Philosophical Society, the meeting-room and library at 55 Newhall Street is to be placed at the disposal of the delegates for the display of their publications, and also to act as a meeting-ground for the representatives of these corresponding societies during the meeting. The addresses to the delegates will be given in the Technical School, Suffolk Street.

The lectures to citizens, which were inaugurated at Dundee last year, will be given on a more extended scale this year at the Digbeth Institute, Birmingham. Five lectures have been arranged by the council of the association. The first of these—"The Decorative Art of Savages"—will be given by Dr. A. C. Haddon, F.R.S., on Thursday, September 11, at 8 p.m. Other lectures will be "The Panama Canal," by Dr. Vaughan Cornish; "Heredity in relation to Man," by Dr. Leonard Doncaster; "The Microscopic Structure of Metals," by Dr. W. Rosenhain; "Radio-activity," by Dr. F. Soddy, F.R.S. These lectures are arranged for that section of the public which is interested in the progress of science, but cannot take part in the meetings of the association. They are not intended for members or associates. The chief points in the programmes of the sections are described below.

SECTION A (MATHEMATICAL AND PHYSICAL SCIENCE).—The section meets this year under the presidency of Dr. H. F. Baker. It is expected that greater interest will be taken in the proceedings of the pure mathematics subsection than in former years. There is a possibility of a discussion on non-Euclidean geometry, which will be of interest to many in addition to the pure mathematicians. In the full section the chief item after the presidential address is a discussion on radiation, arranged for the Friday morning, which will be opened by Mr. J. H. Jeans. Profs. H. A. Lorentz and E. Pringsheim have accepted invitations to be present at the meeting, and will add greatly to the interest and value of this discussion. Prof. Planck may also possibly be there. Of the English scientific men who will be there, Profs. Love and Rutherford will take part in the discussion. Two other discussions have been arranged in conjunction with other sections. With the Engineering Section a joint meeting will be held at which reports of a committee which has been investigating problems of stress distribution will be discussed. The other meeting is with the Geography Section, at which problems of geodesy and mathematical geography will be considered. One paper of great interest to many will be presented by Capt. H. Winterbotham, on the accuracy of the principal triangulation of Great Britain.

Amongst the papers to be contributed to the section, one, by Prof. Barkla, on the nature of X-rays, will be of considerable interest, and will probably give rise to an animated discussion. This paper will probably be read in full section immediately after the presidential address at eleven o'clock on Thursday morning.

The meeting will be of special interest because of the close association of the president of the association, Sir Oliver Lodge, with the section. It is expected that a large number of leading English scientific men will be present, and already the published list of papers shows that a stimulating session may be expected.

SECTION B (CHEMISTRY).—The programme of this section has been framed so as to appeal as widely as possible to chemists, as many as five different subjects being down for discussion. Taking first those which have a practical bearing, the subject of the economical use of fuel is of national importance. The chemist can emphasise the wasteful nature of present practice and describe alternative and more economical practices, free from the bias of the commercial advocate. It is hoped to present at the meeting the views of authoritative speakers on all branches of the subject; the details will be announced later. The subject of metallurgy is of particular interest in Birmingham, and a number of papers are promised by Prof. Cohen, Prof. Turner, Dr. Desch, Dr. Rosenhain, Dr. Holt, and others, which will deal from the scientific side with problems of practical interest. Turning to pure chemistry, the discussion on optical activity should prove of particular value, as all the workers in this country who are specially competent to speak on the subject are expected to be present. The ground has been prepared by Prof. Frankland's

summary in his presidential address to the Chemical Society, whilst new light has been thrown on it by the recent work of Prof. Armstrong and Mr. E. E. Walker. Although of a far more speculative character, the discussion on radio-active elements and the periodic law, which Prof. Soddy is to open, should attract a large audience. For the benefit of its biological followers, the section will cooperate with the Physiological and Agricultural Sections for a discussion of some of the elusive processes included in the title fermentation.

SECTION D (ZOOLOGY).—The programme of the proceedings of Section D contains many items of considerable interest. In addition to delivering his presidential address, Dr. Gadow will open a discussion on convergence in the mammalia; Prof. J. Versluys (Giessen) and Dr. Chalmers Mitchell will also take part, and the palæontological side will be represented. There are several entymological papers which will form an introduction to a discussion on mimicry, to be opened by Prof. E. B. Poulton.

There will be a joint session with the Physiological and Botanical Sections for a paper and demonstration by Prof. Benjamin Moore on the synthesis of organic matter by inorganic colloids in the presence of sunlight, considered in relation to the origin of life. A novel feature will be a demonstration in the Cinema Theatre by Prof. H. Braus (Heidelberg), "Mikrokino Aufnahmen von lebenden Kulturen embryonaler Herzen." These films have previously been shown in Berlin and Vienna, but not in this country. The same author is communicating a paper on the homology of the gills in the light of experimental investigation. Another paper by a distinguished foreign visitor is one on the carapace of the Chelonia, by Prof. J. Versluys.

The afternoon lecture will be given by Prof. E. A. Minchin, who will deal with "Some Aspects of the Sleeping Sickness Problem." An excursion will be made to Burbage, on the invitation of Major C. C. Hurst, to view a number of extremely interesting experiments in inheritance, but the number of members whom it is possible to accommodate must necessarily be strictly limited.

SECTION F (ECONOMIC SCIENCE AND STATISTICS).—After the presidential address by the Rev. P. Wicksteed, the discussion will be concentrated on certain subjects. One of these will be "The Cost of Living," which will be introduced by papers from Prof. Irving Fisher, of Yale, Prof. Bowley, Mrs. F. Wood, and Mr. Cuthbertson. The attitude of trade unions to profit-sharing and co-partnership will be dealt with by Dr. C. Carpenter and Mr. B. C. Kershaw. There will be an important discussion on inland waterways. Papers will be read by Lord Shuttleworth, Sir J. P. Griffith, Mr. W. M. Acworth, and Mr. R. B. Dunwoody; amongst the speakers will be Mr. Neville Chamberlain, Mr. Frank Impey, Mr. J. A. Sauer, Mr. Fred Morton, and Sir J. Brunner. Other papers of a more miscellaneous character will be read by Prof. Chapman, progressive taxation; Prof. Muirhead, the economic order; Mr. A. J. Kenny, on mathematical methods; Prof. Oldham, study of business organisation; Prof. Kirkaldy, the Panama Canal; Mr. C. R. Enoch, human geography and industry planning; Mr. F. Tillyard, towns in the nineteenth century.

SECTION H (ANTHROPOLOGY).—In this section the programme will, as usual, cover a wide field. It includes a number of communications of considerable interest and importance, especially in connection with the study of religion. Dr. W. H. R. Rivers will read a paper entitled "Sun-cult and Megaliths in Oceania," Dr. G. Landtman will give an account of the ideas of the Kiwai Papuans regarding the soul, and Mr. J. H. Powell will describe, with lantern illustrations, the ceremony of hook-swinging in India, while Mr. W. J. Perry will present to the section the results of an examination of the custom of orientation in Indonesia. Major Tremearne will deal, in two separate papers, with the Bori ceremony of the Hausas of Tunis and the magic of the Nigerian Hausas. Semitic medical magic and folklore, as exemplified in a number of unpublished formulæ from the inscriptions, will form the subject-matter of a communication from Mr. R. Campbell Thompson, who will also submit for the consideration of the section his suggested decipherment of the Hittite inscriptions. Egyptian archæology will be represented by papers from Prof. Flinders Petrie and others. Prof. Petrie also proposes to describe the results of an anthropometric examination of the skeletal remains found in his excavations during the past season. Among the remaining archæological communications may be mentioned Dr. Capitan's description of recent discoveries of paintings in the Palæolithic caves of France, and papers by Dr. Ashby on Italian archæology.

An interesting topic which has not been under discussion in the section for some considerable time will be touched upon in papers by Mr. T. W. Thompson, on gipsy tabus and funeral rites, and by Dr. Rivers and the Rev. G. Hall, on gipsy pedigrees.

Finally, mention must be made of a paper by Prof. Fleure and Mr. T. C. James on the ethnology of Wales, which is of a special importance not only on account of its conclusions, but as an example of a statistical method.

SECTION I (PHYSIOLOGY).—The main feature of interest in the Section of Physiology is that, for the first time, there will be a subsection of psychology in connection with the above section. This subsection ought to be very attractive, as a large number of papers have been promised. One meeting will be devoted to a joint sitting of the whole section to hear papers of interest to both physiologists and psychologists. During the rest of the meeting, however, the subsection will meet independently.

A discussion on the physiology of reproduction will be held jointly with the Section of Agriculture on Monday, September 15, and Dr. F. H. A. Marshall will open this discussion.

The address of the president of the section will open the meeting, and the reports of research committees will, as usual, be taken early in the meeting. The report of the committee on anæsthetics should lead to some discussion, as Sir Frederic Hewitt wishes to raise the subject of legislative restriction of the employment of anæsthetics. Another subject of interest will be a paper which Prof. B. Moore is giving before a joint meeting of zoologists, botanists, and physiologists, on the synthesis of organic matter by inorganic colloids in presence of sunlight, in relation to the origin of life.

SECTION L (EDUCATIONAL SCIENCE).—The sectional programme is unusually full and interesting. After the presidential address a joint meeting with Section H will discuss "The Educational Use of Museums," in which Dr. Hoyle, of the National Museum of Wales, Mr. Chubb, of the Liverpool Museum, Sir Richard Temple, Prof. Newberry, Dr. Harrison, and others will take part. On the following day a question of national importance is down, viz. "The Function of the Modern University in the State." As the academic heads of several of the universities concerned have promised to speak, the meeting should be a large one. Amongst others, Sir Alfred Hopkinson, Sir Harry Reichel, Dr. Hadow, Dr. Alex. Hill, Dr. H. A. L. Fisher, Miss Tuke, Sir James Yoxall, Mr. Alfred Moseley, Sir George Kenrick, and Miss Burstall are expected to take part. The president of the

association will also come, unless Section A proves too attractive.

Following its custom of recent years, the section, meeting jointly with the Psychological Subsection, will give Monday to the consideration of psychological investigations, so far as they illuminate educational practice. Dr. Kimmins will read a paper on the need for educational research, which will be followed by a discussion, and papers on the psychological processes involved in learning to read and spell will be read. On Tuesday a demand for the registration of schools will be raised by Mrs. Bryant, Bishop Welldon, and Bishop McIntyre; and Mr. P. B. Ballard, Mr. T. S. Usherwood, and Mr. W. F. Fowler will present the case for handwork as a factor in education. On Wednesday, Sir George Fordham will read an important paper on the working of the Act of 1902. This should provoke considerable interest in view of coming legislation. Other papers to be read include one on "The Use of Suggestion in Discipline and Training," by Mrs. Meredith, and the Montessori method, by Dr. Jessie White.

SECTION M (AGRICULTURE).—As usual in the agricultural section, a special feature is being made of joint discussions with other sections. An important meeting is being held with the botanists, when prolificness of barley is to be discussed. The chief British authority, Mr. E. S. Beaven, is giving an account of his extensive trials, and Messrs. Hunter, Hackett, and Bennet are describing the experiments made by the Irish Department of Agriculture. Another meeting is arranged with the physiologists to discuss the factors influencing sterility and fecundity in live-stock. Dr. F. H. A. Marshall is opening the discussion, and Messrs. K. J. J. Mackenzie, L. Doncaster, G. W. Smith, and others are expected to take part. The section is also participating in the biochemical discussion on fermentation.

A number of papers of very general interest are promised. Sir Richard Paget is dealing with the possibility of partnership between landlord and tenant. Prof. Fraser Storey describes the German forestry methods, and Mr. Walter Collinge is to deal with a curious disease of cereals. Considerable attention is being devoted to soil problems. Mr. T. Goodey is giving a summary of his investigations at Rothamsted on the protozoa of the soil, and Dr. Hutchinson and Mr. McLennan are describing experiments showing that soil may be partially sterilised by means of caustic lime. Mr. C. T. Gimingham is presenting an account of ammonification and nitrification in pasture soils.

Ecologists will be interested in Dr. Winifred Brenchley's summary of the relationships of weeds to arable land. Miss Taylor is dealing with certain fruit problems, and Messrs. Barker and Gimingham with Bordeaux mixture. The foreign guest is Prof. Sörensen, from Copenhagen, who will be very generally welcomed by men of science in this country.

Altogether the programme promises to be of considerable interest. Among the excursions is a visit to the Burbage Experimental Station, where Major Hurst's breeding experiments are to be seen.

NOTES.

WE announce with great regret that Prof. Francis Gotch, F.R.S., Waynflete professor of physiology in the University of Oxford, died on July 15 at sixty years of age.

WE REGRET to announce the death on July 3, in his fifty-sixth year, of Dr. R. Lendlmayr von Lendenfeld, professor of zoology and rector of the German University at Prague.

PROF. A. FOWLER, F.R.S., has been awarded the Valz prize of 450 francs by the French Academy of Sciences for his investigation of the principal series of hydrogen lines and other contributions to astronomical physics.

DR. HANS BUSCH has taken over the editorship of the *Physikalischen Zeitschrift*, and it is requested that contributions for that journal be addressed to him at Göttingen, Friedländerweg 61.

THE death is reported, in his seventy-first year, of Dr. Charles Greene Rockwood, who was professor of mathematics and natural philosophy at Bowdoin College from 1868 to 1873, professor of mathematics and astronomy at Rutgers College from 1873 to 1877, and professor of mathematics at Princeton from 1877 to 1905. Prof. Rockwood was a member of the Princeton Eclipse Expedition to Colorado in 1878, and contributed a large number of articles on seismology to American scientific periodicals.

THE science section of the R. Accademia di Bologna has issued a circular relating to the first biennial prize of 3000 lire from the fund given by Prof. Elia De Cyon for the encouragement of scientific research. Memoirs are invited on a number of subjects, including the functions of the cardiac and vasomotor nervous systems, the functions of the thyroid and pineal glands, and of the labyrinth of the ear. The memoirs may be written in Latin, Italian, French, or English. The award will be made on March 1, 1915. Full particulars can be obtained from the secretary of the academy, Mr. Ercole Giacomini, at Bologna.

MR. JOHN MUIR, the American naturalist, is appealing to nature-lovers throughout the United States to use their influence to save the Yosemite National Park from spoliation. The city of San Francisco is trying to rush through Congress a Bill permitting it to acquire the Hetch Hetchy Valley as a site for a reservoir. The proposed scheme would turn this valley into a lake, and would close to the public the Grand Canyon of the Tuolumne, a river which at this point is a succession of waterfalls of every variety of height and beauty. This would mean depriving the rest of the United States of 500 square miles, or more than one-half the total area of the present National Park. Mr. Muir supports his protest by showing that this destructive scheme is not really essential to meeting the needs of San Francisco, which could find other, if more expensive, sources of water supply. He quotes the report of an advisory board of army engineers in support of this contention.

UNTIL quite recently the discovery of pygmy flints, established in England by Rev. R. A. Gatty, had not been confirmed in Scotland. Mr. R. M. Leslie Paterson, in *Man* for July, now reports the discovery of flints of this type near the confluence of the river Feugh with the Dee, on the 10-ft. terrace level. This district abounds in stone circles, and contains burial-places and pottery of the Bronze age, thus showing that it was continuously occupied by prehistoric man. The present discoveries include pygmy flints of various types—rough knives, duck-bill and thumb scrapers, borers, and a saw. But, curiously enough, not a single arrow-head has yet been found.

IT has hitherto been believed that the Maori religion represented a cult of the powers of nature, with ancestor worship; that they had no conception of a Supreme Being, and that their deities were malevolent, to whom no true invocations were offered, but merely rude charms and incantations. In *Man* for July Mr. Elsdon Best, on information received from an old member of the tribe, describes the cult of one of the late Mr. Andrew Lang's "High Gods of Low Races," in the worship of a deity known as Io, whose name was deemed so sacred that it was never uttered in public. The priest is said to have performed his devotions in a secluded spot in the forest, or he used to enter a river in a state of nudity, and stood waist-deep in the water, having first immersed the upper part of his body. The account of this remarkable cult is full, and apparently authoritative, however it may conflict with our preconceived views of the religious beliefs of the Maori people.

WE are indebted to the author, Mr. L. M. Lambe, for a copy of a paper from *The Ottawa Naturalist*, vol. xxvii., p. 21, on the bones of a fore-limb of an iguanodont dinosaur of the genus Trachodon from the Edmonton formation of Alberta, Canada.

IN vol. ix., No. 11, of *The South African Journal of Science*, reference is made to the discovery in the Lower Cretaceous marls of Bushman's River—the locality where the type skull of Owen's *Anthodon serrarius* was obtained—of the broken femur of a reptile fully as large as the corresponding bone of Diplodocus, and, when complete, measuring about 5 ft. in length. Whether it belongs to Anthodon, now believed to be a dinosaur, remains to be proved.

SINCE the publication of Mr. Boulenger's volume on the reptiles and amphibians in the "Fauna of British India," two new species of land tortoises, namely *Testudo travancorica*, of the Western Ghats, and *T. baluchiorum*, from Baluchistan, have been added to the Indian list, while *T. latinuchalis* and *T. horsfieldi* have been shown to range into the British Indian area. A third new species, *T. parallelus*, from the Singhbhum district of Chota Nagpur, is described by Dr. Annandale in the second part of vol. ix. of Records of the Indian Museum. In the same paper Dr. Annandale also describes a new species of terrapin from Chota Nagpur, under the name of *Geoëmyda indopeninsularis*, which is of interest as showing that the genus Nicoria is inseparable from Geoëmyda, in the sense in which these terms are used in the "Fauna." This obviates much confusion in nomenclature, as it renders superfluous the name Heosemys, proposed by Dr. Stejneger to replace Geoëmyda, as employed by Mr. Boulenger.

THE co-existence of man with extinct animals in South Africa forms the subject of an article by Dr. R. Broom in vol. xii., part 1, of the Annals of the South African Museum. The most convincing evidence of this is afforded by a layer of peat at Haagenstad salt-pan, about thirty miles north of Bloemfontein. Below the upper layer of pure peat, 8 to 10 ft. thick, is another layer, of about the same thickness, composed of peaty sand, and beneath this is a bed of broken bones, burnt bones, and human implements. Although most of the implements were unfortunately dispersed, a stone spear-head and knife secured for the Bloemfontein Museum amply attest their human origin. Among several species of extinct and existing mammals, special interest attaches to the frontlet and horn-cores of a gnu (*Connochætes antiquus*), which are stated to be almost exactly intermediate in character between those of the white-tailed gnu (*C. gnu*) and the brindled gnu (*C. taurinus*). The same issue contains six papers, some by Dr. Broom, others by Mr. S. H. Haughton, and others by both writers, on new and other vertebrates from the Permo-Triassic beds of South Africa.

DR. HANS PREUSS has published (*Schriften der naturforsch. Ges.*, Danzig, Band 13) an elaborate account of the vegetation of the Baltic coast of Germany (Schleswig-Holstein, Mecklenburg, Pomerania, West and East Prussia), his paper of 213 pages being illustrated by sixty-two photographs. This important paper is of great interest to ecologists in Britain, since the maritime vegetation of the North German coast presents considerable general resemblances to that of our shores, apart from its greater richness in species and the presence of such groups as the "Pontic" forms, which have doubtless migrated from the warmer regions of Central Europe along the river valleys to parts of the Baltic littoral.

PROF. V. ARCICHOVSKIJ has forwarded reprints of five recent papers appearing in various German and Russian journals. Two of these give descriptions of methods for experimental work with seeds freed from micro-organisms; in one of these the author describes and figures a modification of Hansen's sterile chamber, adapted for investigations with sterilised seeds and for pure cultures of higher plants. A third paper deals with the culture of higher plants in a simple air-chamber improvised from an ordinary flower-pot; excellent results were obtained in the cultivation of bean plants in moist air, the nodules being unusually large and numerous, as well as with other species, and the author advocates this method in preference to the use of water or sand cultures, in which access of air to the roots is hindered by the excess of water used.

MR. J. F. DASTUR, of the Agricultural Research Institute, Pusa, has published (Memoirs Dept. Agriculture in India, vol. v., No. 4) an account of a new disease of the castor-oil plant caused by *Phytophthora parasitica*, n. sp. In his introduction the author gives a brief account of the cultivation of the castor-oil plant in India, and the varied uses to which the oil is put besides that due to its medicinal properties. Though so widely distributed, this plant has hitherto been regarded as immune from serious fungus pests, except the castor rust, but at Pusa the crop has been attacked by two serious pests, the new Phytophthora now described and a species of Cercospora, to be dealt with later. The former destroys seedlings by causing "damping off," and also attacks leaves of older plants, and is the most injurious of the fungal

parasites of castor. The structure and life-history of the fungus are fully described and illustrated by means of ten excellent plates, one being coloured to show the characteristic brown leaf spots which form the first external indication of the disease.

TECHNICAL BULLETIN No. 16 of the Michigan Agricultural College Experiment Station deals with the grain-size and moisture content of soil in relation to bacterial activity. Aëration and thickness of the moisture film may be considered to be the important physical factors of the soil in relation to the activity of aërobic bacteria. Aëration increases as the square of the grain-size, while the increase of the moisture film is directly proportional to the grain-size. A coarse soil is therefore of advantage to the aërobic bacteria. The grain-size in cultivated soils is generally so small that the optimum moisture film is reached only in the waterlogged state.

IN the Bulletin of the Imperial Earthquake Investigation Committee (vol. v., pp. 109–37), Prof. Omori again directs attention to the small slow movements of the ground which he calls pulsatory oscillations. The period of these oscillations ranges from about four to about eight seconds, and Prof. Omori shows that the period at a given moment is identical even at Tokyo and Osaka, which are nearly 250 miles apart, not only in its mean value, but also in its variation from day to day. The amplitude of the oscillations is much greater on soft than on hard ground, and Prof. Omori suggests that the oscillations are produced at some depth in the solid crust and magnified when transmitted to the soft soil of the alluvial plains. A remarkable feature of pulsatory oscillation is their complete dissimilarity at stations only a few miles apart, it being impossible to identify the different maximum groups even at two observatories in Tokyo. This indicates that pulsatory oscillations are not the results of a progressive disturbance like an earthquake. Prof. Omori regards them rather as the results of underground disturbances originating at an infinite number of points, due probably to volcanic activity or to changes in the internal pressure caused by the transit of a deep barometric depression or by the existence of heavy ocean swells.

MR. R. C. MOSSMAN (Argentine Meteorological Office) has contributed to *Symons's Meteorological Magazine* for June the third of his useful articles on southern hemisphere seasonal correlations. During the months January to March a remarkable parallelism is pointed out since 1897 in the curves of mean temperature at Alice Springs (Australia) and Cordoba (Argentine Republic), both stations being located in a continental situation. In eleven out of fourteen years discussed (1897–1910) the departures from the means for the period have the same sign. But previous years (1879–96) show no definite agreement. During the same months an opposition is generally shown in the mean temperature curves at Perth (Western Australia) on one hand, and at Valparaiso and Santiago (Chile) on the other; for Valparaiso data for only nine years (1901–9) were available. There is also an opposition between the mean temperature at Santiago and the thickness of the ice at Duluth (Lake Superior). These results, as Mr. Mossman remarks, are of interest as they indicate an interrelation between the action centres governing the conditions during the period in question in Australia, South America, and the United States.

A WELL-ILLUSTRATED article in the Journal of the Franklin Institute for May reproduces an address given before the institute in January by Mr. E. A. Sperry, president of the Sperry Gyroscope Company, and deals with the engineering applications of the gyrostat. It appears that the gyroscope has been successfully applied to the stabilising of the United States steamer *Worden*, and that the application has enabled a more complete study of the effects of rolling of vessels on the power necessary to propel them to be made. To the gyrostatic compass we have directed our readers' attention previously. The application of the gyrostat to the control of the wings and rudders of an aëroplane has now been successfully carried out, and we have, in addition, recorders of the rolling and pitching of vessels and artificial horizons depending on the gyrostatic principle, all working satisfactorily.

THE report of the Advisory Committee for Aëronautics for the year 1912–13 gives a general account of the work accomplished. The construction of the new four-foot wind channel at the National Physical Laboratory has been undertaken in the light of numerous experiments, and the pulsations in the flow which are the chief cause of difficulties in air-channel experiments have been so much reduced that the accuracy of individual measurements can be relied on in general to within one-half per cent. This channel replaces one of the same size, but a new 7-ft. channel is projected, and the necessary sum for its construction will be included in the estimates for 1913–14. In this respect the laboratory will be provided with means for experiments on fully rigged models of complete aëroplanes, an acceptable addition to its resources too long delayed. Amidst a number of interesting and important researches carried on, the investigation of the stability problem will command most attention, alike from mathematicians, physicists, and from those who have to trust themselves to their incessant vigilance to keep their frail craft upon an "even keel" in the air, and we therefore are glad to note that great advance has been made in the study and investigation of this problem, though sufficient time has not elapsed to put the knowledge so derived to the test of practical application. The close relationship between the work carried on at the Royal Aircraft Factory and that at the laboratory gives reason to hope that the inevitable divergence between laboratory and full-scale experiments will be ascertained and allowed for, and we are glad to note the cooperation that exists to forward the experiments. We hope to return to the work of this department of the laboratory when the technical report of the committee is ready.

IN a paper published in the *Gazzetta Chimica Italiana* (vol. xliii., i., 38) Prof. F. Angelico and Mr. F. Catalano

have brought forward additional evidence in support of the generally accepted view that traces of formaldehyde are present in the foliage leaves of plants during the period of active assimilation under the influence of sunlight; they show, moreover, that formaldehyde is absent when the same plants are kept in darkness so as to suppress the chlorophyllian function. Parasitic plants, such as *Psalliota campestris* and Coprinus, which do not contain chlorophyll, also fail to give any indication of the presence of formaldehyde. The authors made use in their experiments of the glucoside atractylin, which is present in *Atractylis gummifera*; this substance they find to be the most delicate test yet devised for minute traces of formaldehyde; a solution obtained, for example, by adding three drops of 40 per cent. formaldehyde to one litre of water gives, under suitable conditions, a distinct violet coloration with the reagent. This behaviour is quite specific, no other aldehyde or substance responding in the same way.

THE report of the meeting of the Swiss Scientific Association held last autumn at Altdorf includes accounts of the many permanent commissions which the association has instituted. One of the most notable is in charge of the definitive edition of Euler's works; five volumes, including the "Algebra," "Dioptrica," and "Mechanica," have been published since 1911. The work of the geological commission and the glacier commission is prolific in measurements, maps, and observations. The nature protection commission, instituted in 1906, is successfully carrying out the project of a *grande réserve*, or national park, in the Grisons (the commune of Zernetz). Newly instituted is the commission for the study of atmospheric electricity. Among the papers read, a comprehensive study of the mountain structure of central Switzerland, by Dr. P. Arbenz, is one of the most considerable. Mr. Weiss discusses recent research in molecular physics, and his own work on magnetons. "Radiation and Matter," by von Kowalski, includes investigations in atmospheric electricity; Mr. R. Chodat describes the problems of plant-coloration and his own important experiments in this difficult subject. Mr. Pictet shows that the flight of insects in relation to artificial light is not a case of tropism. Very interesting conclusions on the effects of storms upon forests are drawn by Mr. van Ufford from the destruction of the forest at The Hague in 1911. Mr. Mirimanoff carries further than Poisson and Oettinger the mathematical theory of the game *trente et quarante*. The sixty-nine papers read at the meeting are well distributed among the various sciences, and deal in many cases with significant and important research.

PROF. J. WALKER, F.R.S., of Edinburgh University, is just completing a "Text-book of Organic Chemistry for Students of Medicine," which will shortly be published by Messrs. Gurney and Jackson, London, and Messrs. Oliver and Boyd, Edinburgh.—Dr. Reinheimer is about to issue through Messrs. Kegan Paul, Trench, Trübner and Co., Ltd., a volume entitled "Evolution by Co-operation: A Study in Bio-Economics."—"The Living Plant," a description and interpretation of its functions and structure, by Dr. W. F. Ganong, will be published shortly by Messrs. Constable and Co., Ltd.

OUR ASTRONOMICAL COLUMN.

A METEORITE SEEN TO FALL AND FOUND.—It is not often that a meteorite is actually seen to fall to the ground, but this was the case with the specimen described by Messrs. Masumi Chikashige and Tadasu Hiki, in the Memoirs of the College of Science and Engineering, Kyoto Imperial University (vol. v., No. 1, September, 1912). It was at 6.30 on the morning of April 7, 1904, that the meteorite fell at the village of Okano, in the neighbourhood of the town Sasayama, in the province of Tamba, Japan. The white glowing mass was observed by a peasant, and when he came to the spot he found a stone which looked like a block of iron with the long point upwards, and imbedded about 80 cm. A teacher 30 km. to the north observed the meteorite also as a white glowing mass, at an altitude of about 70°. The chemical analysis, which is given in the paper, is as follows, in percentages:—Iron, 94·85; nickel, 4·44; cobalt, 0·48; copper, trace; phosphorus, 0·23. Thus nickel-iron amounted to 98·52 per cent., and phosphor-nickel-iron 1·48 per cent. This result is very similar to that obtained in the De Sotoville meteorite, namely nickel-iron 98·71 per cent., and phosphor-nickel-iron 1·29 per cent. The authors complete their monograph with three excellent plates showing the external appearance of the meteorite and sections before and after treatment.

MEASURES OF PROPER MOTION STARS.—The Carnegie Institution of Washington has just issued another large volume (No. 168), the contents of which in this case consist of the valuable series of measures of proper motion stars made by Mr. Burnham with the 40-in. refractor of the Yerkes Observatory in the years 1907 to 1912. Attention may be directed in the first instance to the promptitude of publication of such a mass of valuable data, for this large volume, containing no fewer than 311 pages, includes measures so recently made as last year. The total number of measures made in the present work is about 9500, and all places are given for 1880 unless otherwise mentioned. The original places as given in the General Catalogue of Double Stars have been retained, and the stars in part i. reduced to the same epoch. The measures are published in two parts. The larger number of stars selected for measurement are given in part ii. of this volume, and are taken from the General Catalogue of Double Stars for reasons stated in the notes and observations in that work. Part i. includes all other stars for which prior observations with the micrometer have been made. The small stars from zone 26° of the Oxford Astrographic Catalogue were compared with one or more fainter stars in the field. Mr. Burnham has added three more stars, namely 37 Tauri, 55 Tauri (OΣ 79), and OΣ 82, to the list of Boss's thirty-nine bright stars, principally in Taurus, which appeared to have a common proper motion of approximately 0·10″ in the general direction of about 100°.

THE TOTAL SOLAR ECLIPSE OF AUGUST 30, 1905.—In a beautifully got-up portfolio measuring about 20×25 in., just issued by the Hamburg Observatory, Prof. R. Schorr publishes a series of nine reproductions illustrating the photographs of the

corona he and his party secured during their expedition to Souk-Abras, in Algeria, in August, 1905. Perfect weather was experienced on this occasion, and the programme was carried out in its entirety. When it is stated that the diameter of the moon on these plates measures 7·5 inches, the scale of the reproductions can be better understood. The main object of the expedition was to obtain the structure of the inner corona by means of photography, and for this purpose a horizontal telescope of 20 metres focal length was used, fed by a cœlostat. The objective itself was by Zeiss, and of 160 mm. aperture, and achromatised for wave-lengths 531·7 and 405·1 $\mu\mu$, the resulting solar image being 19 cm. in diameter. In the introduction to these plates Prof. Schorr gives details as to the kind of photographic plates used, and the details of exposure. Great pains seem to have been taken to make the reproductions as representative of the original negatives as possible, and the result is remarkably successful. Each plate is accompanied by a celluloid sheet over it, on which the correct orientation and prominent features are marked. The last plate is a reproduction of a drawing by Dr. Graff of the structure of the inner corona, in which are combined the details shown in all the negatives. Fortunately, on the occasion of that eclipse the corona was fully of quite extraordinary detail, especially in form, and this record is therefore of particular interest. The atlas is a valuable outcome of a most successful expedition.

KELVIN MEMORIAL WINDOW.

THE memorial window to Lord Kelvin, subscribed for by engineers in Great Britain, Canada, and the United States, was dedicated at a special service in Westminster Abbey on Tuesday. The window is in the east bay of the nave on the north side. The light from it falls upon the graves of Kelvin and Isaac Newton, and immediately beneath it are the graves of Darwin and Herschel. The window, which was designed by Mr. J. N. Comper, is chiefly ecclesiastical and historical in character. The lights contain two large figures under canopies; and in front of the pedestals of these two figures are tablets held by angels, containing the words :—"(1) In memory of Baron Kelvin of Largs, (2) engineer, natural philosopher, b. 1824, d. 1907." Beneath these again are the arms of Lord Kelvin and of Glasgow University.

The Dean of Westminster, in the course of an address, is reported by *The Times* to have said that forty years ago there were at Cambridge an extraordinary constellation of great men of mathematical genius—Adams, Clerk-Maxwell, Cayley, and Stokes—occupying professorial chairs. Of the four, two had been justly commemorated in the north aisle of the Abbey. Another Cambridge man, William Thomson, was destined to surpass his four friends. In originality, in range of study, in ingenuity and resource, Kelvin was pre-eminent. It was said by Goethe that to make an effort in the world two conditions were essential—a good head and a good inheritance. Lord Kelvin and his four friends had both. The new world of electricity had been already discovered. They entered into that inheritance and transformed its glories for the practical utility of mankind. It was Kelvin who subdued the whole province of the new realm of science. All through his life, in the face of a strong prevailing current of materialism, Kelvin preserved the simplicity of his early Christian faith. He wrote in 1892 : "The real phenomenon of life infinitely transcends human science." He spoke with the humility of a great man, and many could look back with gratitude to the example which the religious belief of a man of his gigantic intellect furnished to those of a younger generation. His name was one of the most epoch-making in the domain of natural philosophy.

The chairman of the Memorial Committee then offered the window to the Abbey, and it was gratefully accepted by the Dean on behalf of himself and the Chapter.

THE EXETER MEETING OF THE ROYAL SANITARY INSTITUTE

AT the twenty-eighth congress of the Royal Sanitary Institute, held at Exeter on July 7–12, many useful papers were contributed, one or two of which dealt with research work of scientific interest.

Mr. James Crabtree contributed a paper which embodied some experiments on the lines of those carried out by Dr. E. J. Russell and his co-workers on the part played by protozoa in soils, the experiments here recorded relating to sewage disposal beds. From these experiments it is evident that the fauna of the bacteria bed play an important part in keeping the bed open and porous; it seems probable that they play a further part by the actual digestion of some of the more easily resolvable colloidal matter precipitated on the beds. The conclusion arrived at is that the animal population of the bacteria (contact) bed is entirely advantageous in maintaining the capacity of the bed, probably in keeping down extraneous bacteria, and thus assisting purification to some extent, and also by bringing about some actual digestion of colloidal deposited matter.

Dr. Gilbert G. Fowler and Mr. E. Moore Mumford contributed an interesting paper on the bacterial clarification of sewage. The area and cost of sewage filter beds depends mainly upon the amount of colloidal matter present in the sewage, and some confusion of ideas is probably due to the fact that the ordinary sewage filter is called upon to do two entirely different things at the same time, namely on one hand to oxidise, granulate, and finally discharge as humus the colloidal matters present, and, on the other, to oxidise and nitrify substances in true solution. If this oxidising and coagulating process could be brought about by suitable open-tank treatment before the filtration process, it is obvious that the latter could be enormously accelerated, if not dispensed with altogether; and the whole operation of sewage treatment could be conducted on a much smaller area.

In the course of a research on another matter, one of the authors had occasion to study the reactions of an organism occurring in nature in pit-water impregnated with iron. This organism is a true facultative organism, preferably an aërobe, and it exercises a specific action on iron solutions. The action of the bacillus on iron solutions proceeds in two stages, in which the aërobic and anaërobic actions appear to be symbiotic, at any rate under the conditions occurring in nature. The aërobic action is to precipitate ferric hydroxide from iron solutions; while the anaërobic action is to transform the hydroxide thus precipitated into bog ore, with partial reduction of the iron to a ferrous state. It was found that in order to precipitate the iron sufficiently the organism required a certain proportion of albuminoid organic matter. It was, therefore, natural to expect that ordinary sewage matter could be utilised in this way. Experiment, in fact, showed that a previously sedimented sewage effluent could be effectively clarified in this way when acted upon by this organism in presence of small quantities of ferric salts, aërobic conditions being maintained in the liquid by means of a current

of air. An experimental plant has been erected at the University of Manchester, which will permit of accurate observations of this process and the collection of further detail.

Mr. F. Southerden has extended the investigations made at Leeds, Glasgow, and London, upon atmospheric pollution, to the atmosphere over the city of Exeter and its immediate surroundings. He finds that rain-water collected less than a mile from the centre of the city is very noticeably superior to that collected more centrally, the proportion of dissolved solids and sulphate reaching only about one-half, but there is no marked difference as regards the chlorine or ammonia, and so he concludes that these are derived in the main from sources other than coal smoke. The experiments make it clear that the atmospheric pollution of Exeter, though less in amount, is similar in its nature to that in larger towns.

Mr. Southerden also gave the results of his investigations upon the effect of coal smoke on the stonework of Exeter Cathedral. The stonework consists of limestone of varying quality and texture, and the oxy-acids of sulphur derived from the combustion of coal convert the calcium carbonate of the stone into soluble calcium sulphate, and the surface of the stones slowly crystallises and expands in such a way that disintegration results. The author concludes that the exact conditions which lead to scaling are not simple, but the extent of sulphate formation appears to be an important factor, and the destructive influence of sulphuric acid is doubly important, for in the more sheltered situations it leads to disintegration by scaling, and in exposed positions calcium sulphate is formed and dissolved away, thus hastening the destruction brought about by more natural agencies, such as frost, wind, and rain. The blackening which is very noticeable on portions of the stone structure is due to a thin film of soot, from which it has been possible to extract a small amount of tar.

REPORT OF THE ADVISORY COMMITTEE ON FORESTRY.

A FEW weeks ago was issued a Blue-book of general interest, the Report of the Advisory Committee on Forestry for the period July to October, 1912 (Cd. 6713, price 6*d*.). The Advisory Committee on Forestry comprises such well-known names as Sir E. Stafford Howard, Sir S. Eardley-Wilmot (late Inspector-General of Forests, India), Sir D. Prain (director of Kew), Sir William Schlich (the Oxford professor of forestry), and Prof. Somerville, of the Oxford School of Rural Economics, who is perhaps as well known for his writings on forestry as for those on agriculture; and Mr. E. R. Pratt, president of the Royal English Arboricultural Society. Of the ten members of the Committee only four are professional foresters, so that the professional element is not even in a majority. Mr. R. L. Robinson, the chief of the forestry branch of the Board of Agriculture and Fisheries, fulfills the office of secretary to the Advisory Committee, and is apparently the author of the two chief appendices to the report, though one of these is not signed. These appendices, on forest research and development, contain a mass of technical information and interesting general observations, which will well repay perusal by those interested in British forestry.

The Blue-book contains the advice of the Forestry Committee on three questions submitted to it for opinion by Mr. Runciman.

The first of these questions relates to forest surveys, which it is advised should be divided into two classes: (*a*) preliminary or flying surveys, (*b*) detailed surveys.

The surveys proposed should bring together much useful information, and supply a long-felt want in the cartography of these islands. We have excellent geological, topographical, meteorological, and other maps; but he who wishes to see what is the extent and value of the woodlands must be satisfied with the ordinary ordnance maps and a few forest maps. The ordnance maps give no indication of the quality, and are often misleading as to the quantity, of the forest. Yet few of the special maps that exist have the importance of a forest map, with the national issue of 30,000,000*l*. yearly sent out of the country for timber and forest produce, which could be produced easily in these islands! The extension of forest surveys is therefore an excellent scheme, which should meet with universal approval.

When, however, we go on to read that surveys of both types are necessary "*as a preliminary step towards the inauguration of afforestation operations*," the forest surveys assume a sinister aspect. If they are to be taken as an excuse for postponing the commencement of practical forestry, the country will be better without them. This, perhaps, is why Mr. Munro Ferguson adds his rider to the report: "I am of opinion that 2000*l*. is a sufficient sum to apply for survey work for the next two years, after which the expenditure could be reviewed in the light of experience." In the estimate at p. 50, the total cost of the surveys is given at 35,000*l*., and the time at eleven years; and this is for a partial survey, not embracing the whole of the seven areas mentioned in the report of the Advisory Committee. These seven areas for the forest surveys are:—

1. South Wales.
2. North Wales.
3. Westmorland, Cumberland, and Northumberland.
4. Kent, Surrey, and Sussex.
5. Berks, Hants, Wilts, and Dorset.
6. Derby, Lancashire, and the West Riding.
7. Lincoln, Norfolk, Suffolk, and Essex.

It is recommended that surveys be begun in districts 1, 3, 4, and 7, and that in conducting these preliminary surveys use should be made to the fullest extent of the knowledge which local owners, foresters, and agents possess. The cooperation of the Royal English Arboricultural Society and of local committees is also invited. This is excellent.

The report expresses doubts as to the advisability of publishing these forest surveys. It is not clear wherein lies the difficulty of doing so, but obviously they should be of much general utility, both to the public at large and the student of forestry.

The second question on which the advice of the Forestry Committee has been asked relates to "demonstration areas." These have figured largely in British forest literature of recent years, and the Advisory Committee states that "it has received their very careful consideration" (though, indeed, this phrase is repeated in the answer to each question). It seems possible that forest demonstration areas are one of those side issues which during the last three years in British forestry have served to distract attention from the main question—the inauguration of practical forestry by the acquisition and planting of ground on a large scale. Here Mr. Munro Ferguson has added another rider which will receive the hearty approval of every forester—"I agree with paragraph 6, that the Forest of Dean, with the adjoining Crown woods, is well suited to meet the requirements imposed by a demonstration forest, and am of opinion, therefore, that the whole area should be removed from the control of the deputy-surveyor and placed under a trained forest officer." Some years ago, when the post of deputy-surveyor of the Forest of Dean became

vacant, some 600 applications were received for the vacant post, one of them actually being a worthy minister of a local Methodist connection. This shows the loose manner in which forest appointments had come to be regarded in this country. At that time there were probably not a dozen quite qualified foresters available in the whole of Britain.

Rules are framed for the maintenance of experimental plots in private forests. It is possible that in some cases useful purposes may be served by these rules; but it may be anticipated that most frequently we shall find the private forest owner conducting useful experiments in his own forests; and the forest officers, with their wider facilities, carrying on their own experiments in the State forests.

The third reference relates to the training of woodmen, both foremen woodmen and the more fortunate men whose lot it is to work with their own hands. Those who have had experience of the excellent training given in the Government school in the Forest of Dean would endorse all that is here said in its favour. The two forest schools, in the Forest of Dean and in the Chopwell Woods (county of Durham), provide for the training of about fourteen men yearly. We heartily endorse the recommendation that increased provision should be made for the training of men of their type. The census of 1901 returned 12,035 woodmen employed in England and Wales.

The appearance of this Forestry Blue-book is opportune; it shows that Mr. Runciman is actuated by an earnest wish to break away from the difficulties and delays that have so long beset British forestry. It is indeed time that the first sod in practical British forestry were turned. While the Development Commission, with its grant of 500,000*l.* yearly, has been running for three years, no beginning in practical State forestry has yet been made in Britain.

It is not evident from a perusal of the Blue-book why there should be further delay. The obvious course to be followed now is at once to open negotiations for the acquiring of land—either by direct negotiation, or by purchase as it comes into the market; and, so soon as an area has been secured, to depute the competent forest officials in the Whitehall Forest Office to proceed with the planting, in consultation with local opinion and experience. The examination of sites for State forests seems to offer scope for the energies of the five forest advisors recently appointed to the five forest areas into which England and Wales have been divided. These forest advisors are stationed at Oxford, Cambridge, Cirencester, Bangor, and Newcastle.

Following the practice of other countries, the State forest nurseries referred to in the Blue-book should be initiated, as early as may be; not only for the supply of young trees at economical rates for planting in the State forest, but for *free issue to private forest owners*, and to such municipal or other public bodies as may be disposed to undertake forest planting on their own account. The private forest owner in Britain has had a hard time these last years, with falling prices for timber and underwood, and increased taxation. The woodlands that he maintains are a national benefit, and he may well ask that the State should now help him with something more substantial than good advice in forestry!

A somewhat pressing question that the Advisory Committee has not yet touched upon is what monetary contribution, if any, should be allowed to municipal (or other corporate) forest planters by way of grant-in-aid, in the case of loss on their forest planting. India and Cape Colony are, in State forestry, some thirty years ahead of this country and the other British Colonies. For many years in Cape Colony municipal and other non-private planting has been aided on the 1*l.* for 1*l.* principle; that is to say, to every 1*l.* of approved forest expenditure Government has added another 1*l.* With this contribution the State retains certain guarantees for the proper management of the forest or trees planted.

It is, as we have seen, now three years since the Development Commission obtained the grant of half a million a year for developing the natural resources of the country in various ways, the most lasting and far-reaching of these ways being forestry. During the first year provision was made for the planting of about ten square miles of forest in Ireland; but in Great Britain to this day no decided step has been taken in practical State forestry. We may therefore express the very earnest wish that, useful though the contemplated forest surveys may be, they will not be allowed to delay, for one day, the initiation of State forestry in Britain.

In the present season of the year, England is beautiful, almost in proportion to its woodedness! Every consideration of sentiment and hard fact demands the beginning, without further delay, of practical afforestation.

ORNITHOLOGICAL NOTES.

IN view of persistent reports as to the marked decrease, or even disappearance, of the landrail, or corncrake, as a breeding bird in many parts of the country, more especially the eastern and south-eastern counties, the editors have issued with the June number of *British Birds* a schedule of inquiries on this matter. In a covering note Dr. Ticehurst points out that answers should be strictly limited to the presence or absence, now or in the past, and the relative numbers and changes in numbers, of breeding birds in different districts.

A beautifully illustrated article on the albatrosses of Laysan Island, in the South Pacific, appears in the April number of *The American Museum Journal*, based on a visit paid to that wonderful bird-resort by Mr. H. B. Dill in 1911. In spite of periodical raids by plumage-hunters, the albatrosses still retain their original lack of fear, parties of them walking up to a visitor as if to greet him. Some idea of the vast numbers of sea-birds on the island may be gathered from an estimate that their daily product of guano is about 100 tons. Some years ago a company was started to work this guano, but the venture was not a success, owing to the fact that the frequent rains wash out a large proportion of the ammonia from the deposits.

To the April number of *The Emu* (vol. xii., part 4) Dr. R. W. Shufeldt contributes an illustrated article on the osteology of the Cape Barron goose (*Cereopsis novae-hollandiae*). Although the skull presents certain well-marked peculiarities, the rest of the skeleton is that of a typical goose. The genus has been assigned to a special subfamily, but the affinities of the bird are clearly with the snow-goose (*Chen hyperboreus*).

According to *The Christian Science Monitor*, Boston, Mass., of May 29, Mr. R. C. Murphy has returned to New York from an ornithological expedition to South Georgia, bringing with him 500 skins and skeletons of large sea-birds, while others are to follow. These are to be divided between the American Museum of Natural History and the Brooklyn Institute of Arts and Sciences. Mr. Murphy states that on a small island a mile in diameter he has seen 4000 pairs of birds nesting on the ground. The principal specimens represent albatrosses, petrels, and three kinds of penguins. R. L.

GREAT ADVANCE IN CRYSTALLOGRAPHY.[1]

TWO pictures of the actual apparatus employed (one of which is produced in Fig. 7), and an explanatory diagram of it (Fig. 8), will enable the precise nature of the experiment to be grasped. A plate, 1 cm. square and 0·5 mm. thick, was cut from a good crystal of zinc blende parallel to a cube face, and

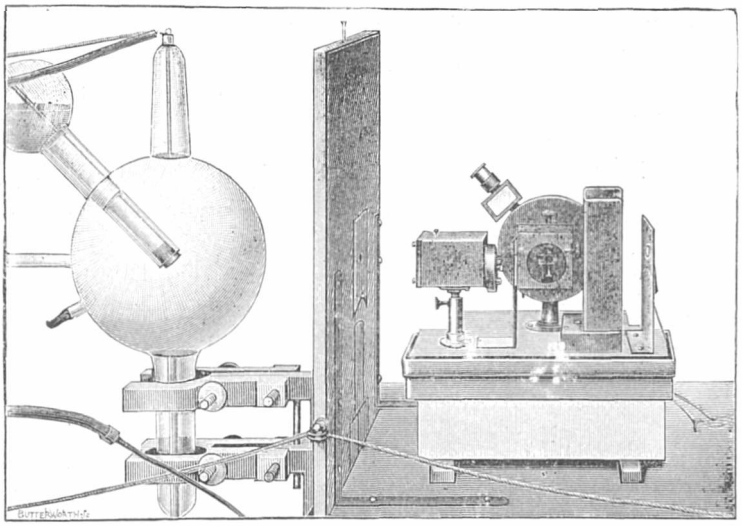

FIG. 7.—Apparatus of Friedrich, Knipping, and Laue for passing X-rays through crystals and photographing the effect.

adjusted on the crystal holder of a goniometer in the path of a very narrow pencil of X-rays from the bulb, isolated by their passage through a succession of lead screens (lead being impervious to X-rays) pierced by small holes. The last screen, which gave the final form to the pencil of rays, was a plate of lead 1 cm. thick, pierced by a cylindrical hole 0·75 mm. in diameter, and fitted with a delicate means of adjustment so that the axis of the boring could be brought

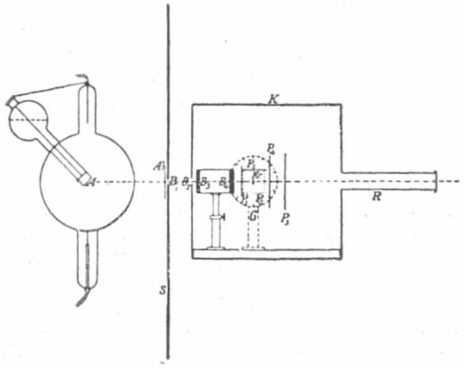

FIG. 8.—Diagrammatic representation of apparatus of Friedrich, Knipping, and Laue. A, Antikathode of X-ray bulb; B_1, B_2, B_3, B_4, diaphragms of lead; K, leaden box-screen with tubular termination R; S, large leaden screen; G, goniometer; P_1, P_2, P_3, P_4, P_5, photographic plates; Kr, Crystal; Al, aluminium plate.

exactly perpendicular to the crystal plate. The beam of pure X-rays of circular section, after passing normally through the crystal plate, was received on a Schleussner-Röntgen photographic plate, which was afterwards developed with rodinal.

The developed plate showed an intense circular spot at the centre, caused by the direct X-rays, and a considerable number of other spots of elliptical shape, arranged in a geometrical pattern. Three of these original photographs are exhibited on the screen (and two are also reproduced in Figs. 9 and 10). If a series of such photographic plates be used, at different distances from the crystal (as for Figs. 9 and 10), the fact is revealed that the spots are formed by rectilinear pencils of rays spreading in all directions from the crystal, and some of them inclined more than 45° to the direction of the incident rays. These deflected beams show similar properties to the original X-rays, ionising air and helium just like the latter, and with the same degree of variation with the pressure. Hence, there can be no doubt that the character of these deflected rays issuing from the crystal is that of unaltered X-rays, and that they are due to the deflection of X-rays by planes situated at different angular positions in the interior of the crystal. In short, we are in face of reflection of X-rays from planes of atoms in the crystal.

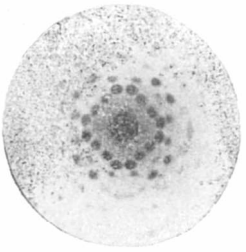

FIG. 9.—Spot photograph afforded by zinc blende. Incident X-rays perpendicular to a cube-face, and parallel to a tetragonal axis of symmetry.

Now a study of the spots reveals the further interesting fact that the pattern shows the full symmetry (that of class 32) of the cubic system to which the

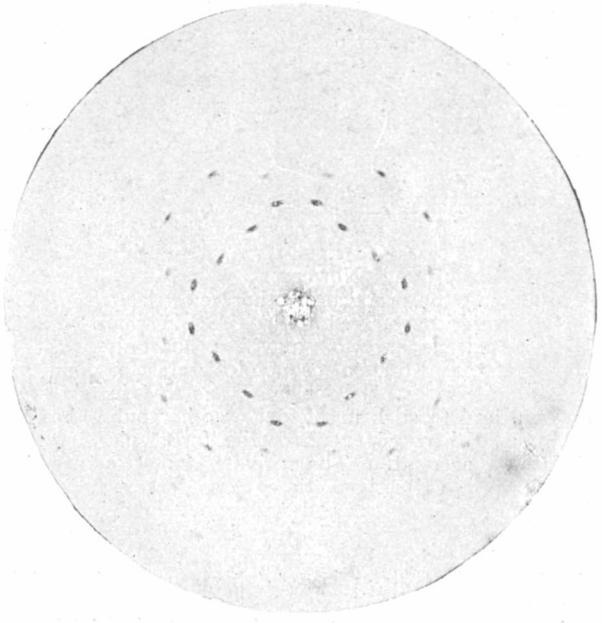

FIG. 10.—Spot photograph afforded by zinc blende. Incident X-rays perpendicular to a cube-face, and parallel to a tetragonal axis of symmetry.

crystal belongs, although zinc blende exhibits the slightly lower symmetry of the hexakis-tetrahedral class (31), one of the formerly so-called hemihedral classes of the cubic system. This clearly proves that it is the planes of similar and similarly situated (same-

[1] From a discourse delivered at the Royal Institution on Friday, March 14, by Dr. A. E. H. Tutton, F.R.S. (continued from p. 494).

ways orientated) atoms in the crystal that are producing the reflections; in other words, the planes of the space-lattice.

At first Laue, who published a separate memoir on the theory of the experiments, considered that it was the space-lattice due to similarly situated zinc atoms which afforded the spot patterns, as he had been engaged with Prof. Summerfeld in experiments relating to the action of zinc on X-rays. But there appears no reason why the sulphur atoms should not be similarly capable of producing reflections of these extremely fine vibrations of corpuscles, and as the space-lattice is the same for both elements, according to all versions of the geometrical theory of crystal structure, there is really no reason why we should not consider the reflections as due to the general space-lattice of zinc blende. Laue considered the "molecules" of the crystal to form a three-dimensional grating—that is, a Raumgitter—and that each molecule is capable of emitting secondary vibrations when struck by incident electromagnetic waves from the X-ray bulb; also that the molecules are arranged according to the simple cube space-lattice (No. 1). The incident waves being propagated parallel to one of the cube axes (edges), the wave-surfaces will be parallel to the plane of the other two cube edges. He then considers the spots to be interference maxima of the waves scattered by the orderly arrangement of the molecules in the crystal. The equations of condition were next found for interference maxima of direction cosines α, β, γ, and for incident wave-length λ, and from the position of each spot the direction cosine of the pencil of rays which formed it was calculated, assuming all the transmitted pencils to come from the centre of the crystal. Thirteen spots in each quadrant were investigated, and in every case Laue's equations were satisfied; hence, the conclusion that the spots are due to interference of secondary Röntgen radiation appears to agree with the positions of the spots, provided only radiations of certain definite wave-lengths are present in the incident rays.

The lecturer pointed out, in an article in NATURE of November 14, 1912, that the structure of zinc blende was probably not so simple as had been assumed by Laue, and that the space-lattice with a point at the centre of each side of the cube (No. 3) was the more probable one, the structure being that assigned to it by Barlow and Pope, as already described in this lecture.

A satisfactory explanation has since been advanced by W. L. Bragg, which does accord with this structure and with other essential conditions referred to by the lecturer, altogether avoids the assumption of only a few wave-lengths, and agrees with a simple reflection of unchanged X-rays from the planes of points of the general space-lattice of zinc blende. He regards the incident radiation as composed of a series of independent pulses, which, falling on a number of atoms definitely scattered in a plane, are separately reflected, each atom acting as a centre of a secondary wave, and the whole building up a wave-front. The interference maximum is thus due to the reflection of the incident pulses from a system of parallel planes of similar atoms, that is, from one of the parallel series of planes of the space-lattice. Now besides the principal planes of the space-lattice, the cube planes, the points of the space-lattice also lie in a considerable number of other planes, all of which are possible crystal faces corresponding to rational indices. For instance, the octahedral planes are very easily traced, as also those of the rhombic dodecahedron. A minute fraction of the energy of a pulse traversing the crystal will be reflected from each parallel plane in succession, and the corresponding interference maximum will be produced by a train of reflected pulses. The crystal thus actually manufactures rays of definite wave-lengths, just as a diffraction grating does, the only difference being here in the extremely short length of the waves, which is the very reason why X-rays can penetrate in this manner into the Raumgitter structure. Each incident pulse produces a train of pulses, resolvable into a series of wave-lengths, λ, $\lambda/_2$, λ_3,$\lambda/_4$, &c., where $\lambda = 2d \cos\theta$, d being the shortest distance between successive identical parallel planes in the crystal, and θ the angle of incidence of the primary X-rays on the plane of points of the space-lattice. The intensity of any spot depends on the energy in the spectrum of the incident radiation characteristic of the corresponding wave-length, and this varies considerably so that certain parts of the spectrum are much more pronounced than others. Also it depends on the number of reflecting atoms in the plane—that is, on the reticular density of the possible crystal face corresponding to the plane. Hence, the greater the reticular density, the more intense the spot produced in the photograph. As reticular density is also proportional to importance of face, the primary faces having the greatest reticular density, it follows that the most important facial planes reflect the intensest spots, a fact which may prove of great value in enabling us to discover the real primary planes in doubtful cases. Each spot reflected by a plane (considered as passing through the origin and two other points) lies at the intersection of two ellipses, and the figure on the screen, showing an analysis of one of the spot photographs, exhibits this clearly. Indeed, the plane of atoms corresponding to any spot can be found from the two ellipses; for each ellipse is the section of a cone by the plane of the photographic plate, the axis of the cone being the line joining the origin (centre of the triaxial system, and considered as one of the three points determining the plane) and the particular atom (the second or third point of the three, of definite coordinates), and the generator of the cone being the incident beam.

The interesting results of Bragg are in full accord with the assumption of the centred-face cubic space-lattice (No. 3), but not with either the simple-cube or the centred-cube space-lattice (Nos. 1 and 2). They also account for the elliptical shape of the spots. The amount of ellipticity depends on the distance of the photographic plate from the crystal. When the two are very close the spots are round, but they become more and more elliptical as the plate is receded (compare Figs. 9 and 10). The phenomenon is due to the fact that the initial rays are not strictly parallel, and the effect will be clear from the next slide. The vertically diverging rays striking the reflecting planes of the upper part of the crystal meet them at a less angle of incidence than those of the lower part, and so the reflected rays converge. Horizontally diverging rays, however, diverge still more on reflection. Hence the section of the reflected beam is an ellipse with major axis horizontal.

It is of importance to note that the centred-face cubic space-lattice is characteristic both of the arrangement of identically (sameways) orientated and environed atoms of the same element, zinc or sulphur, and of the atoms of both elements regarded as equal spheres in contact. In the slide already shown (Fig. 5), of Barlow and Pope's model, the spheres of sulphur are coloured yellow to distinguish them from the grey-coloured spheres of zinc. If we ignore the colour and consider them as similar spheres, we see that they form the centred-face cubic arrangement. The hemihedral nature of zinc blende is, however, very likely connected with some real difference of

volume between the atomic spheres.[5] As the spot figure is holohedral it would appear to be due to the space-lattices of similarly placed atoms of either (but in each lattice only one) element, rather than to the spheres of the combined system of atoms.

This latter conclusion is further borne out by the result of the new work by Laue on quartz. The photograph now shown, so kindly sent by Prof. Laue, exhibits the trigonal nature of the symmetry very clearly, and Prof. Laue informs me that the same figure is afforded by both right and left quartz, so that it does not reveal the hemihedral character of quartz, but possesses the full holohedral symmetry of the trigonal space-lattice, and exhibits the threefold nature of the axis of symmetry which is perpendicular to the plate and along which the X-rays were directed.

Prof. Laue has also experimented with the crystals of a number of other cubic substances, and, like zinc blende, they all show holohedral symmetry about a tetragonal axis.

W. L. Bragg has found that stronger photographs of the same nature can be obtained from mica, using nearly grazing incidence, and it is by use of this fact that Mosely and Darwin have been able to study the reflected rays electrically, and found them to resemble ordinary X-rays. By the kindness of Mr. Bragg, a diagram of his apparatus and a positive lantern slide of one of his mica spot photographs are exhibited on the screen.

Incidentally these experiments appear likely to throw light on the much-debated question of the nature of the X-rays. As all the experiments unite in indicating that a fraction of the X-rays suffers reflection at the planes of atoms parallel to the more important possible crystal faces, all being planes of atomic points of the space-lattice, it would appear that the X-rays are some type of wave-motion, or at any rate some kind of pulse with an extended wave-front. Yet after reflection they retain the same corpuscular character which Prof. W. H. Bragg has shown they possess. For the liberation of a high-speed electron from an atom traversed by the X-ray cannot be explained, according to Rutherford, unless it be supposed that the energy of the X-ray is concentrated over a minute volume, and can be given up in an encounter with a single atom. Hence these experiments show that the X-rays possess at the same time the apparently opposite properties of extension over a wave-front and concentration in a corpuscular point.

It appears to the lecturer that the simpler explanation is that we are truly dealing with waves, but that the wave-lengths of the X-rays are excessively short, approaching atomic dimensions, and that the amplitude of the effective waves is actually smaller than the reflecting atom. This view that the X-rays are waves is further supported by the results of some experiments just completed by Barkla, in which a diverging pencil of X-rays was directed on a crystal of rock-salt, and the issuing rays received on a photographic plate in the same manner as in the experiments already described. The developed plate shows a new phenomenon, namely, striation of the spots obtained by reflection from the planes of atoms of the space-lattice, especially in the reflections from the cubic cleavage planes. The striations are, in fact, true interference bands, due to interference of the reflections from equally spaced parallel planes of the space-lattice. By the kind courtesy of Prof. Barkla, two of these interesting photographs are projected on the screen. On the assumption that the X-rays are waves, and that the reflecting plane is one passing through corresponding portions of single NaCl molecules—which agrees with the choice of a representative point from each simple molecular grosser unit, or of a similarly situated atom of one of the two chemical elements present in each molecule NaCl to act as such representative point of the space-lattice—Barkla has calculated that the wave-length is the one hundred and sixty millionth of a millimetre, $0{\cdot}6\times10^{-8}$ mm. If the grosser unit be polymolecular, the wave-length works out larger, being proportional to the cube root of the number of atoms in the molecule. If eight molecules form the grosser unit of sodium chloride crystals, as suggested by some chemists, the wave-length is found by Barkla to be twice this value, namely $1{\cdot}2\times10^{-8}$ mm.; and if sixteen molecules of NaCl are comprised in the grosser unit, as would be the case if Barlow and Pope's structure for the cubic binary compounds be correct (the space-lattice in the case of rock-salt being that of the simple cube, No. 1), the wave-length would be still longer, about the seventy millionth of a millimetre, $1{\cdot}5\times10^{-8}$ mm. Now it is very interesting that these values are of the same order as those derived from determinations of the velocity of electron ejection, which varied from 1 to 2×10^{-8} mm.

The most trustworthy recent estimations of the size of a molecule of rock-salt indicate a diameter about 3×10^{-7} mm. Hence the diameter of a crystallographic molecule 8NaCl would be 6×10^{-7} mm., and of 16NaCl about $7{\cdot}5\times10^{-7}$ mm.

It should be emphasised, in concluding the account of this fascinating new field of research, that all these reflections occur in the body of the crystal, and are not surface effects. Cleavage planes usually afford stronger results merely because they are generally primary planes of high reticular density. The effect is sometimes heightened by conducting the X-rays at nearly grazing incidence; but this is by no means necessary, and in Laue's experiments several of the planes were inclined as much as 30° to the incident rays.[6]

The experimental proof of the existence of the space-lattice imparts all the more confidence in approaching the other great advance which has lately been achieved. The completion of the four-volume catalogue of crystallographically measured substances by Prof. von Groth provokes the question: What more is needed in order to enable a crystallised substance described in this book to be recognised by means of a few measurements on the goniometer? For it is now proved up to the hilt that, except in the cases of cubic crystals identical in angles in accordance with their perfect symmetry, every solid crystallisable substance is characterised by its own peculiar crystalline form and interfacial angles. This is quite true, even to the last minute of angular measurement, when the conditions of crystallisation are ideal. When thus perfect, even isomorphous sub-

[5] Prof. T. W. Richards shows (*loc. cit.*) how four molecules of ZnS, each composed of an atom of zinc and an atom of sulphur of very different volumes, can form the cubic crystal unit of an edifice possessing cubic systematic symmetry, the different volumes of the two kinds of atoms causing it, however, to exhibit hemihedral class-symmetry.

[6] Since this lecture was delivered, the following further experiments with X-rays and crystals have been described in NATURE (1913, vol. xci., pp. 111, 135, and 161). H. B. Keene has obtained with crystals of galena, mica, and rock salt analogous results to those of Laue, Friedrich, and Knipping, the spot diagrams corresponding to the holohedral systematic symmetry in each case. T. Terada has found that the transmitted rays may be rendered optically visible by means of an ordinary fluorescent screen, provided the pencil of rays be from 5 to 10 mm. in diameter and the crystal adequately transparent to the rays; this latter he found to be the case with crystals of alum, borax, cane-sugar, fluorspar, mica, rock crystal, and rock salt, in thicknesses of 4 to 10 mm. M. de Broglie has obtained spot diagrams similar to those of Laue, Friedrich, and Knipping with fluorspar, magnetite (using an octahedron face), and rock salt; but all the spots were striated with parallel fringes. Finally, Owen and Blake have obtained what appears to be a line spectrum of X-rays by using the surface of a crystal of gypsum as a diffraction grating. The lines were always the same with different crystals, using the same X-ray bulb, but the different lines varied in intensity with the hardness (degree of vacuum) of the bulb. The evidence from the action of crystals on X-rays is thus accumulating that the X-rays are waves of exceedingly short wave-length.

stances show differences among themselves to the extent of a definitely measurable number of minutes. But such perfection of growth is not easy to attain, and, in ordinary crystallisation without special precaution against disturbance, is rarely found. The essential crystallographic measurements can, however, be made in an hour's time, provided use be made of the two- or three-circle form of goniometer, such as the excellent one devised by Dr. Herbert Smith. This form of goniometer enables all the needful measurements of the interfacial angles to be made with a single setting of the crystal on the wax of the holder. But practical difficulties have hitherto still stood in the way. Excellent as is von Groth's classification—and the most suitable for a work of reference of the full and comprehensive character of this permanent monument of the master's industry and wide knowledge of chemistry, related compounds being arranged and compared in close proximity—the very nature and size of such a work renders it unsuitable for the purpose of discovering rapidly the chemical composition of a substance from its geometrical elements. An index of substances arranged in the order of their symmetry and the numerical values of the crystal constants within the system is what is needed, and this has now for the first time been drawn up for the ten thousand measured substances by Prof. von Fedorow.

Another difficulty then presents itself. It often entirely depends on how a crystal is held in space, that is, which direction in it is regarded as the vertical axis, which the right-and-left axis, and which the front-and-back axis, as to what the nature of the crystal constants (elements) will be. Moreover, even if two different observers choose these similarly, they may select a different parametral plane (a fourth face other than the three faces parallel to the axes, and cutting off unit lengths from the latter) to determine the axial ratios. Hitherto, beyond a few arbitrary rules —for instance, that the right-and-left axis of a rhombic crystal shall be longer than the front-to-back axis —there has been no definite guiding principle for the determination of the setting. Prof. von Fedorow has now given us one, by means of which we can be sure which are the real vertical faces (prismatic or pinakoidal), which is the basal plane (the pair of top and bottom faces), and which set of pyramid faces are the important ones fixing the relative axial lengths. The true setting has been determined by Prof. von Fedorow for every one of the substances in his index, and the crystal elements for such setting calculated.

The mode of classification adopted in this index-catalogue is based on the values of the five fundamental angles which, in general, characterise the crystals of any specific substance. A cubic crystal has definite angles which are entirely fixed and rendered invariable by reason of the perfect symmetry. At the other extreme come triclinic crystals, the general case, in which all five fundamental angles are different and quite independent of each other. On monoclinic crystals there are three independent angles, from which the other two can be calculated. Rhombic crystals have only two independent angles, which, if measured, enable the other three to be calculated. Hexagonal, tetragonal, and trigonal crystals possess only one angle independent of the symmetry, determinative of the relative length of the unique axis of hexagonal, tetragonal, or trigonal symmetry.

The first object of von Fedorow in order to arrive at the correct setting is to decide which are the primary axial-plane and parametral faces; and he is wonderfully aided here by the discovery of the fact that the faces most extensively developed under ideal conditions of growth are those over which the points of the space-lattice are most densely strewn. Hence, von Fedorow tries to discover the faces of greatest reticular density, the primary faces, by calculation. For it is a well-known fact that the most diverse habits—due to different faces being most prominently developed under different conditions of environment—are shown by the crystals of the same substance.

Having thus determined the correct setting, and measured the principal angles, including the five fundamental angles, the results are recorded in the index-table in an abbreviated symbolic form if the substance be a new one, or, if it has previously been measured, and therefore appears in his index-table, he discovers the fact at once by the identity of the elements found with those of a substance given in the table. The average time occupied in all this by Prof. von Fedorow or one of his skilled assistants is about two hours. Mr. T. V. Barker, who studied with Prof. von Fedorow before acting as demonstrator of mineralogy at Oxford, has been of considerable help in submitting the new method to a very severe test, from which it has emerged with flying colours. He collected, at Prof. von Fedorow's suggestion, fifty specimens of substances which had been crystallographically examined in this country and described in the recognised publications. Five of these were furnished by the lecturer, six others by Prof. Armstrong, with the aid of Messrs. Colgate and Rodd, others by Drs. Chattaway and Drugman and Mr. Marsh at Oxford, and the remainder by Mr. Barker himself. Each specimen was only marked by a number, no name or formula being given, on its dispatch to St. Petersburg. The result was that Prof. von Fedorow identified without any difficulty forty-eight of the fifty substances. The crystals of one of the two others were too imperfectly developed to be of use, and the fiftieth specimen was that of a substance which it was afterwards discovered had never hitherto been measured, a fact which was first indicated by its elements not tallying with those of any substance mentioned in the table. This latter occurrence confers even greater confidence in accepting the new method.

It thus appears that in Prof. von Fedorow's hands, or those of his pupils, the method is practically infallible, provided the crystals are well developed and not of cubic symmetry. If the latter perfect symmetry be developed, reference must be made to the optical properties, which the lecturer has always insisted have been far too much neglected, and are here seen to be indispensable. The optical methods themselves, moreover, as regards their use with small crystals on the polarising microscope, have been further perfected by von Fedorow, his universal stage placing the rapid methods of two- and three-circle goniometry at the disposal of the microscopist. It must also be remembered that Prof. von Fedorow's method does not discriminate between the members of isomorphous series, as the crystals usually available are not of the high degree of perfection requisite in order clearly to substantiate the last few minutes of any particular angle; for the differences of angle between the members of series formed by metallic family analogues have been shown by the lecturer to be very minute, although unmistakable given the most perfect crystals, and have also been found to obey the law of progression according to the atomic weight of the metal. For instance, ammonium zinc sulphate was simply returned by Prof. von Fedorow as a member of the isomorphous series of monoclinic double sulphates and selenates crystallising with $6H_2O$. Qualitative analysis would be necessary after

all, in order to discover the actual member of the series present. Moreover, there are certain features of Prof. von Fedorow's own peculiar version of the theory of crystal structure, such as his idea about pseudo-cubic and pseudo-hexagonal types, and his dealing in consequence with many substances as being deformations of a higher symmetry than they actually show, which to the lecturer appear unnecessary complications likely to discourage the use of the new method. But these defects can, and doubtless will, be eliminated as the method becomes practically applied. That crystallochemical analysis will ever entirely replace qualitative chemical analysis, however, is neither to be expected nor desired, even if alone on the ground of the admirable training and experience in chemical operations and principles which chemical analysis affords.

In conclusion, it must be obvious that a great advance has really now been made in crystallography. For the geometrical conception of crystals as homogeneous structures, based on the fourteen space-lattices as the grosser structures and the 230 point-systems as the ultimate atomic structures, has been not only theoretically perfected, but proved by direct experiment to represent the actual fact, by the epoch-making work of Laue, Friedrich, and Knipping. The descriptions and chemical relationships of all the ten thousand measured substances have been brought together in the great book of Prof. von Groth, and the material further sifted, reduced to correct setting, and arranged according to symmetry and elements by Prof. von Fedorow, in a tabular form immediately available as a reference index for identification purposes, thus providing the material for a true crystallochemical analysis. The science of crystallography is thus now placed on a secure foundation, supported equally by mathematics, geometry, and experiment, and its natural data are rendered available for chemists and physicists alike.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Mr. C. W. Dyson Perrins, a former member of Queen's College, has offered to give the sum of 5000*l.* towards the erection of the proposed new chemical laboratory, if such sum is required after the expenditure of the 15,000*l.* granted for the purpose by the trustees of the Oxford University Endowment Fund.

THE honorary degree of LL.D. was conferred on Mr. W. Botting Hemsley, F.R.S., on July 8 by the University of Aberdeen.

DR. W. C. MCCULLAGH LEWIS has been apppointed to the chair of physical chemistry in the University of Liverpool, in succession to Prof. F. G. Donnan, F.R.S.

THE following honorary degrees were conferred by Queen's University, Belfast, on July 9:—*D.Sc.*: Prof. Norman Collie, F.R.S.; Sir Joseph Larmor, M.P., F.R.S.; Sir Arthur Rücker, F.R.S. *LL.D.*: Sir Donald MacAlister.

AMONG the bequests of the late Lord Avebury is one of 1000*l.* to the University of London to found a prize in mathematics or astronomy in memory of his father, Sir John William Lubbock, first Vice-Chancellor of the University.

DR. J. RITCHIE, superintendent of the laboratory of the Royal College of Physicians, Edinburgh, has been appointed to the new chair of bacteriology instituted in the University of Edinburgh, under the bequest of Mr. Robert Irvine, Royston, Granton.

AMONG recent appointments at University College, London, are:—Dr. Marie Stopes, lecturer in palæobotany for three years; Miss Winifred Smith, lecturer in taxonomy for three years; Dr. Paul Haas, demonstrator in organic and applied chemistry and in chemical physiology, and Mr. H. Terrey, demonstrator in chemistry to medical students; Mr. N. F. Kelsey, demonstrator in mechanical engineering, and Mr. D. W. Fletcher in graphics.

THE following official announcement referring to the Education Bill has been issued on behalf of the Government:—"The measure which will shortly be introduced by Mr. Pease in the House of Commons, although it is technically described as an Education Bill, is in reality only a one-clause measure designed to enable the Government to afford a limited amount of immediate relief to education authorities. It will, when introduced next week, form a not inappropriate peg upon which to hang a statement of the Government's policy in the development of a national system of education."

AT the annual graduation ceremony at St. Andrews University on July 10 honorary degrees of LL.D. were conferred on Lieut.-Col. Sir C. H. Bedford and Dr. G. A. Boulenger, F.R.S., among others. In addressing the graduates the principal, Sir James Donaldson, said that both France and Germany have come gradually to form an exact notion in regard to university work. Their idea is that after the culture obtained in the secondary schools the students who are to proceed to degrees should spend three years at the university and should devote themselves to the original study of certain subjects in which they find their interest. There must be entire freedom for the student to form his own plans and studies and entire freedom for the professor to search for the truth for its own sake in disregard to consequences. The Germans have kept to that idea since 1815, and the French have now come to the same conclusions. We are in many respects far behind this ideal, and we cannot expect to be a match for those nations in the great conflicts of the world, but it is the duty of young and old to look into the question, particularly at this time, and see if we cannot do something to put ourselves on an equality with Germany and France.

THE recommendations made in the second report of the Advisory Committee on the distribution of Exchequer grants to universities and university colleges, which was issued last February, having been approved by the Board of Education, the Committee proceeded with a further consideration, in conjunction with the universities and colleges, of the federated superannuation scheme adumbrated in the second report. In its third report the committee outlines a federated scheme of superannuation for professors and other members of the staffs of colleges. Two problems were debated; first, the selection of a limited number of insurance companies to undertake the contracts involved by the superannuation system; and secondly, the drafting of a suitable form of legal agreement between the institution and the members of the staff which when adopted by colleges concerned would give practical effect to the principles set out in the second report. The form of agreement indicates, by means of alternative readings, the various forms which will be necessary to meet different cases. In practice institutions will probably find it convenient to have separate forms of agreement to meet different types of cases. The superannuation scheme itself expresses in legal terminology the principles outlined in the second report, and in order to

secure interchangeability it seems essential, the third report points out, that this part of the legal document should be adopted without amendment by every institution cooperating in the system. A pamphlet has been prepared setting out the main features of the options available and the precise terms offered by the selected insurance companies; it also embodies the detailed arrangements with the companies, and copies will be furnished on request by the companies concerned.

FROM time to time attention has been directed in these columns to the recent successful endeavours to develop the University of Hong Kong. The prospectus for the session 1913–14, and a pamphlet providing details concerning the faculty of engineering, have reached us, and an examination of the arrangements made shows that there is likely to be much useful work done in the next few years in the spread of higher scientific education in China. A resolution adopted by the Court of the University says: "It is resolved that the objects of the University are (*inter alia*) to afford a higher education, more especially in subjects of practical utility, such as applied science, medicine, &c. Similarly, in a dispatch from the Viceroy of Canton, we read "the teaching of applied science, including civil, mechanical, and electrical engineering and surveying, meets the present and most urgent need of our country." The University possesses spacious laboratories for experimental work and is assured already of excellent equipment. In the first year of the University fifty-three students applied for admission in the faculties of engineering, medicine, and arts, and of that number thirty-eight elected to take instruction in engineering. When the University commenced instruction in engineering science it was stated definitely that no student would receive a degree unless he attained the same standard as that required by the London University. To that policy the faculty of engineering is committed, and the regulations have been framed with that object in view.

THE eighth report has been published (Cd. 6871) of the Rural Education Conference, which was constituted by minutes of the Presidents of the Board of Agriculture and Fisheries and of the Board of Education in 1910. The conference has had under consideration the following reference received from the Board of Agriculture and Fisheries last November:—"To inquire into the methods which local education authorities adopt with the object of promoting efficiency in the performance of manual processes, *e.g.* ploughing, hedging, ditching, sheep-shearing, milking, and basket-making, and to advise as to any further action that may appear to be desirable for the purpose of developing skill in workmen employed in agriculture." After the examination of eleven expert witnesses representing farmers and educationists, the conference drew up a number of recommendations which may be summarised very briefly. To develop skill in agricultural employees it is recommended that instruction in certain manual processes of agriculture should be provided for the elder boys and girls attending elementary schools in rural districts; local education authorities should regulate the holidays in country schools so as to leave the boys free to work on the land at a time when their work is most useful; classes in manual processes for men employed upon the land should be conducted so as to be more in the nature of assistance to, rather than the formal instruction of, those who attend; instruction in manual processes should be provided more generally throughout the country, present instruction should be made more thorough, and practical instruction be encouraged in every possible way.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 7.—M. F. Guyon in the chair.—Paul **Appell**: Developments in series proceeding according to the inverse of given polynomials.—J. **Boussinesq**: The equations of dynamic equilibrium of the superficial layer separating a liquid from another fluid.—A. **Lacroix**: The rhyolitic and dacitic rocks of Madagascar, and in particular those of the Sakalave region. Complete analyses of twenty-one rocks are given, and the distribution of the rocks in the area discussed.—A. **Müntz** and E. **Lainé**: Studies on the irrigation of soils. The minimum irrigation gives the best cultural results; it depends on the slope of the land, the nature of the vegetation, and the dimensions of the distributing channels.—G. **Charpy** was elected a correspondant for the section of chemistry in the place of the late Louis Henry.—Ch. **Platrier**: Meromorph solutions of certain linear integral equations of the third species.—M. **Barré**: Helicoids of the second species.—Th. **Got**: The symmetries of the reproductive groups of indefinite ternary quadratic forms.—A. **Romieux**: Contribution to the study of the terrestrial deformation.—C. G. **Bedreag**: Electrification by the X-rays. The charge depends on the pressure, the nature of the metal of the electrode, difference of contact potential between the electrode and the surrounding walls, and ionisation of the gas. In the present communication a special study is made of the function of the metal.—André **Chéron**: A new arrangement for the examination of stereoscopic photographs.—Henri **Labrouste**: The visibility of traces of foreign substances deposited on a surface of pure water. The method described permits of the thin layers being detected by optical means without the use of any special apparatus.—Mlle. Cécile **Spielrein**: The equilibrium of lithium sulphate with the alkaline sulphates in presence of their mixed solution at 100° C.—Ruby **Wallach**: The thermal analysis of clays. The double galvanometer of Le Chatelier-Saladin with a thermocouple was applied to the examination of various kaolins and clays, the heat absorption due to the volatilisation of water being shown by well-marked depressions on the curve. A slight heat evolution between 900° C. and 1000° C. was also observed in some cases, an effect probably due to a transformation of alumina.—André **Job** and Paul **Goissedet**: The cerium acetylacetonates. Ceric acetylacetonate has been prepared and analysed.—M. **Dumesnil**: Diketones obtained by the action of the xylylene dibromides on the sodium derivative of *iso*propylphenylketone and their decomposition by means of sodium amide.—Roger **Douris**: The addition of hydrogen to some secondary α-ethylenic alcohols in presence of nickel.—Marcel **Baudouin** and Louis **Reutter**: The analysis of the contents of some Gallo-Roman vases and of a flask of perfume, found in a vault at la Vendée. These vases date probably from the third century. Styrax, turpentine, resin, asphalt, or Judean bitumen, and incense were found. These prove indirectly the existence of commercial relations between France and Asia Minor, Somaliland and Judea.—J. **Durand**: A layer of aragonite crystals in the marls attributed to the Upper Trias in eastern Corbières.—C. **Gaudefroy**: The dehydration figures of different types obtained in the same crystals.—A. **Guilliermond**: The rôle of the chondriome in the elaboration of the reserve products in fungi.—A. **Marie** and Léon **MacAuliffe**: The anthropometric study of 200 Madagascans.—E. **Gley** and Alf. **Quinquaud**: The influence of the suprarenal secretion on the vasomotive actions dependent on the splanchnic nerve.—A. **Barbieri**: The difference in chemical composition between the great sympathetic system and the axial

nervous tissue of the cranial and spinal nerves.—E. **Bourquelot** and M. **Bridel**: The synthesis of β-geranyl-glucoside with the aid of emulsin; its presence in plants. The glucoside can be synthetised from geraniol saturated with water and glucose in presence of emulsin; a larger yield is obtained in aqueous acetone solution. The presence of this glucoside was proved in *Pelargonium odoratissimum*.—P. Noël **Bernard** and J. **Bauche**: The influence of the mode of penetration (cutaneous or buccal) of *Stephanurus dentatus* on the localisations of this Nematod in the organism of the pig and on its evolution.—E. **Pinoy**: The necessity of a bacterial association for the development of a Myxobacterium, *Chondromyces crocatus*.—F. **Picard** and G. R. **Blanc**: Coccobacillary infections in insects.—F. **Kerforne**: The Devonian iron minerals of Brittany.—Antonin **Lanquine**: The presence of layers containing Witchellia, of the lower Bajocian, at some new points of the Var.—Alfred **Angot**: A new barometric formula. The barometric formula communicated to the last meeting is equivalent to Babinet's formula. The latter in its original form is more easy to memorise.—Ladislas **Gorczynski**: The reduction in the solar radiation for 1912 from pyrheliometric measurements made in Poland.

BOOKS RECEIVED.

Some Secrets of Nature. With an Introduction by W. J. P. Burton. Pp. xiv+144+plates. (London: Methuen and Co., Ltd.)

The Romance of Nature. A Nature Reader for Senior Scholars. With a Preface by Rev. A. Thornley. Pp. xix+164+x plates. (London: Methuen and Co., Ltd.) 2*s*.

Démonstration du Théorème de Fermat. By Prof. E. Fabry. Pp. 22. (Paris: Hermann et Fils.) 1.50 francs.

Grundriss der Fermentmethoden. By Prof. J. Wohlgemuth. Pp. ix+355. (Berlin: J. Springer.) 10 marks.

Petrographische Untersuchungen an Gesteinen des Polzengebietes in Nord-Böhmen. Des xxxii. Bandes. Der Abhandlungen der Mathematisch-Physischen Klasse. No. VII. By K. H. Scheumann. Pp. vi+607–776. (Leipzig: B. G. Teubner.) 8 marks.

Memoirs of the Geological Survey of India. Vol. xl. Part 1. The Oil-Fields of Burma. By E. H. Pascoe. Pp. x+269+xxxix+54 plates. (Calcutta: Geological Survey of India; London: Kegan Paul and Co., Ltd.) 5 rupees, or 6*s*. 8*d*.

Les Idées Modernes sur la Constitution de la Matière. Conférences Faites en 1912. By E. Bauer, A. Blanc, E. Bloch, Mme. P. Curie, A. Debierne, and others. Pp. 370. (Paris: Gauthier-Villars.) 12 francs.

Les Moteurs Thermiques dans leurs rapports avec la Thermodynamique. Moteurs à explosion et à Combustion. Machines alternatives a Vapeur. By F. Moritz. Pp. vi+297. (Paris: Gauthier-Villars.) 13 francs.

Proceedings of the Third Meeting of the General Malaria Committee held at Madras, November 18, 19, and 20, 1912. Pp. iv+289. (Simla: Government Central Branch Press.)

The Tarn and the Lake: Thoughts on Life in the Italian Renaissance. By C. J. Holmes. Pp. x+48. (London: P. Lee Warner.) 2*s*. 6*d*. net.

The British Parasitic Copepoda. By T. Scott and A. Scott. Vol. i. Text. Pp. ix+252+2 plates. Vol. ii. Plates. Pp. xii+lxxii plates. (London: The Ray Society; Dulau and Co., Ltd.) 15*s*. net.

Das Tierreich. Edited by F. E. Schulze. Lief. 34 to 38. (Berlin: R. Friedländer und Sohn.) 18 marks; 38 marks; 13 marks; 3.50 marks; 5.20 marks respectively.

Animal Husbandry for Schools. By Prof. M. W. Harper. Pp. xxii+409. (London: Macmillan and Co., Ltd.) 6*s*. net.

The Development of the Human Body. By Prof. J. P. McMurrich. Fourth edition. Pp. x+495. (London: H. Kimpton.) 12*s*. 6*d*. net.

Die Europaeischen Schlangen. By Dr. F. Steinheil. Zweites Heft. Plates 6–10. (Jena: G. Fischer.) 3 marks.

Sitzungsberichte der Physikalisch-medizinischen Sozietät in Erlangen. 44 Band. 1912. Pp. xxvii+256. (Erlangen: M. Mencke.)

Irritability: a Physiological Analysis of the General Effect of Stimuli in Living Substance. By Prof. Max Verworn. Pp. xii+264. (New Haven, Conn.: Yale University Press; London: Oxford University Press.) 15*s*. net.

Travers' Golf Book. By J. D. Travers. Pp. 232. (London: Macmillan and Co., Ltd.) 8*s*. 6*d*. net.

Palæontologische Zeitschrift. Edited by Prof. O. Jaekel. Band I. Heft 1. Pp. 160+3 plates. (Berlin: Gebruder Borntraeger.) 25 marks.

The Eugenics Education Society. Fifth Annual Report, 1912–13. Pp. 76. (London: Kingsway House, Kingsway.)

A History of the First Half-Century of the National Academy of Sciences, 1863–1913. Pp. ix+399+plates. (Washington: The National Academy of Sciences.)

Department of Commerce and Labor. The Foreign Commerce and Navigation of the United States for the Year ending June 30, 1912. Pp. 1342. (Washington: Government Printing Office.)

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