THURSDAY, DECEMBER 12, 1912.

VEGETATION STUDIES IN THE NEW WORLD.

Die Vegetation der Erde. Sammlung pflanzengeographischer Monographien. Edited by Prof. A. Engler und Prof. O. Drude. XII., Die Pflanzenwelt der peruanischen Anden in ihren Grundzügen dargestellt. By Prof. A. Weberbauer. Pp. xii+355. Price 20 marks. XIII., Phytogeographic Survey of North America. A Consideration of the Phytogeography of the North American Continent, including Mexico, Central America, and the West Indies, together with the Evolution of North American Plant Distribution. By Prof. J. W. Harshberger. Pp. lxiii+790. Price 40 marks. (Leipzig: W. Engelmann, 1911.)

THE two last volumes to be added to Drs. Engler and Drude's series of plant geographical monographs deal with the vegetation of the Peruvian Andes on the one hand, and that of North and Central America and the West Indies on the other. The field in both cases is vast, and Prof. Harshberger's volume is of considerable bulk. Dr. Weberbauer's volume can scarcely be considered a worthy successor to the able monograph prepared by Dr. Reiche on plant distribution in Chile (vol. viii. of this series, published in 1907), which is all the more a matter of regret since the Peruvian Andine flora is one of particular interest. A good account of the vegetation of this region, in its relation to that of Chile and Argentina in the south and Ecuador to the north, still requires to be written.

Both volumes are excellently printed and illustrated, and by the illustrations alone Dr. Weberbauer's book fulfils a certain purpose.

A work on the flora of the Peruvian Andes labours under the initial disadvantage of dealing with only a portion of a vast tract of connected country stretching from Chimborazo to the Straits of Magellan. Moreover, since Peru lies so much nearer the equator, the vegetation is much less homogeneous in character than is the case in Chile. Four distinct botanical regions are included in Peru, each of which demands separate treatment, and the affinities of which lie rather in the longitudinal direction—that is to say, with similarly situated regions of countries to the north and south—than in the transverse. These regions are the coast flora; the middle region, often desert in character; the alpine-Andine flora of the western and central Cordillera, and the flora of the moist eastern slopes of the Andes.

The alpine region may be considered to extend from about 10,000 feet to the limits of vegetation on the western Cordillera, and to include the western slopes of the eastern range. Its flora is in direct continuation with that of northern Argentina and Chile, and is remarkably distinct and characteristic, showing very little relationship to that of the lower western slopes, and still less to that which is found as soon as the crest of the eastern Cordillera is crossed.

This highly-specialised nature of the high Andine flora was fully appreciated by Weddell, and it would have been far more valuable had the "Chloris Andina" been continued first, and a generalisation on the Andine flora as a whole followed in due course. Much still requires to be done in the careful study of the extensive collections of South American plants in European herbaria, and then another Hooker will be needed to give us a masterly review of the vegetation of the Andes as a whole.

The volume under discussion follows the general plan of the series. The physical geography of the region is first dealt with; then follows a short second part in which the characteristics of the different natural orders found in Peru are mentioned, as well as conspicuous genera, &c. In Part iii. the general character and distribution of the vegetation is described, and its zones are indicated and discussed in detail.

The inclusion of the flora of the tropical eastern slopes, which is so Brazilian in its affinities and so different from the rest of the vegetation, seems almost out of place in a work on the Peruvian Andes and cannot be rightly understood without careful comparison with the flora of western Brazil. Dr. Weberbauer's book, taken as a whole, suffers from being more of the nature of an account of his own travels rather than a general treatise. He has travelled far and wide in the Cordillera, and has proved himself to be an admirable collector; but, valuable as is his work in many respects, it does not appear, from the volume under review, that he has thereby constituted himself the proper person to write a comprehensive work on the flora of Peru.

The task undertaken by Prof. Harshberger is even more vast than that of Dr. Weberbauer, and the result is the accumulation of an immense amount of material which has often been but poorly digested. German readers are to be congratulated on being presented with an extract by Prof.

Drude of fifty pages, in lieu of the 700 which have to be faced by English-speaking botanists. The main portion of the volume consists of four parts: "History and Literature of the Botanic Works and Explorations of the North American Continent"; "Geographic Climatic and Floristic Survey"; "Geologic Evolution, Theoretic Considerations and Statistics of the Distribution of North American Plants," and "North American Phytogeographic Regions, Formations, Associations." Following the American custom, the author leaves out the normal "al" ending of adjectives wherever possible, with unpleasant results. The book consists very largely of extracts taken from the many papers mentioned in the voluminous bibliography, and taken with very little discrimination or critical examination. In consequence, there is a sad mixture of good, bad, and indifferent. For example, the statement that Vallisneria occurs "in the sea in a tangled mass" off Newfoundland is inserted without comment, when, as is well known, it is a fresh-water plant, and *Zostera marina* is the plant in question. Many similar examples of the inclusion of erroneous statements from unworthy sources might be given.

From the way the volume is pieced together it is not possible to gain any vivid impression of the flora of North America as a whole. There is no broad generalisation based on the information which has been so laboriously collected, but the subject-matter tends to be broken up into minutiæ of detail.

As an example of the way in which the book is made up of information somewhat indiscriminately pieced together, it may be mentioned that the author quotes himself by name as the authority for some of his own statements on p. 381.

The whole of North America is divided up into zones, sections, regions, areas, formations, &c., and it is not possible to discuss here the accuracy or otherwise of the citations from which the information is built up. As the sources on which the author has drawn for his information are often far from accurate, it is unfortunately not possible to depend very much on the statistics based upon such questionable data.

The smaller defects in printing, &c., are not numerous, though it will be noticed, among other things, that Fig. 26 has been printed upside down.

Our chief cause of regret is that this book should have appeared as one of the volumes of Engler and Drude's series, "Die Vegetation der Erde," and that it should thereby receive a certain stamp of authority.

SIGNS AND SYMBOLS, EGYPTOLOGY, AND FREEMASONRY.

The Signs and Symbols of Primordial Man, being an Explanation of the Religious Doctrines from the Eschatology of the Ancient Egyptians. By Dr. Albert Churchward. Pp. xxiii + 449. (London: Swan Sonnenschein and Co., Ltd., 1910.) Price 25*s.* net.

THIS is a book well worth reading, difficult to describe, and impossible to criticise. The title would lead one to expect a scientific analysis and classification of ancient signs and symbols, as well as a digest of the religious doctrines from the eschatology of the ancient Egyptians. The author in his own discursive way deals with an abundance of materials for a truly scientific work, but the best that can be said of the scientific character of the book is that, with ordinary care in dovetailing the materials and exact references to sources, it would have been a useful work of reference.

What makes criticism impossible is (1) the author's wholesale repudiation of all authorities and theories which cross his path, and (2) the fact that the book is dedicated to "All my brother Masons." The book covers a vast field outside Egypt, but almost every paragraph bears a stamp which may be interpreted: All was once Egyptian, now Masonic. With great erudition and ingenuity—and good-humoured pugnacity—facts and theories of all sorts are massed together in no particular order to form what must be charming reading for Freemasons. There is no lock which the author's key cannot open. There is no other authority on any of the subjects discussed to be allowed to bar the author's path. He knows and believes; 18°, 30°, and 33° also know and believe; and everybody else either does not or should not know. To deal with the author's exploits in the open field of scientific inquiry would be perfectly useless, because at any adverse turn of the argument some Masonic mystery would envelop both the author and the subject, and you would strike a "dead wall of mystery." Astronomy and orientation are discussed in a grandly dogmatic fashion, and most astounding statements are unaccompanied with anything like a scientific demonstration.

The title of the book will doubtless attract readers other than Masonic, and they will find, with a multitude of other statements of the same kind, the origin of the pre-Columbian Americans finally accounted for; Mexican crafts in the Mediterranean laden with Masonic treasures from Egypt; Egyptian priests invading Ireland and Britain; the Ainu of Japan in Egyptian universi-

ties; Pythagoras going about Egypt begging for crumbs of information withheld from him, but jealously guarded for the benefit of English and American Freemasons; and the North American Indians talking Welsh, an old story.

The following citations selected quite at random on adjoining pages illustrate the author's method. Referring to the epagomenal days of the Egyptian year, the author observes: "The first, third, and fifth of the epagomenal days were considered unlucky. In Freemasonry these numbers have a peculiar significance, which all M.M.'s understand, and with the common herd of people these days are still considered as unlucky days and numbers. How many know why or the origin of it?" (p. 14). How first-rate authorities are "herded" by our author is shown in his estimate of Dr. Eduard Seler's work, "that he has not succeeded in giving the true decipherment of any of his translations of the various codices of the Mayas, Mexican, and Central American nations that he has attempted to, and until he recognises Egypt as the primordial and origin we are of opinion that he will not" (p. 15). JOHN GRIFFITH.

PEDAGOGICS.

(1) *Education.* A First Book. By Prof. Edward L. Thorndike. Pp. ix+292. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1912.) Price 6*s.* net.

(2) *L'Education Physique ou l'Entraînement Complet par la Méthode Naturelle.* Exposé et Résultats. By Georges Hébert. Pp. iii+85+8 plates. (Paris: Librairie Vuibert, 1912.)

(1) IT need scarcely be said that any book on education by Prof. Thorndike will be suggestive and helpful; yet it is not quite easy to realise the constituency for which his latest work is specially written. If this first book is meant for students in training for the teaching profession, it seems to contain at once too little and too much. The volume is a simple introduction to the whole theory of education. Rather less than one-seventh of the book concerns the elementary practical situations which usually come into the control of the beginner. Experience shows that practice, unless it is begun before there is some power of reflection, furnishes the best starting point for the future teacher, and a first book for the trainee should therefore concern itself primarily with bringing out the fundamental features of the practical situation. Chapters on the meaning and value of education, the aims and results of education and the like appear so remote from the problem of the moment that students are apt to be impatient of them. A background of classroom experience would, however, give point and meaning to such discussions.

On the other hand, if the book is written for those who have already had teaching experience and come up for a fuller theoretical course, one would again have expected a different proportion in the various parts of the book. Indeed, the slightness of all the discussions almost puts this type of reader out of consideration. Prof. Thorndike has nevertheless written with his usual clearness and charm, and nobody who reads the book can fail to find some new illustration, some new way of putting an old point, or some suggestive phrase which he will treasure, and as to our general quarrel with it, we ought to add that probably no two authorities are agreed as to what is the best way of introducing the future teacher to the study of his profession.

(2) The English Board of Education has made up its mind about what is the best method of physical training for school children. All this is written down in an official book which every teacher in training must master. Such a proceeding on the part of the Board has its critics, who are not slow to say that there is no one and only system of physical training, and that more depends on the spirit in which the physical exercises are gone through than on the particular movements it embraces. "Teach your boys to walk, to run, to jump, to box, and to swim, and leave those artificial extension movements, which mean nothing, alone!" This is the spirit of M. Hébert's little book. It is not, of course, written in criticism of our Board of Education; it is just a simple account of the methods applied to the physical training of French sailors and of the results achieved. The author calls it the natural method, because his system is based on just those movements which men are called upon to make in the ordinary course of a life of freedom. Teachers and others who are concerned about physical training will find the work interesting and suggestive. It is abundantly illustrated.

J. A. G.

OUR BOOKSHELF.

The Significance of Ancient Religions. In relation to Human Evolution and Brain Development. By Dr. E. Noel Reichardt. Pp. xiv+456. (London: George Allen and Co., Ltd., 1912.) Price 12*s.* 6*d.* net.

THE nature of this work by Dr. Reichardt can be best indicated by a citation from the introduction: "And the practical value of the study of these religions lies in this, that not only does it acquaint us with the forces that have determined human history and built up human character; it affords us, moreover, the key to all the bewildering

problems of modern psychology. For these religions tell us exactly what has taken place in the human brain during this period of development. The evolutionary process . . . has added to the human brain a new layer of cells; and it is the progressive development of this new layer of cells, carried on through each successive wavelet, that has given rise to the astounding phenomena of human history."

The reviewer, although familiar with recent research on the cortex of the brain, has failed to identify "the new layer of cells" mentioned by Dr. Reichardt. It appears from his text that these cells were at first "barred from contact with the outside world by the pre-existing mind organ," but in the Greeks it appears "the new mass of cells entered into relation with the outside world," giving "them that brilliant power of objective ideation which still glorifies them in our eyes." The author's explanation of the evolution of human religions and human faculties has the merit of simplicity and the unfortunate demerit of being founded on imagination rather than on ascertained facts.

Michael Heilprin and His Sons. A Biography. By Gustav Pollak. Pp. xvi+540. (New York: Dodd, Mead and Co., 1912.) Price 3.50 dollars net.

MICHAEL HEILPRIN was in many ways a remarkable man. A Polish Jew, who, after a short residence in Hungary, betook himself to the United States, he exhibited an extraordinary faculty for accumulating information. The editor of his life states that he read eighteen languages and his memory was stored with tens of thousands of dates. In America he drifted into literary work and became a writer of articles in encyclopædias and journals and a frequent contributor to the *Nation*. Of his two sons, Louis, the elder, followed in the footsteps of his father, but Angelo was destined to achieve a wider fame.

Born in Hungary, Angelo Heilprin was taken to Philadelphia at the age of three years. He studied for a year in London at the Royal College of Science, and was much impressed by Huxley's personality and tuition. At first geology claimed his attention, especially invertebrate palæontology, but in later years he became a well-known traveller, visiting Mexico, the Arctic, British Guiana and Alaska. His greatest achievement in this line was his work in Martinique, where his daring ascent of Montagne Pelée within a few days after the great eruption of May, 1902, showed that in addition to his eminence as a scientific investigator he was a man of indomitable energy and dauntless courage. He died at the early age of fifty-four, having apparently overtaxed his strength by continual travel, writing and lecturing.

This biography scarcely does justice to its subject, as there is little biographical matter and the book consists mostly of long cuttings from articles in encyclopædias and journals. Angelo Heilprin had an attractive personality and a fine scientific record, of which we get only faint and distant glimpses in this story of his life.

LETTERS TO THE EDITOR.

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The Rise of Temperature Associated with the Melting of Icebergs.

IN a letter to NATURE published in the issue of December 1, 1910, I showed by means of microthermograms taken on a trip to Hudson's Straits that an iceberg melting in salt water produces a rise of temperature. The experiments were performed on the Canadian Government steamship *Stanley*, and indicated that when approaching ice a rise of temperature occurred followed by a rapid fall of temperature a quarter of a mile abeam of the berg.

During the past summer I had an opportunity of examining in detail the temperature effects of icebergs. The Canadian Government placed their steamship *Montcalm* at my disposal for the tests, and three weeks were spent through the Straits of Belle Isle. Careful records were made of the temperature effects of icebergs and land. These tests have shown conclusively that it is the rise of temperature which is the direct action of the melting iceberg, and that when a fall of temperature is observed near ice it is due to the influence of a colder current from the north in which the iceberg is carried. The cooling influence of the ice itself is very small. Cooler currents exist in the main Arctic current, whether accompanied by ice or not, but the presence of the ice causes a zone of water of higher temperature to accumulate for a considerable distance about it.

The icebergs I studied in the Straits of Belle Isle and off the eastern end of the Straits in the Labrador current showed no cooling effect even within a few yards of them.

In Fig. 1 I show the isothermal lines about a typical berg off the eastern end of the Straits of Belle Isle. This diagram was obtained by arranging a number of courses for the ship from all sides up to the ice along radii of six miles.

As a good example of how icebergs and groups of icebergs affect the water temperature, I show a microthermogram in Fig. 2 taken from the records which were obtained in a westward passage through the Straits of Belle Isle. In every case the approach to ice caused a rise of temperature.

The explanation of this iceberg effect which I gave at my Friday evening discourse at the Royal Institution last May was founded on Pettersson's theory of ice melting in salt water. By this theory, which can easily be verified by a simple experiment, ice melting in salt water produces three currents: (1) a current of sea water cooled by the ice, which sinks downward by gravity; (2) a current of warm sea water moving towards the ice; (3) a current of light fresh water from the ice, which rises and spreads over the surface of the salt water.

I at first thought that it was this surface current of fresh water that influenced the microthermometer in the actual sea tests. The fringe of this lighter water would be warmer than the sea water on account of the action of the sun and scattered radiation, which is very strong at sea. The lighter water would retain the heat because it could not mix readily with the sea water. Near the iceberg I considered that a fall of temperature would result from the cooling influence of the surface current of fresher water.

My recent tests have shown, however, that an iceberg melts so slowly that no effect of the dilution can

be detected even right beside the berg. I took a number of samples of sea water at different distances from the berg, as well as from places far from ice. These samples I carefully bottled and brought home to the laboratory, where they were most accurately tested by the electric conductivity method in our physico-chemical department by Dr. McIntosh and Mr. Otto Maass. The tests were carried out at a constant temperature in the most favourable circumstances, and there is no reason to doubt their correctness. Their comparison shows no dilution due to the icebergs, which goes to show how quickly the melted water from the berg is mixed with the sea water. Larger variations were found over different parts of the sea than were obtained in the proximity of ice.

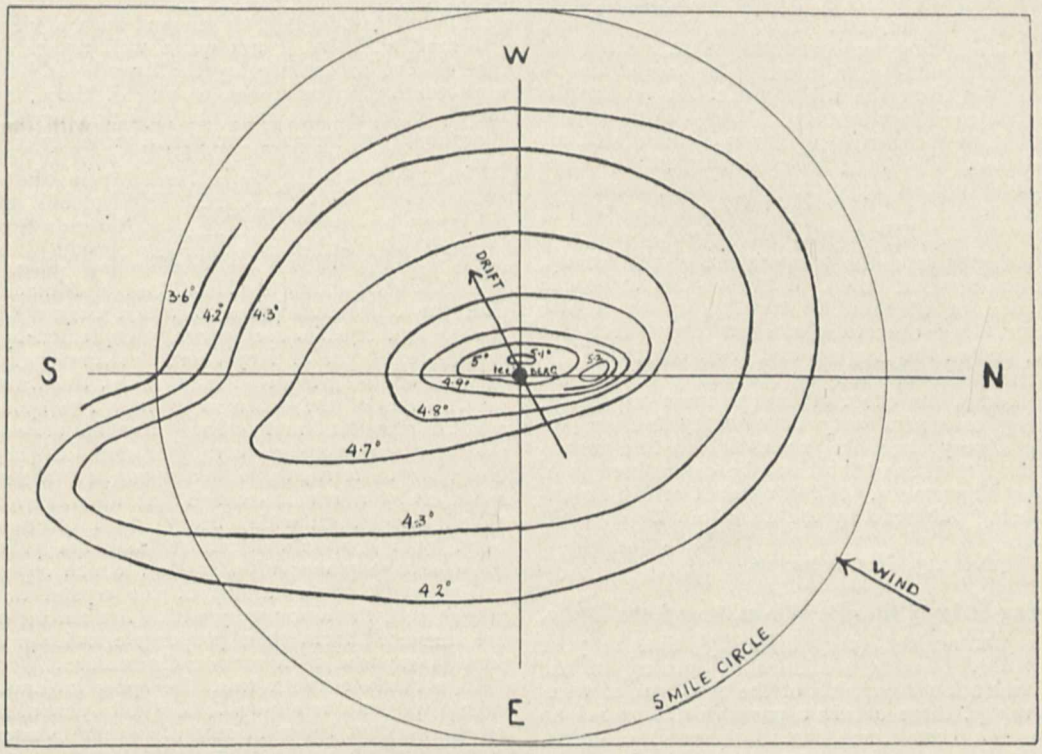


FIG. 1.—Isothermal lines around an iceberg.

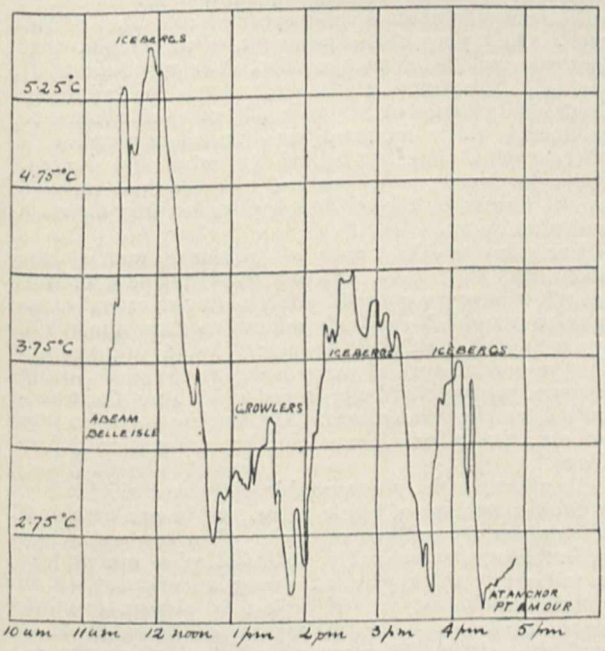


FIG. 2.—Microthermogram through the Straits of Belle Isle, showing the rise of temperature caused by ice.

My tests have shown that an iceberg probably causes only two of the Pettersson currents, *i.e.* a cold current sinking downwards carrying with it all the melted ice water, and a horizontal surface current of sea water flowing in towards the ice to cause its melting (see Fig. 3). By this means we should expect the sea in the immediate proximity of icebergs to be warmer than further away, because the sea surface

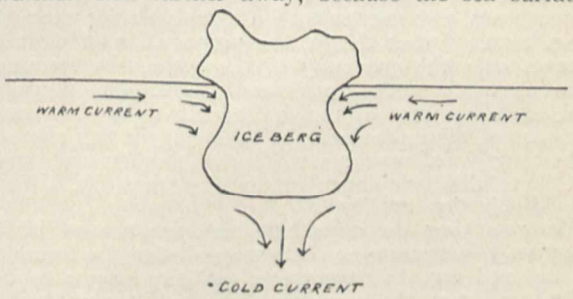


FIG. 3.—Convection currents due to iceberg melting. The fresh water from the melting berg is carried downwards.

current is moving inwards towards the berg, and does not share in the normal vertical circulation which tends to keep the sea surface temperature cooler.

It is interesting to find that an iceberg causes its own current of warmer water, thus providing for its own destruction. Abundant evidence is at hand to show the melting process going on under the water-line.

Dissolved Air.

In my observations of icebergs I was greatly struck with the large amount of dissolved air in the ice

The white colour of the berg is due to innumerable air bubbles in the ice, and not to snow on the surface. An iceberg is very deceptive in this way. While it looks quite soft, the ice is so hard as to make it difficult to chop with an axe. The ice water which I prepared for drinking on board ship with iceberg ice effervesced like soda-water, merely due to the liberation of the air from the melting ice. It is possible that the sudden disappearance of bergs with a loud report is due to their explosion from accumulated air in the interior. One berg which I studied was casting off small pieces, apparently by the pressure of the pent-up air.

Effect of Land.

While icebergs send the temperature of the sea up, the coast-line sends it down. I believe this to be due to the action of the land in turning up the colder under-water. My observations show this effect not only here, but on the English and Irish coasts.

From the point of view of the safety of our St. Lawrence route, the effect of land is most important. The iceberg causes us very little worry because we have only a very short ice track, but to find means whereby the presence of land can be determined is of the greatest importance. A full account of my experiments is being published by the Canadian Department of Marine. H. T. BARNES.

McGill University, November 16.

The Bending of Long Electric Waves Round the Globe.

I HAVE just noticed (very belatedly) that in your reprint of Dr. Fleming's admirable opening of the British Association discussion of the problems of wireless telegraphy, there occurs a passage that raises an objection to a certain mathematical result of mine. Dr. Fleming's opinion in all matters radio-telegraphic is of such great weight that his objection, whether sound or not, is sure to prejudice the fair consideration of a hypothesis I have based on the mathematical result in question, and since the objection has obtained the wide publicity of your columns while my own account of the matter has not, I trust you will allow me space to comment upon it. Comment seems especially necessary on account of Dr. Fleming's eloquent advocacy of certain rival hypotheses.

Put briefly, the theorem is to the effect that the velocity of long electric waves through air containing charged ions is greater than the velocity through un-ionised air, and this leads to a hypothesis for explaining, among other things, the propagation of electric waves over the convexity of the globe. In forming the electromagnetic equations I took the average dielectric constant of the ionised air to be the same as that of the un-ionised air, following in this respect the example of previous writers on similar problems. It is to this customary assumption that Dr. Fleming's objection applies.

In rebutting the objection there are several plain courses. For example, I might recall that the formula I deduced for the increase of velocity may also be obtained from the accepted theory of "anomalous" dispersion—a theory in which the influence of a finite change of the dielectric constant is considered to be negligible. But in the present instance it seems preferable to take another course, and to ask, plainly, Why should the presence of electrified molecules in the number required by my hypothesis affect the dielectric coefficient used in the differential equations? It must be noticed that the concentration of the ions demanded for bending a ray to fit the curve of the earth is of the order 10^6 ions per c.c., assuming the ions to be molecular in size; and thus the proportion of ions to molecules is of the order 10^{-13}. It appears to me most unlikely that such a small proportion of ions can affect the real dielectric coefficient of the medium, especially in view of the fact that there does not seem to be any direct or indirect evidence based on experimental or theoretical knowledge of gases that can be held to support such a view.

I may add that I am quite well aware of many real difficulties confronting the hypothesis. I am not now writing in reference to any of those, but wish merely to point out that the objection urged by Dr. Fleming is, so far as I can see, a remotely conjectural one. W. H. ECCLES.

University College, Gower Street, W.C.,
December 2.

The Specular Reflection of X-rays.

IT has been shown by Herr Laue and his colleagues that the diffraction patterns which they obtain with X-rays and crystals are naturally explained by assuming the existence of very short electromagnetic waves in the radiations from an X-ray bulb, the wave length of which is of the order 10^{-9} cm. The spots of the pattern represent interference maxima of waves diffracted by the regularly arranged atoms of the crystal. Now, if this is so, these waves ought to be regularly reflected by a surface which has a sufficiently good polish, the irregularities being small compared with the length 10^{-9} cm. Such surfaces are provided by the cleavage planes of a crystal, which represent an arrangement of the atoms of the crystal in parallel planes, and the amount by which the centres of atoms are displaced from their proper planes is presumably small compared with atomic dimensions.

In accordance with this, the spots in Laue's crystallographs can be shown to be due to partial reflection of the incident beam in sets of parallel planes in the crystal on which the atom centres may be arranged, the simplest of which are the actual cleavage planes of the crystal. This is merely another way of looking at the diffraction. This being so, it was suggested to me by Mr. C. T. R. Wilson that crystals with very distinct cleavage planes, such as mica, might possibly show strong specular reflection of the rays. On trying the experiment it was found that this was so. A narrow pencil of X-rays, obtained by means of a series of stops, was allowed to fall at an angle of incidence of 80° on a slip of mica about one millimetre thick mounted on thin aluminium. A photographic plate set behind the mica slip showed, when developed, a well-marked reflected spot, as well as one formed by the incident rays traversing the mica and aluminium.

Variation of the angle of incidence and of the distance of plate from mica left no doubt that the laws of reflection were obeyed. Only a few minutes' exposure to a small X-ray bulb sufficed to show the effect, whereas Friedrich and Knipping found it necessary to give an exposure of many hours to the plate, using a large water-cooled bulb, in order to obtain the transmitted interference pattern. By bending the mica into an arc, the reflected rays can be brought to a line focus.

In all cases the photographic plate was shielded by a double envelope of black paper, and in one case with aluminium one millimetre thick. This last cut off the reflected rays considerably. Slips of mica one-tenth of a millimetre thick give as strong a reflection as an infinite thickness, yet the effect is almost certainly not a surface one. Experiments are being made to find the critical thickness of mica at which the reflecting power begins to diminish as thinner plates are used. The reflection is much stronger as glancing incidence is approached. W. L. BRAGG.

The Cavendish Laboratory, Cambridge,
December 8.

The Investigation of Flint.

THE need for a more accurate knowledge of the dynamics of flint, as pointed out by Sir E. Ray Lankester in NATURE of November 21, is very obvious.

Though not so remarkable as the Savernake polished flints, yet some are to be found in the shingle for some miles both east and west of Brighton. Flints, too, with even more glaze than either of these are met with on the arable land of this district. These I assume got at some time the benefit of the vegetable ash resulting from the burning of weeds, being raked up along with them. Originally they came in the chalk from the North Downs for the use of the crops.

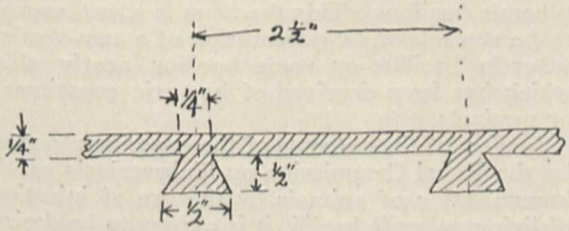
A caution may be useful as to what may be expected as the result of frost action. I have watched many of our Wealden sandstones for about twenty years, chiefly because of my study of the honeycomb weathering. One wall I guess at least 100 yards long, on the west side of Mount Pleasant Hill, has soil behind it nearly to the top. It shows good dusty weathering along a line about 2 ft. from the pavement at the junction of the second and third courses of stone. There are, however, two very distinct patches, each two or three yards wide, where this is entirely absent. Why is this? Merely, I believe, because the places happen to get extra rain-water from two adjoining trees, and are never dry all the winter. Parts, however, which are wet and dry alternately frequently suffer.

Why, I wonder, is it that the small mammilations seen on the squared flints of the churches in the eastern counties are absent in the southern counties? Again, the Norfolk paramoudra deserve more study than they have had hitherto. This year at Seaford I found a 2-in. layer of chert at the top of the chalk, which I was told is usual there. The explanation seemed to be that rain-water had taken up silica from the overlying sands and gravels. On the west of Cuckmere Haven the chalk cliffs have also remarkable rings of chert, sometimes 6 in. thick, surrounding each of the numerous pipes seen in the chalk there. These chert cylinders can be seen lying on the shore owing to the erosion by the sea. For a long time these were great puzzles, but their explanation was discovered last year by my friend, Mr. Hy. Preston, of Grantham. GEORGE ABBOTT.

Tunbridge Wells, November 23.

Remarkable Formation of Ice on a Small Pond.

SOME soil (which is of a heavy nature), being required, had been dug out to a depth of about a foot. The sides and bottom were thus quite irregular. Rain-water lodged in the hole, thus forming the pond, which was about 4 ft. long, 1 ft. 6 in. wide, and 5 in. maximum depth; the major axis was N.E. and S.W.,



and the upper surface of the ice about 8 in. below the general level of the ground.

The ice was first noticed at 0.30 p.m. on Sunday, December 1. Dark sinuous lines about ⅜ in. wide and running about parallel to the major axis were plainly visible. These were seen to be due to the water below touching the ice along these lines, while the bands (about 2½ in. wide) of white between the lines were due to the water not being in contact with the ice at these portions of the under-surface. The water in the pond had gradually percolated away, and had thus left an air space of about ⅛ in. between itself and the under-surface of the ice between the dark lines. On breaking the ice and getting a piece out, it was found to have the remarkable cross section shown in the sketch. The ice was quite clean and clear, and the dovetail ribs were well off the bottom of the pond. The ribs were remarkably regular in form and dimensions, and there were about six lines of them running from end to end of the pond.

There was no wind, and the frost on the grass near by was crisp, indicating that the temperature was still below 32° F.

A. S. E. ACKERMANN.

Anthropology at the British Association.

I NOTICE in the article on anthropology at the British Association in NATURE of November 21 a slight misstatement, which I should be obliged if you would correct.

The coloured photographs which I showed to the section were taken partly by my friend Mr. Mellor and myself, and the scenes represent different tombs which I excavated in 1903–05. ROBERT MOND.

Combe Bank, near Sevenoaks, November 25.

ATMOSPHERIC ELECTRICITY.

DURING the last few years a large number of experiments and observations have been made which, instead of solving the central problem of atmospheric electricity, appear to have made it more difficult than ever. It seems desirable, therefore, that a short statement of the present position should be placed before the large body of physicists who have not yet considered this exceedingly interesting subject.

Measurements of the electrical conditions of the atmosphere have now been made over the land from north polar regions through the equator to south polar regions, over the centres of the Atlantic and South Indian Oceans, and on Samoa in the Pacific Ocean. Thus the conditions over both land and ocean areas have been investigated, and everywhere it has been found that the air is a conductor and that the potential gradient is practically the same. The result can be expressed in rather a more objective way by stating that the earth has been found to be a negatively charged sphere, of a nearly uniform surface density, surrounded by a conducting atmosphere. This, however, cannot be a complete statement of the case, for by the laws of electrostatics a charge cannot exist within a conductor, and in consequence the charge on the surface of the earth must be transferred more or less quickly to the outside of the conducting atmosphere. In spite of this, the charge on the earth's surface remains undiminished. Whence, then, comes the negative charge to make this possible? This is the chief problem of atmospheric electricity.

To make it clear that the surface of the earth does lose electricity, it will be as well to state the methods used to determine the loss. The surface of the earth is at a uniform potential, which

for convenience is called zero. If, therefore, a certain area of this is insulated, it can only remain at the potential of the remainder so long as it receives or loses no charge. If it was losing a charge before it was insulated, it can only be kept at zero potential after insulating by supplying it with the charge lost. In 1906 C. T. R. Wilson designed an instrument by means of which an insulated plate could be kept at zero potential while exposed to the atmosphere, and the charge which had to be supplied to do this could be measured. The result proved an actual loss of negative electricity. The amount of this loss was found to be equal to that which can be calculated from a knowledge of the potential gradient and the conductivity of the air.

Realising that the plate in Wilson's instrument did not exactly represent a piece of the ground and that measurements at odd times could always be objected to, a method was developed in Simla by which a continuous record could be obtained of the charge necessary to keep at zero potential a large area—17 square metres—which was to all intents and purposes a part of the surface of the ground. This instrument was in use for nearly a month, and registered a continuous loss of negative electricity. These experiments indicate clearly that during fine weather negative electricity actually passes from the earth into the air. This disposes of the possibility of the lost charge being renewed uniformly over the whole earth by such processes as the fall of charged dust, friction of the air on the earth's surface, or the absorption of ions from the air. The loss over the whole earth is equivalent to a constant current of more than 1000 amperes. As this loss takes place from all regions of the earth, subject to normal or fine weather conditions, it would appear that the return current can only exist in regions of disturbed weather, and it is known that in such regions the potential gradient is often reversed and the rain charged.

A reversed field certainly causes a flow of negative electricity into the earth, but as the time during which the field is reversed in any one place is only a very small fraction of the time during which it is normal, the flow of electricity would have to be enormous if the loss were made good in this way. Such a large flow could not possibly escape detection, and no one has seriously put forward this as a solution of the problem.

There is still the possibility that the electricity comes to the earth in the disturbed area as a negative charge on the rain. For many years this was the most favoured theory for the supply of the negative electricity, but in 1908–9 measurements were made in Simla which showed that there, at least, the rain carried down more positive than negative electricity. Since then many measurements have been made on the electricity of rain, and now we have before us the results of observations made in Porto Rico, Simla, Vienna, Potsdam, Puy-en-Velay and Dublin. In every one of these cases the Simla result is confirmed, and there can be no doubt now that in all kinds of rain, from the intense rain of thunderstorms to the drizzle of a depression, more positive than negative electricity is brought to the earth. Thus rain, instead of solving our problem, has made it more difficult.

It has been suggested that the charge may be returned in the lightning of thunderstorms. Prof. Schuster has discussed this point in his recent book, "The Progress of Physics" (p. 150), and comes to the conclusion: "It does not seem to me, judging by present information, that lightning discharges from cloud to earth can play an important part in increasing or diminishing the charge of the earth," and there are other reasons, not mentioned by Prof. Schuster, for coming to the same conclusion.

We have now discussed the conditions in disturbed areas and have not found the return current, for neither the reversed field, the precipitation, nor the lightning provides it. Thus the science of atmospheric electricity has come to a deadlock, and there is at present no indications of a way out.[1] We may sum up the position in the following statement. A flow of negative electricity takes place from the surface of the whole globe into the atmosphere above it, and this necessitates a return current of more than 1000 amperes; yet not the slightest indication of any such current has so far been found, and no satisfactory explanation for its absence has been given.

GEORGE C. SIMPSON.

PROF. FRIEDMANN'S TREATMENT OF TUBERCULOSIS.

THE announcement of the successful application of any new method of treating tuberculosis must always arouse intense interest and create new hope among those who are suffering from, or waging war against, this disease. For the latest of these, devised by Prof. Friedmann, of Berlin, it appears to be claimed that it acts not only curatively in cases where tuberculosis has already commenced, but prophylactically where there exists a danger of infection to those not already tuberculous. A large number of cases have been treated in Berlin and Vienna, and it is said that where the disease is not far advanced it is cut short, and that in children as yet unaffected the tissues and organs have been protected against the invading tubercle bacillus. This therapeutic agent appears to be some form or preparation of a non-virulent tubercle bacillus or some bacillus nearly allied which has been deprived of its toxic constituents or products.

In view of the outcome of the experiments made by the Royal Commission on Tuberculosis on the immunisation of animals by the use of injections of living tubercle bacilli, it is almost to be desired that the vaccine is of the nature of a prepared proteid and does not contain any living bacilli, however modified. Judging from the accounts we

[1] Prof. Ebert has proposed an explanation, but against it fatal objections have been raised. Those interested might consult the series of articles which appeared in the *Physikalische Zeitschrift* between March, 1904, and December, 1905.

have seen of the method, it can scarcely be a modification of the "immune body" treatment, with which, it is maintained, some success has been attained. It appears more likely that we have to deal with some modification of Calmette and Guerin's method, in which the bovine tubercle bacillus is cultivated on a glycerinated medium to which a small proportion of ox-bile has been added. Here, after about forty generations of such culture, the bacillus becomes so far modified that when injected intravenously into the bovine animal it is incapable of setting up an active tuberculous process, and so modifies the tissues and especially the wall of the alimentary canal of the treated animal that an ordinary culture of a virulent "bovine" bacillus is no longer able to retain its position in the tissues of the host, and, consequently, is unable to set up any tuberculous process.

It is, of course, too early to pronounce any definite opinion, either favourable or adverse, on these various methods. It must be realised that a certain proportion of the cases in which there is tuberculous infection recover without any special treatment; that others recover when supplied with plenty of fresh air, good food, and when the hygienic conditions generally are favourable, and that these agencies are called into play by all who are engaged in the intelligent study and treatment of tuberculosis.

SIR GEORGE HOWARD DARWIN, K.C.B., F.R.S.

GEORGE DARWIN, whose decease occurred at Cambridge on Saturday, December 7, came, as is well known, of illustrious scientific lineage, having been born in 1845 at Down, the second son of Charles Darwin, author of "The Origin of Species," and thereby the renovator of the biological sciences. Like many contemporaries who attained to distinction in scientific pursuits, his school education was gained under the Rev. Charles Pritchard, F.R.S., afterwards Savilian professor of astronomy at Oxford. He went up to Trinity College, Cambridge, in 1864, graduated as second wrangler and second Smith's prizeman in 1868, the present Lord Moulton being senior; he was elected a fellow of Trinity the same year, and enjoyed the statutory tenure of ten years. In addition to mathematical subjects, he was interested in economic and political science, and with a view to practical life was called to the Bar in 1874. About this time he wrote a well-known statistical memoir on the marriage of first cousins, an early example of the present exact investigations in cognate biological domains. Considerations of health, however, prompted his return to Cambridge, where he devoted himself to mathematical science, especially in its astronomical aspects. He had already initiated his most striking contributions to the subject of the evolution of the solar system, especially the moon-earth system, and to cosmogony in general, when he was elected to the Plumian chair of astronomy and experimental philosophy in 1883. He was re-elected fellow of Trinity, as professor, in 1884, and his marriage dates from the same year.

If one were asked to name a domain in which the power of mathematical analysis had conspicuously asserted itself over phenomena apparently most complex and fortuitous, the prediction of the tides up to their closest details, by procedure now systematised so that it can be applied almost without technical skill, would surely come to mind. The principles of the application of harmonic analysis to this subject were laid down by Laplace, following up the beginnings established long before by Newton; but it was a far cry from this to actual systematic performance. The outstanding name in this magnificent achievement is that of Lord Kelvin, whose intellectual energy kept the subject to the fore, while his inventive genius originated the machines by which calculations too long and laborious for arithmetical processes were reeled off automatically. But it is very doubtful whether tidal practice, in which British methods dominate the world, or the refinements of tidal theory, would stand in their present completeness if Kelvin had not enjoyed the good fortune, when he was himself getting submerged in other problems, of finding a colleague so imbued with the subject, so expert and tenacious amid the complexities of numerical calculation, as George Darwin proved himself to be. His tribute to Lord Kelvin, to whom he dedicated volume i. of his Collected Scientific Papers, which relates to this subject, gave lively pleasure to his master and colleague:—

> Early in my scientific career it was my good fortune to be brought into close personal relationship with Lord Kelvin. Many visits to Glasgow and to Largs have brought me to look up to him as my master, and I cannot find words to express how much I owe to his friendship and to his inspiration.

The practical developments of tidal theory and prediction were published to the world in a series of reports to the British Association, worked out mainly by Darwin, from the year 1883 onward. In 1879 he had broken ground in another direction, entirely fresh. The recognition of lunar tidal friction as a cause of lengthening of the day goes back to Kant. The problem as to how the tidal loss of energy is divided between the earth's rotation and the lunar orbit had baffled Airy; it had been shown by Purser that the principles of energy and momentum conjointly can lead to its solution; but it remained for Darwin to develop, by aid of graphical representations which have become classical, most striking inferences regarding the remote past history of our satellite. This discovery was the starting point of a series of memoirs in the next subsequent years, which applied similar procedure to the precession of the equinoxes and to other features of the solar system.

In the later years of last century, during Lord Kelvin's meteoric visits to Cambridge to attend the annual meetings of the Fellows of Peterhouse,

and to absorb whatever of scientific interest was going on, he was certain to find his way to Newnham Grange, to compare impressions on tidal and cosmical theory and to concert plans for future action. So thoroughly was Darwin from the first immersed in and a partner of Kelvin's work on these subjects, that the necessary rewriting, for the second edition, of the large section of Thomson and Tait's "Natural Philosophy" which deals with tides and their cosmical relations, was confided entirely to his hands.

In 1898 he supplemented this work by publishing a non-mathematical treatise on the tides and kindred phenomena in the solar system, which was developed from a course of Lowell lectures delivered at Boston, and has taken rank with the semi-popular writings of Helmholtz and Kelvin as a model of what is possible in the exposition of a scientific subject; it has accordingly been translated into many foreign languages. The preparation of a new edition of this book, expanded and in part rewritten to include recent developments, was one of the last works of his life.

His studies in astronomical evolution necessarily required him to push the history of the motions of the planetary bodies back into the past, far beyond the times for which the usual practical approximations of gravitational astronomy are suitable or valid. To this end he began to apply a process of step-by-step plotting to the determination of orbits in the classical problem of three bodies,—essayed in simpler cases by Lord Kelvin, but in its adequate use laborious, and demanding skill in arrangement of arithmetical processes; this work culminated in an extensive memoir in "Acta Mathematica" in 1896. The maps of families of orbits there published attracted the attention of other mathematicians. In particular, Poincaré—utilising the general mode of discrimination and classification which he had already employed with signal success in Lord Kelvin's and George Darwin's problem of the forms possible for fluid rotating planets—pointed out the necessary existence of some intermediate classes that had escaped the analysis. And S. S. Hough, H.M. Astronomer at the Cape, who had in his Cambridge days collaborated with Darwin in tidal theory, followed with a memoir devoted to fuller developments. This fascinating subject continued to occupy Darwin's attention up to the end of his life; one of his last public appearances in London was to communicate a paper on it to the Royal Astronomical Society.

His thorough familiarity with the methods of reducing to mathematical order the tangled data of tidal observation marked out Darwin as a desirable expert guide in the national meteorological service; for much was hoped for meteorology thirty years ago from the practical application of harmonic analysis to the voluminous records of barometer and thermometer. Accordingly the Royal Society, which then had control of the service, nominated him a member of the Meteorological Council soon after his return to Cambridge. When that Council was rearranged as a Committee under the Treasury a few years ago, he became one of the two representatives whom the Royal Society was requested to nominate to the new body; and he continued to render valuable service in this capacity until the end.

The earliest of topographic surveys, the model which other national surveys adopted and improved upon, was the Ordnance Survey of the United Kingdom. But the great trigonometrical survey of India, started nearly a century ago, and steadily carried on since that time by officers of the Royal Engineers, is still the most important contribution to the science of the figure of the earth, though the vast geodetic operations in the United States are now following it closely. The gravitational and other complexities incident on surveying among the great mountain masses of the Himalayas early demanded the highest mathematical assistance. The problems originally attacked in India by Archdeacon Pratt were afterwards virtually taken over by the Royal Society, and its secretary, Sir George Stokes, of Cambridge, became from 1864 onwards the adviser and referee of the survey as regards its scientific enterprises. On the retirement of Sir George Stokes, this position fell very largely to Sir George Darwin, whose relations with the India Office on this and other affairs remained close, and very highly appreciated, throughout the rest of his life.

The results of the Indian survey have been of the highest importance for the general science of geodesy, and well-deserved tributes have been paid to them by Helmert, of Berlin, and other chief exponents of the science. It came to be felt that closer cooperation between different countries was essential to practical progress and to co-ordination of the work of overlapping surveys. Accordingly, about fifteen years ago the International Geodetic Association was established, through scientific and diplomatic influences, to take cognisance of all problems of refined surveys and triangulations, and other investigations relating to the form of the earth, in which international cooperation is essential to complete results. Sir George Darwin was appointed by the Foreign Office, on the advice of the Royal Society, as the British representative on this important international body; and its work was henceforth one of the main interests of his life. It came to the turn of England to receive the triennial assembly in the year 1909, and a very successful meeting at London and Cambridge was organised mainly by his care. He was preparing to go to the meeting of the association in Hamburg last September when his fatal illness supervened.

An important public service has been rendered in this country for many years by the Cambridge University Press, through the application of its resources to the publication in definitive collected form of the works of the great men of science whom this nation has produced, thereby sustaining the national credit in a way which in other countries is promoted mainly by Government subsidy. The collected papers of Sir George Stokes,

Arthur Cayley, James Clerk Maxwell, Lord Kelvin, J. J. Sylvester, J. C. Adams, P. G. Tait, J. Hopkinson, and other men of science have in this way been garnered, and have taken their permanent place among the national possessions. It came as a great gratification to George Darwin when, in 1907, the syndics of the University Press signified to him their desire to become responsible for a collected edition of his scientific memoirs, to be prepared under his own supervision. In May, 1911, the last of the four substantial royal octavo volumes in which his work is thus arranged for future generations was published.

In the affairs of the University of which he was an ornament, Sir George Darwin made a substantial mark, though it cannot be said that he possessed the patience in discussion that is sometimes a necessary condition to taking share in its administration. But his wide acquaintance and friendships among the statesmen and men of affairs of the time, dating often from undergraduate days, gave him openings for usefulness on a wider plane. Thus at a time when residents were bewailing even more than usual the inadequacy of the resources of the University for the great expansion which the scientific progess of the age demanded, it was largely on his initiative that, by a departure from all precedent, an unofficial body was constituted in 1899 under the name of the Cambridge University Association, to promote the further endowment of the University by interesting its graduates throughout the Empire in its progress and its more pressing needs. This important body, which was organised under the strong lead of the late Duke of Devonshire, then Chancellor, comprises as active members most of the public men who owe allegiance to Cambridge, and has already by its interest and help powerfully stimulated the expansion of the University into new fields of national work; though it has not yet achieved financial support on anything like the scale to which American seats of learning are accustomed. Another important body in the foundation and development of which Sir George Darwin took an active part is the Cambridge Appointments Board, which, by bringing trained graduates into connection with the leaders of the commerce and industry of the nation, has worked with notable success for their mutual advantage.

Sir George Darwin's last public appearance was as president of the fifth International Congress of Mathematicians, which met at Cambridge on August 22–28 of this year. The time for England to receive the congress having obviously arrived, a movement was initiated at Cambridge, with the concurrence of Oxford mathematicians, to send an invitation to the fourth congress held at Rome in 1908. The proposal was cordially accepted, and Sir George Darwin, as *doyen* of the mathematical school at Cambridge, became chairman of the organising committee, and was subsequently elected by the congress to be their president. Though obviously unwell during part of the meeting, he managed to discharge the delicate duties of the chair with conspicuous success, and guided with great *verve* the deliberations of the final assembly of what turned out to be a most successful meeting of that important body. But this improvement was only temporary; on their return to Cambridge a month later his friends were most deeply grieved to find that, after some weeks of illness, an exploring operation had strengthened the fears of malignant disease which had not been absent from his own mind for some time.

In the previous year there had come to him what he naturally regarded as the crowning honour of a life devoted to scientific pursuits, the award by the Royal Society in October, 1911, of their highest distinction, the Copley medal for the year. He had himself strongly advocated the claims of his kinsman, Sir Francis Galton, who was the medallist of the preceding year, unconscious that his own name had been standing on the list for consideration. Galton died within a year of the award, and his life, written by Darwin for the Dictionary of National Biography, appeared last October. The Royal Society has thus the melancholy satisfaction of having been just in time in two successive years in conferring her highest mark of distinction on the achievements of two of her distinguished sons. J. L.

MR. S. A. SAUNDER.

IT is with deep regret that we have to record the death, on Sunday night, December 8, of Mr. S. A. Saunder, at sixty years of age. In Mr. Saunder astronomical science has lost a devoted and conscientious worker who gave himself whole-heartedly to a line of study requiring much ability, and involving immense labour, but offering no prospect of startling results.

Mr. Saunder was an assistant master at Wellington College. He became a Fellow of the Royal Astronomical Society in 1894, and from 1907 to February last he was one of the most active and hard-working of honorary secretaries. A few years ago he was appointed Gresham Professor of Astronomy in the City of London. He gave his last course of lectures (on the tides and tidal friction) early in November, but the fatal illness was then upon him, and it was with great difficulty and pain that he brought the lectures to a conclusion.

Mr. Saunder's scientific work lay especially in the domain of selenography, in which he achieved well-deserved distinction. His paper in the Monthly Notices of the Royal Astronomical Society for January, 1900, on the determination of selenographic positions and the measurement of lunar photographs, was the first of a series of similar papers. In the fourth paper of the series he gave a first attempt to determine the figure of the moon. In the Memoirs of the R.A.S., vol. 59, he published the results of measures of four negatives taken at Paris by Loewy and Puiseaux, with a catalogue of 1433 measured points on the lunar surface. All the positions were carefully reduced to mean libration, and their places given in rectangular co-ordinates. A still more extensive work was published in the R.A.S. Memoirs, vol. 60: Results of measures of two Yerkes negatives by Mr. G. W. Ritchey. The catalogue contains

2885 points, all carefully reduced by Prof. Turner's method, and forming a very valuable contribution to our knowledge of the lunar surface.

One object in view in the preparation of these extensive catalogues of lunar details was that they should be the foundation of a standard chart of the moon. Mr. Saunder had carefully studied the subject of lunar nomenclature, and was much impressed with its unsatisfactory state. He proposed that in future new names should be added very sparingly, but that objects observed should be referred to by their coordinates in the catalogue or in the chart. Charts of all the central portions of the moon, entirely based on Mr. Saunder's measures, which he plotted for the purpose, are now in progress and approaching completion.

NOTES.

AT the recent annual meeting of the Royal Geological Society of Cornwall the Bolitho gold medal was awarded by the president and council to Mr. Geo. Barrow, for his services to Cornish geology in connection with the re-survey of the west of England.

AT the suggestion of Prof. Ernst Cohen, the Dutch sculptor, Pier Pander (Rome), has executed a beautiful bronze medallion of van't Hoff. We are requested to state that anyone desiring to purchase a copy of it should send (before January 1, 1913) a postcard to Prof. Ernst Cohen, van't Hoff Laboratorium, University, Utrecht, Holland. The medallion will then be sent by the firm entrusted with the work. If 100 copies are sold the price will be 6.50 marks. The price will be reduced to 5.50 marks if 200 copies can be sold. The medallion has been executed after a portrait relief in marble by Pier Pander.

THE Tokyo *Asahi* announces the forthcoming formation in Japan of a society for the prevention of tuberculosis. The initiators are Dr. Baron Takagi, Dr. Baron Sato, and Dr. Kitasato. The preliminary meeting was held on October 29, when an influential committee was appointed to make the necessary arrangements. Good work has been done in the campaign against tuberculosis by minor local organisations in Japan, but the formation of the new society is the first serious public attempt to grapple with the disease. It is stated that, although no precise statistics are available, the number of persons who fall victims to tuberculosis in Japan may be estimated at no fewer than a million per annum. As the population of the country is about fifty-one million, this would indicate an annual death-rate of nearly twenty per thousand from the disease.

MAJOR E. H. HILLS, C.M.G., F.R.S., treasurer of the Royal Astronomical Society, has been appointed honorary director of the Observatory, University of Durham.

THE next meeting of the American Association for the Advancement of Science will be held in Cleveland from December 30 next to January 4, 1913. Prof. E. C. Pickering will be the new president. The address by the retiring president, Prof. Charles E. Bessey, on some of the next steps in botanical science, will be delivered on December 30. The sections among which the business of the meeting will be distributed, with the name of the retiring president of the section and the subject of his address, are as follows:—Mathematics and Astronomy, "The Spectroscopic Determination of Stellar Velocities," Prof. Frost; Physics, "Unitary Theories in Physics," Prof. R. A. Millikan; Chemistry, "The Chemistry of the Soil," Prof. Cameron; Geology and Geography, "Significance of the Pleistocene Molluscs," Prof. Shimek; Zoology, "Section F—Is it Worth While?" Prof. Nachtrieb; Botany, "The Scope of State Natural Surveys," Prof. Newcombe; Anthropology and Psychology, "The Study of Man," Prof. Ladd; Social and Economic Science, "Comparative Measurements of the Changing Cost of Living," Prof. Norton; Education, "Educational Diagnosis," Prof. Thorndike; Physiology and Experimental Medicine, "The Function of Individual Cells in Nerve Centres," Prof. Porter. During the days of the meeting twenty-six American scientific societies will also meet.

THE Melbourne meeting of the Australasian Association for the Advancement of Science will be held on January 7–14 next. The president-elect is Prof. T. W. E. David, C.M.G., F.R.S., and the retiring president Prof. Orme Masson, F.R.S. The meeting will be held at the University, which is surrounded by large grounds, and can provide ample accommodation. Prof. Baldwin Spencer, C.M.G., F.R.S., who is spending the year as chief protector of aborigines in the Northern Territory, will deliver a lecture on some of the results he has obtained. A joint discussion of several sections will be held on the genus Eucalyptus and its products. A forest league is being formed in the various States, under the auspices of the association, which it is hoped will rouse public opinion to the necessity of preserving forests, especially round the head waters of the rivers. A large number of committees will present reports, and a full programme of papers is expected. The following are the presidents of sections:—Astronomy, Mathematics, and Physics, Prof. H. Carslaw; Chemistry, Prof. C. Fawsitt; Subsection Pharmacy, Mr. E. F. Church; Geology and Mineralogy, Mr. W. Howchin; Biology, Prof. H. B. Kirk; Geography and History, Hon. Thos. M'Kenzie; Ethnology and Anthropology, Dr. W. Ramsay-Smith; Social and Statistical Science, Mr. R. M. Johnston; Agriculture, Mr. F. B. Guthrie; Subsection Veterinary Science, Prof. Douglas Stewart, Engineering and Architecture, Col. W. L. Vernon; Sanitary Science and Hygiene, Dr. T. H. A. Valintine; Mental Science and Education, Sir J. Winthrop Hackett. The general secretary for the meeting is Dr. T. S. Hall.

SPEAKING at the annual dinner of the Farmers' Club on Tuesday, Mr. Runciman, president of the Board of Agriculture and Fisheries, referred to the assistance which the Development Commissioners propose to give to agricultural research. In the course of his remarks, he said:—It was not enough merely to adopt a policy of slaughter, scheduling areas, and so forth. They should adopt so far as possible all the services that science could supply. They must give their re-

search institutions, universities, and colleges the needful to ascertain more and more the nature of their most dangerous diseases. He had received permission only that day to announce that one of the schemes he had been enjoining for some months in the country had so far met with the approval of the Development Commissioners that they would shortly recommend to the Treasury a release from the Development Fund of moneys for the following objects: First of all to provide in every one of what were now called the provinces, for the purposes of agricultural education, the services at the headquarters of those provinces of men concerned with advice as to soils, crops, and so forth, but who should be concerned also with live stock; that each one of these men should be an organiser or supervisor, to organise in that province a live stock scheme which would be described in further detail. The Commissioners were also prepared to enable them, with an annual sum, to have engaged in their office a man of the highest class, who could not know everything about every branch of live stock, but, by general knowledge, would be able to give administrators advice which at present they were without. Thirdly, premiums would be provided from the Development Fund for the breeding of heavy horses, Shires, Clydesdales, and Suffolk Punches.

THE annual general meeting of the Royal Agricultural Hall, Islington, was held yesterday, December 11, when the report of the council was presented. The total number of governors and members of the society during the year has been 10,307, as compared with 10,306 in the previous year. About the same number of samples were submitted for analysis by the chemical department of the society as during the preceding twelve months, this being 426. Special reference is made in the reports to Bombay cotton cake containing excessive sand, rice meal composed mainly of rice "shudes" (husks), barley meal adulterated with pea husks, and sharps adulterated with pea husks and containing an excessive amount of sand. Among much other important work done at the Woburn Experimental Farm may be mentioned an interesting series of experiments on varieties of lucerne and on methods of sowing this crop which was carried forward, the best results coming from Russian (Europe) lucerne, and then from Canadian and Provence seed. The plots sown on bare ground were uniformly better than those laid down in a barley crop. There were also trials with different varieties of wheat—including French wheats—and of barley. Progress has been made during the year with the experiments which are being carried out at Woburn for the purpose of demonstrating that by means of isolation it is possible to rear healthy stock from tuberculous parents. It is hoped that the final report on the experiments will be ready some time next year. The council decided last year to offer the society's gold medal annually for original research in agriculture. Five essays have been submitted by qualified candidates.

WITH reference to the letters in NATURE of November 14 and December 5 concerning the moon and poisonous fish, a correspondent writes from Doncaster to say that twenty-five years ago he heard many stories from sailors of the ill-effects caused by eating fish which had been exposed to moonlight. He adds:—"The probabilities are that the same belief was held by the sailors in the early days of emigration to South Africa, and transmitted to the colonists."

MR. W. F. DENNING believes that the shaking of windows and similar effects experienced at Sunninghill and the neighbourhood on November 19, as mentioned in NATURE of November 28, p. 365, had their origin in meteoritic explosions. In the course of a letter published in *The Westminster Gazette* of December 9, he says:—"I have investigated several instances of similar kind, and the conclusion has been irresistible that they were induced by fireballs undergoing disintegration high in the atmosphere. And in the recent case this explanation is rendered highly probable from the fact that the period from November 19 to 23 is well known astronomically for its abundance of detonating fireballs. Messrs. Greg and Herschel attributed a special significance to the period named, and their deductions have been fully corroborated by later experiences."

A COPY has been received of the fifth annual report (1911–12) presented by the council to the court of governors of the National Museum of Wales. It contains an account of the ceremonies in connection with the laying of the foundation-stone of the new building by the King on June 26 last, and much information as to the progress made during the year. The Treasury has agreed to an estimate of 233,000*l.* for the erection and furnishing of the new building. The financial position at present is as follows:—Local contributions, 42,000*l.*; an equal amount from the Treasury, 42,000*l.*; making the total sum available at present 84,000*l.* This leaves a deficiency of 149,000*l.*, one-half of which will be found by the Government, provided a like amount is forthcoming from other sources. The Treasury has increased its grant towards maintenance for the year 1912–13 to 3000*l.*, as compared with 2000*l.* in the past. The Cardiff Corporation has erected a building and has leased it to the museum for a period of five years from July 1 last, at a rental of 130*l.* per annum, for the purposes of a temporary museum. Expenditure to the amount of 567*l.* has been incurred in the purchase of specimens during the year, and an appendix of eight pages is devoted to a list of donations of specimens to the museum.

A SUMMARY of the weather during the recent autumn has been issued by the Meteorological Office as comprised by the results for the period of thirteen weeks ended November 30. The mean temperature for the whole period was below the average over the entire kingdom, the greatest deficiency being 2° in the south-east of England; the deficiency was also considerable in the south-west of England and in the Channel Islands. The autumn rainfall was below the average everywhere except in the east of Scotland, where the excess amounted to 0·83 in. The duration of bright sunshine was below the average over the entire kingdom. At the close of autumn the temperature of the

soil at the depth of one foot was very generally above the normal, and it was also generally high at the depth of 4 ft. The mean temperature of the sea for the closing week was mostly above the average, and was, in general, warmer than in the corresponding period of last year. For the neighbourhood of London the Greenwich observations show that the mean temperature for the autumn was 48·6°, which is 2·1° below the normal; the mean for September was 4·4° below the average, and in October the deficiency was 2·2°, whilst in November there was an excess of 0·3°. The highest shade temperature during the autumn was 69° and the lowest 29°, the latter observed in both October and November. In September there were only four days with the temperature in excess of the average. The aggregate autumn rainfall was 5·49 in., and the rainfall was deficient in each of the three months, being in the aggregate 1·73 in. less than the normal. In all rain fell on thirty-five days. The duration of bright sunshine was 265 hours, which is two hours in excess of the average for the last thirty years.

THE October number of *The National Geographic Magazine* is devoted to China, and contains, as usual, a splendid collection of illustrations. Canal life is described by Mr. F. H. King, and Lhasa, "the most extraordinary city in the world," by Dr. Shaoching H. Chuan. Of special interest is the article on China's Treasures, by Mr. F. McCormick, in which he deals with the famous Rock Temples. Of these the most remarkable are the series of Buddhist shrines at Lung Men, in the province of Honan, where the sides of a gorge have been excavated and the walls of the caves ornamented with thousands of figures. The district of Shensi contains the colossus of Buddha, 56 ft. high. The buried monumental remains throughout the country are of enormous extent. Of these little has been examined, but their importance is illustrated by the remarkable bricks recently found at Peking, and the bells 2000 years old unearthed at Kiangsi, and now said to be in the Forbidden City.

To *The Field* of November 23 Mr. Pocock contributes an important summary of statements as to the obliterative effect of the colouring of zebras, the earliest of these being by Sir Francis Galton (1853). It is pointed out that the passages quoted indicate that independent observers have noticed the obliterative nature of the colouring in five distinct members of the group, and it is urged that the same credence must be assigned to these statements as to those of observers who take an opposite view.

EVIDENCE is gradually accumulating that the South American family Iniidæ, now represented by the freshwater dolphins of the genera Inia and Pontoporia (to retain a well-known name), was abundant in America during Tertiary times. The latest addition to the list is the new genus and species, *Hesperocetus californicus*, established by Prof. True (Smithson. Misc. Collect., vol. lx., No. 11) on the evidence of an imperfect lower jaw, with teeth, from the Californian Tertiaries. The genus, which is provisionally referred to the Iniidæ, is remarkable for the length of the symphysis of the lower jaw and the large size of the teeth, which recall those of the extinct Delphinodon, classed by the author with the Delphinidæ. Other extinct Iniidæ are Saurodelphis, Pontoplanodes, and Ischyrorhynchus.

THE Codling moth (*Carpocapsa pomonella*) has lately been the subject of much careful research in the United States. In his admirable memoir on the insect published in 1903 (U.S. Dept. Agric., Bull. Entom., No. 41) Mr. C. B. Simpson referred doubtfully to the possible occurrence of a third brood of the insect in certain American localities. We have now received A. G. Hammar's "Life-history Studies on the Codling Moth in Michigan" (*ibid.*, No. 115., part 1, 1912). Statistical studies of the generations during the three years 1909, 1910, and 1911 are illustrated by many elaborate tables and curves, derived from observations at various localities in the State. It appears that some of the caterpillars hatched in the spring of one year hibernate and pupate the next spring, as in the usual life-cycle of the insect in our islands. Others pupate in summer, and from the pupæ some moths emerge quickly to lay the eggs of the second brood, while others do not emerge until the next spring. Most of the caterpillars of the second brood hibernate, but a few pupate in autumn, and from a small proportion of these pupæ moths emerge, to become the parents of a third brood of larvæ, all of which must hibernate. Thus it follows that "The wintering larvæ may include larvæ of the first, second, and third broods. The spring brood of pupæ may include pupæ of the first, second, and third broods. The spring brood of moths may include moths of the first, second, and third broods"—a somewhat surprising result.

DR. F. TOBLER has published an important monograph of the genus Hedera ("Die Gattung Hedera," Gustav Fischer, Jena, price 6.50 marks). The author describes two new species of ivy (*Hedera himalaica* and *H. japonica*), making six species in all, which are well illustrated by reproductions from photographs. Besides detailed descriptions of the morphology of the genus, the work includes an interesting chapter on the biology and physiology of the ivy, followed by chapters on the history of the genus and its culture as a garden plant; it is to be wished, however, that for the sake of completeness, the author had dealt with the comparative anatomy of the genus—apart from the characteristic star-shaped hairs of the ivy leaf, no microscopic descriptions or figures are given.

FROM Dr. C. J. Chamberlain, of Chicago University, we have received reprints of two recent papers on the Cycadaceæ, continuing his previous studies on this important group of plants, and, like them, published in *The Botanical Gazette*. In a paper on the adult cycad trunk, the author describes the structure of the mature stem in species of Zamia, Dioön, and Ceratozamia, and with excellent material at his disposal has considerably supplemented the descriptions of earlier writers. The two species of Dioön studied show growth zones which may or may not correspond to the periods of activity resulting in the formation of the crowns of leaves; one of the species shows a remarkable resemblance in details of stem structure to the

Cretaceous fossil genus Cycadeoidea, a member of the extinct family Bennettitales, which was in some respects more primitive than the cycads, and formed a link between this group and the Pteridospermæ, or fern-like seed-plants. In a second paper the author describes the development and fertilisation of *Ceratozamia mexicana*, and notes the curious fact that the normally small and evanescent ventral canal nucleus may enlarge and approach the egg, possibly fertilising it.

We have received from Messrs. Flatters and Garnett, Ltd., 32 Dover Street, Manchester, a copy of their lantern slide catalogue "E," together with specimen slides illustrating a large range of subjects (biology, geology, astronomy, textile fibres and machinery, scenery, &c.). The slides submitted for inspection are remarkably fine reproductions from photographs, and the prices appear very reasonable. Of the series of slides listed in this very comprehensive catalogue, those dealing with botanical subjects are the most complete, and these include an extensive set of slides illustrative of plant associations at home and abroad. The list of slides in the section of British plant associations is arranged in accordance with the plan adopted in the recently published standard work on British ecology—"Types of British Vegetation," edited by Mr. A. G. Tansley—and may be warmly commended to teachers and lecturers as the best and most complete set of ecological slides available. One of the most remarkable series of slides offered is that consisting of no fewer than 130 photomicrographs illustrating the development of *Pinus sylvestris*.

Although few details of scientific value have been made known about the disastrous Turkish earthquake of August 9 last, Dr. G. Agamennone has been able to draw some conclusions of interest. The shock, which in places attained the intensity 10 of the Rossi-Forel scale, was strong enough to damage buildings over an area nearly 200 miles long and 125 miles wide, and containing about 20,000 square miles. The epicentre cannot yet be located with accuracy, but it must have been near the north-west coast of the Sea of Marmora. As more than 3000 persons were killed, the earthquake must rank as one of the most destructive European shocks of the last thirty years.

The curious phenomenon known in Japan as *Inada no goko*, or halo in the ricefield, forms the subject of a discussion by Profs. Fuchino and Izu, of the College of Agriculture and Forestry, Kagoshima, in the Journal of the Meteorological Society of Japan (October, 1912). In the early morning, when the dew lies on the plants, and the sun is shining, the shadow of the head of a person standing in the fields is surrounded by a luminous halo, elliptic in form, its long axis corresponding with that of the body-shadow. As the sun rises higher in the sky and the dew evaporates the halo vanishes, but reappears on sprinkling the ground with water. The authors describe some experiments which they carried out with blankets, isolated drops of water, and bottles. They conclude from their experiments that the phenomenon of the halo is caused by the reflected light from the sun-images formed on the green blades by the passage of the sun's rays obliquely through the dewdrops.

Estimates of the age of the earth based on the ratio of the amounts of helium and uranium present in the Carboniferous and older rocks have given results of the order 400 to 1500 million years. Estimates based on the quantity of sodium brought into the oceans by the rivers of the world and the amount in the ocean at the present time lead to 70 million years. A possible explanation of this discrepancy is offered by Dr. F. C. Brown, of the University of Ithaca, in the October number of *Le Radium*. He suggests that sodium is itself a radio-active element with a parent which is insoluble in water. The sodium of the soil would then be due to the decomposition of the parent, and that of the ocean to the solution of the sodium in the soil and its transport by rivers. During the earliest periods the soil content being small, the transport to the ocean would be reduced, and the age calculated from the present content of the ocean would be correspondingly increased.

The Journal of the Washington Academy of Sciences for November 19 contains an abstract of a paper on the atomic weight of bromine by Mr. H. C. P. Weber, of the Bureau of Standards, which is about to be published in the bulletin of the Bureau. The method adopted is that of Noyes and Weber, by the direct synthesis of hydrobromic acid, and it was found capable of giving results of high accuracy. The final value obtained on the basis of oxygen 16, hydrogen 1·00779, is 79·924, as against the International Commission value 79·920.

Two papers on agriculture are included in the October issue of *Science Progress*. Dr. J. V. Eyre gives an interesting account of Russian agriculture, in which he presents a picture of a vast territory, of which only a small part is under cultivation; moreover, on account of the poverty and indolence of the peasants the agriculture is of a very low order, artificial manures and agricultural machinery being almost unknown over vast areas of the country. The writer suggests that a few good harvests would probably do more than anything else to enable the impoverished farmers to carry out the improvements in method with which many of them are already familiar as a result of the active work of instruction undertaken by the Government. Dr. Spencer Pickering contributes the first of a series of papers on horticultural research, in which he describes the Woburn experiments on the planting of trees. These experiments have suggested that rough treatment in planting is often more effective than the careful handling of root fibres, which is usually recognised as correct. Both articles are illustrated by several pages of photographs.

The 1913 issue of "The Scientists' Reference Book and Diary," published by Messrs. James Woolley, Sons, and Co., Ltd., dealers in scientific apparatus, chemical reagents, &c., of Manchester, has all the useful characters of the issues of previous years. The student of science will find it very convenient to have together in the same compact pocket-book a small work of

reference containing important constants and facts, and also a diary arranged by Messrs. Charles Letts and Co. The price, bound in leather with gilt edges, is 2*s*.

MESSRS. J. AND A. CHURCHILL announce for early publication "A History of Chemistry, from the Earliest Times till the Present Day," by the late Dr. J. Campbell Brown; "Notes on Chemical Research: an Account of Certain Conditions which Apply to Original Investigation," by Mr. W. P. Dreaper; "A Text-book of Anatomy for Nurses," by Dr. Elizabeth Bundy; and "Who's Who in Science (International), 1913," edited by Mr. H. H. Stephenson.

OUR ASTRONOMICAL COLUMN.

THE ANNULAR SOLAR ECLIPSE OF APRIL 17.—Those interested in the phenomena of the annular eclipse which took place in April last will find forty-eight columns of records and discussion in No. 4615 of the *Astronomische Nachrichten*. Herr Ladislav Beneš describes the observations of contact times, &c., made at the Strassburg Observatory, and, after discussing them, arrives at corrections for the places of the sun and moon; the central line deduced lies between the lines given by the *Connaissance des Temps* and the *Bureau des Longitudes*, rather nearer to the latter.

The observations made at the Leipzig Observatory are described by several observers, and Herr F. Hayn gives a set of curves showing the measured irregularities of the moon's limb. Prof. Luther brings together a very large number of observations made at various stations in the Rhine province, and derives a central line passing through $\lambda = 6^\circ\ 45'\ 40{\cdot}35''$ E., $\phi = +51^\circ\ 25{\cdot}6'$, giving a correction of $-0{\cdot}4'$ in latitude to the central line published by Prof. Battermann. He also gives a good photograph taken by Herr P. Bohnen. Prof. Wilkens publishes the results of the Kiel observations, giving the true sun and moon positions for the moment of each observation, and finds the corrections published in the American ephemeris were very near the truth.

An interesting paper by Drs. Elster and Geitel, dealing with the sun's observed light-curve during the eclipse, appears in the *Physikalische Zeitschrift*, pp. 852–855.

A REMARKABLE SHOWER OF METEORIC STONES.—In No. 203, vol. xxxiv., of *The American Journal of Science*, Mr. W. M. Foote gives a preliminary account of the shower of meteoric stones which occurred near Holbrook, Navajo County, Arizona, on July 19. Mr. Foote has collected a large mass of evidence which appears to settle the question of authenticity favourably. A large meteor was seen to pass over Holbrook at 6.30 p.m. on the date mentioned, and created a loud noise, which lasted for half a minute or more. Numerous stones were seen to fall near Aztec, raising puffs of dust for over a mile of the sandy desert, and subsequently a great number of these stones were found by the local people; the largest found weighed more than 14 lb., while several of about 5 lb. each were picked up over an elliptical area about three miles long and half a mile broad. The preliminary physical and chemical tests point to an undoubted meteoric origin, and a sample taken from twelve individual stones was found to contain 3·68 per cent. of nickel-iron, with 96·32 per cent. of silica. The principal constituent appears to be enstatite, olivine and monoclinic pyroxene making up the balance; in one section a patch of spinels set in quartz was found.

Altogether more than 14,000 stones, weighing, in all, more than 481 lb., were picked up and preserved, but of these 8000 weighed less than one gram each; 29 stones had weights ranging from 6665 grams to 1020 grams, and some 6000 ranged between 1000 grams and one gram.

THE ORBIT OF COMET 1910*a*.—In No. 4605 of the *Astronomische Nachrichten* M. S. Mello e Simas publishes definitive elements of the orbit of the bright comet 1910*a*. The author has discussed an enormous number of observations, and sets out in full detail the numerous points he has taken into consideration, finally arriving at the conclusion that the orbit is a parabola with an inclination of 138° 46′ 55·78″, the time of perihelion being 1910, January 17·09464 (M.T. Paris). He also discusses the question of the multiple solutions of problems of cometary orbits, which so confused a number of calculators in endeavouring to find a satisfactory orbit for comet 1910*a* during the time of its apparition.

THE "GAZETTE ASTRONOMIQUE."—It is with pleasure that we learn that the *Gazette Astronomique*, published by the Antwerp Astronomical Society, is again to appear each month. The gazette fulfils a very useful purpose in publishing monthly ephemerides and notes for observers, and, also, in popularising astronomical subjects.

THE NEW PHARMACOLOGICAL LABORATORY AT UNIVERSITY COLLEGE, LONDON.

WHEN University College was incorporated in the University of London, a scheme was formed to replace the old laboratories of the medical sciences by more adequate institutes in the south quadrangle. The first part of the plan was completed in 1909, when the Physiological Institute was opened. A second instalment has been rendered possible by a donation of 5000*l*. by Mr. Carnegie, and the Pharmacological Institute was opened on Wednesday, December 4, by Sir Thomas Barlow, president of the College of Physicians. It is to be hoped that the third institute, for Anatomy and Anthropology, may follow in due course and complete the buildings for the medical sciences.

The new pharmacological laboratory has been built from the plans of Prof. F. M. Simpson, of University College, and occupies an area of 42 ft. by 50 ft. immediately adjoining the physiological building on the east. It contains three complete floors and a mezzanine floor, besides the basement, the actual floor space amounting to about 6000 sq. ft., besides the stairway and passages. The building is lighted on three sides by large windows, which occupy the maximum amount of space permissible under the Building Acts. The ground floor is lined with white glazed brick throughout, and contains a reading-room 24 ft. by 18 ft., and the pharmacological-chemical laboratory, 24 ft. by 30 ft., fitted with two large chemical benches and fume cupboards. It communicates with an open-air balcony on the south side, which is arranged for investigations on noxious gases. On this floor there are also a balance-room, a dark-room, and an attendant's workshop. Between the ground and first floors a mezzanine floor contains lavatories and a hospital-room for animals under observation. The animal houses proper lie behind the building.

The first floor contains private rooms for professor and assistant, and two large experimental rooms, 24 ft. by 18 ft. and 24 ft. by 30 ft. respectively. The smaller of these is designed for work with the large kymograph, while the larger is used for smaller movable apparatus. A heavy beam runs through

both rooms at a height of 8½ ft. from the floor, and serves to support shafting and pulleys, which are set in motion by an electric motor in the larger room. Gas and water pipes also run along this beam, which carries, in addition, wires from an electric clock, and a tube supplying artificial respiration, so that these are all available throughout the laboratory. A floor channel running beneath the beam carries off waste water, and, in addition to wall switches, a number of floor plugs are inserted in its neighbourhood to supply light and power where necessary. This laboratory is fitted up with the ordinary experimental apparatus, and with a small centrifuge and incubator for hæmolysis work.

The second floor contains a small preparation and drug room for use in the lectures and demonstrations and the large lecture-room laboratory. This measures 48 ft. by 25 ft., and is fitted up with lecture desk, blackboards, and projection lantern, and with practical room benches for elementary work in pharmacology. A recess off the lecture-room, 18 ft. by 13 ft., is furnished with three tiers of standing places rising one above another, from which the spectators look down directly on the experimental table below. The students are expected to perform the simpler experiments in the laboratory, and these will be discussed and elucidated from the lecture table. The more complicated experiments will be done by the demonstrator on the special table in the recess, and when these are in progress the students will leave their places in the body of the laboratory and stand round and above the demonstration table. In this way it is hoped to be able to correlate the lecture, the practical work, and the demonstrations more closely than is possible when these are all given in different courses and in different rooms.

New Pharmacological Laboratory, University College, London.

MATHEMATICS AND PHYSICS AT THE BRITISH ASSOCIATION.

THE presidential address was delivered by Prof. H. L. Callendar at 10 a.m. on Thursday, September 5. This was published in full in NATURE of September 5 (p. 19).

Wireless Telegraphy.

The principal discussion arranged was a joint one with Section G on the scientific theory and outstanding problems of wireless telegraphy; it was opened by Prof. J. A. Fleming. Dr. Fleming had drawn up a list of twenty-four questions to which definite answers are still required. In the short time available to him it was impossible to go seriatim through these. After outlining the general methods of signalling now employed, he pointed out that the chief question was how such waves, if they are true Hertzian waves, are propagated a quarter of the way round the earth. The mathematical investigations of Prof. MacDonald, Lord Rayleigh, the late Prof. H. Poincaré, and of Dr. Nicholson seem to have proved that diffraction alone will not account for the phenomenon, even though the waves as used by Marconi have a wave length of nearly four miles. Prof. Sommerfeld had come to the conclusion that there must be "surface waves" at the boundary of the earth and atmosphere, and that these vary in amplitude inversely as the square root of the distance, and are sufficiently feebly damped in a horizontal direction to be propagated long distances, irrespective of irregularities of surface. Another theory has been based by Dr. Eccles upon the ionisation of the atmosphere. If the velocity increases with the ionisation, the upper part of a wave may travel faster than that near the surface, and the direction of propagation will be deflected downwards.

Closely connected with this is the inhibiting effect of daylight. Absorption due to ionisation is not sufficient. Refraction owing to varying dielectric constant arising from ionisation may be operative here. Many other problems require elucidation, such as the greatly reduced signalling distance at dawn and dusk, the inequality in north-south and east-west transmission, the theory of directive antennæ, and the location of the direction of the arriving waves.

In the discussion Dr. W. Eccles directed attention to his paper read before the Royal Society in June last. In order to account for the great difference between day and night transmission it seems necessary to suppose that there exists in the upper atmosphere a permanently ionised layer that is not dependent on

solar radiation for its maintenance—a suggestion due to Heaviside. This, in conjunction with refraction due to a gradient of ionisation, enables many phenomena to be explained without appealing either to diffraction or to absorption in the air or by the earth's surface.

Prof. A. E. Kennelly (of Harvard University) pointed out that partially quantitative observations on the effect of sunrise and sunset on signals received near Boston from the Marconi station at Glace Bay, N.S., indicated that an influence on received signals was projected ahead of the sunrise at the sending station. The effects might be partially explained if the ionisation of sunlight in the upper atmosphere produced a wall or nearly vertical series of ionised strata at the boundary of the daylight illumination with absorption in those strata and some irregular reflection from their faces.

Lord Rayleigh thought that there would always be many difficulties so long as we considered the earth a perfect conductor and the air a dielectric. Some seemed to suppose that the following of a wave round the earth was a consequence of the normality of the wave to the surface. That this is not so can be seen at once by realising that the same condition holds in the case of a sound wave.

The Sommerfeld theory was probably mathematically right, but a lot of time would be required to form an opinion as to its applicability to the problem. Sommerfeld came to the conclusion that it is the imperfection in the conductivity of the earth which facilitates transmission. This is certainly not in accordance with the first ideas we would come to. He approved of the lines of Dr. Eccles's investigation, especially in connection with the day and night complications. He was specially interested in the difference found to be necessary between the sending and receiving antennæ. This seemed to be in contradiction to the well-known principle of reciprocity. The explanation may be that for the validity of this principle all the effects must be linear. It is worth while to consider this difference between the two ends.

Prof. Macdonald and Dr. Nicholson both emphasised the certainty of results calculated on the pure diffraction theory, and the insufficiency of that theory, and expressed approval of investigations on the lines which Dr. Eccles took. Dr. Nicholson considered Prof. Sommerfeld's work to be rigorous so far as it went, but it was not certain that the investigation for a flat interface would apply to the earth. A very small area on the earth's surface would correspond to a very large area on a plane if one solution were mathematically transformed into the other.

Prof. A. G. Webster emphasised the importance of the lack of homogeneity of the earth and air. Captain Sankey seemed to despair of recording instruments, because they record everything. Prof. S. P. Thompson directed renewed attention to the pioneer work of Sir Oliver Lodge in 1894. Mr. S. G. Brown mentioned some experiments of his own in 1899. Contributions to the discussion were also made by Prof. Howe, Major Squire, and Prof. F. Baily. In a communicated contribution to the discussion, Prof. A. Sommerfeld emphasised the importance of the surface-waves. He thought that the difference between the day and night effect was due either to the increase of the conductivity of the air or to the upward bending action supposed by Dr. Fleming. He thought that one could not at the same time consider the ionisation a satisfactory explanation of the bending of the waves round the earth in long-distance transmission.

One important outcome of the discussion is that a committee of the Association has been formed to deal with radio-telegraphic investigations. The committee is without any specific instructions, but its first inquiry will probably be as to what concerted action is possible between investigators on this important subject.

General Physics.

Prof. S. P. Thompson gave a simple demonstration of the varying depth of the extraordinary image formed by a cleave of unaxial crystal. A block of Iceland spar was rotated so that the entrance and exit faces remained in fixed planes. Of the two images of a small electric light seen through this block, the ordinary image remains fixed; the extraordinary revolves round it in a tortuous curve.

Lord Rayleigh described some iridescent effects produced by a surface film on glass. These were specially brilliant when the glass was immersed in water, owing to equalisation of the amount of light reflected from the two surfaces. With regard to methods of cleaning, Prof. Webster inquired whether he had tried the well-known use of a gelatine film for removing all traces of dirt.

Prof. E. G. Coker described experiments on the flow of mercury in small steel tubes, especially at high velocities, at which the flow may be turbulent. The lowest velocity at which turbulent motion may commence is found to vary inversely as the diameter of the pipe and directly as the viscosity.

Dr. J. Gray gave several exhibitions of some spinning tops, many of them of new design, which appeared very useful for exhibiting gyrostatic properties.

Prof. W. Peddie described an apparatus for investigating the motion in torsional oscillations when viscous and hysteretic effects are present. The apparatus enabled a determination to be made of the connection between displacement and time throughout the motion. The author discussed the theoretical character of the results obtained.

Dr. S. R. Milner read an interesting paper on the current-potential curves of the oscillating spark. Two induction coils connected in series were actuated by the same mercury break; one of these charged a Leyden jar battery and produced the spark, the other simultaneously discharged through a vacuum tube giving kathode rays which were deviated in two directions at right angles by the magnetic field of the spark current and the electric field of the spark potential-difference. Photographs of the resultant curves due to single sparks were shown.

Dr. W. F. G. Swann described experiments indicating that the conductivity of paraffin wax increases with the field when values up to 100,000 volts per centimetre are employed.

Prof. W. G. Duffield and Mr. G. E. Collis exhibited photographs of a deposit upon the poles of an iron arc burning in air. The deposit, which is of a feathery nature, appears to be an oxide of iron. These growths vary from a millimetre to a centimetre in length; they increase in size by the condensation of metallic vapour or the vapour of an oxide of iron.

A paper by Dr. G. E. Gibson on a new method of determining vapour densities was taken as read in the absence of the author. The quartz manometer employed consists of a bulb of less than 1 c.c. capacity blown on a quartz tube 3 mm. in diameter, and flattened at one end so as to form a flexible membrane 1/10 mm. thick. The interior of this membrane is filled with the vapour under investigation, while the exterior is enclosed in a quartz chamber which communicates with a mercury manometer. A distortion of the membrane caused by a difference in pressure between the interior and the exterior causes a small

quartz plate, which is polished so as to act as a mirror, to undergo a rotation about an axis in the plane of the polished surface.

Dr. T. M. Lowry described some very accurate determinations of the optical rotatory power of quartz, in which particular attention was paid to the purity of the quartz, and to obtaining light pure enough to give a clean extinction when reading a rotation of several thousand degrees, and of sufficient intensity to be read with a small half-shadow angle.

Prof. R. A. Sampson, in giving a short account of a paper on the calculation of the fields of telescopic object glasses, remarked that the object of long-focus lenses was not to diminish the effects of chromatic aberration, but to do so for the other types of aberration.

Prof. D. C. Miller showed a very ingenious and successful instrument for analysing sound vibrations. The membrane set vibrating by the source of sound tilts a mirror mounted on an axle. The essential feature of the instrument is the extreme minuteness of the mirror, which, together with the axle on which it is mounted, does not weigh more than two milligrams. The light received from the mirror is received by a second mirror continuously rotating round a perpendicular axis. Vibration curves were projected on to a screen, the amplitude being about two feet, and the length shown some twenty feet. The constitution of compound notes was thus instantly demonstrated, and in particular the constitution of vowel sounds.

In the report of the committee on electrical standards evidence is given of the satisfactory character of the methods which have been established, in a great measure by this committee, for the measurement of electrical quantities. The committee rightly considers that the primary objects for which it was appointed have been achieved. It has, however, been reappointed for another year in order to complete the business arrangements connected with the republication of the entire set of its reports from 1861 until the present time.

In a report of the committee to aid in the work of establishing a solar observatory in Australia, it is reported that the Commonwealth Government appointed a board to inquire and report upon the best site for an observatory within the federal territory at Yass-Canberra. They unanimously selected a site on the summit of a hill some 2500 feet above sea-level, and the Government has instructed Mr. Baracchi to establish a temporary observatory at the selected site, and to determine definitely whether it answers the requirements of modern scientific research, including astrophysics. The telescope is the gift of Mr. James Oddie, of Balarat, who offered it, together with other instruments, for this specific purpose. A 6-inch Grubb refractor, the gift of the trustees of the estate of the late Lord Farnham, is also to be forwarded to Australia. In view of the action now being taken by the Commonwealth Government, there can be no doubt of its intentions in the matter of solar work.

Atomic Heat of Solids.

The second formal discussion which had been arranged was on the atomic heat of solids. This was opened by Dr. F. A. Lindemann, of Berlin. If the ordinary principles of mechanics are admitted as governing the movements of atoms, equipartition of energy is bound to be attained, and the atomic heat of a solid at constant volume should be exactly 3R. To escape from Rayleigh's formula for the distribution of energy in the spectrum, Planck has assumed that an oscillator may only emit definite discontinuous quantums of energy, and shows that their magnitude is proportional to the frequency; and he develops the formula—

$$E = \frac{2c^2h}{\lambda^5} \frac{1}{e^{\frac{h\nu}{KT}} - 1},$$

where h is a new universal constant $6{\cdot}55 \times 10^{-27}$ erg. sec., $K = R/N$, and ν is the frequency. This formula appears to agree with experimental results. From this, on certain assumptions, Einstein has shown that the atomic heat of N atoms should be—

$$C_v = \frac{a^2e^a}{(e^a - 1)^2}, \text{ where } a = (h\nu)/(KT).$$

This formula is only approximately correct, and fails altogether if one inserts the true frequencies calculated from the reststrahlen, from the compressibility, density and atomic weight, or from the melting point, density and atomic weight. Nernst and Lindemann have empirically modified this formula by adding a second term in which α has half the value in the first, thus corresponding to frequencies an octave below those in the first term. This formula holds accurately for the atomic heat of the metals, diamond, NaCl, KCl, NaBr, and KBr, using the values of ν given by the reststrahlen.

It follows that the free electrons, if there are any, can only have a very small specific heat, for the atomic heats of conductors and non-conductors may be represented by practically identical curves. Further, it can be shown that "Nernst's theorem" is a consequence of the fact that the atomic heats are infinitely small at the absolute zero.

In the discussion, Dr. G. E. Gibson sketched an hypothesis by means of which the difficulty of Planck's assumption of a discontinuous absorption and emission of energy might be removed. He supposes that the discontinuity is confined solely to the collisions between the molecules with which the resonators are connected, so that during the time between collisions the resonators are subject to the ordinary laws of thermodynamics.

Lord Rayleigh was glad that, though the law of equipartition led to his own equation, this had not been so presented as to make it appear that he believed it to apply to all wave lengths. He considered that the difficulty attending the five degrees of freedom of a diatomic gas had not yet been removed satisfactorily. However stiff the molecule is made axially there is still a degree of freedom connected with axial separation of the two atoms. He was extremely interested in the quantum theory; the success it had obtained showed that it should not be given up, although at the same time it seemed to be throwing away most of our dynamical ideas. It implies the extraordinary result that when two molecules meet they may not take up motion because it is too small to be taken up at all!

Dr. J. W. Nicholson laid emphasis on the discrepancy between Lindemann's conclusion that the atomic heat of electricity is very small and the usual conclusion from the electronic theory of metals which requires a value for it so large as to be inadmissible. He felt very much in accord with the ideas put forward by Dr. Gibson.

Prof. Rutherford said that one point appealed to him. Foreigners seem to be content without realising a practical model or mechanism of the processes they assumed to take place. He did not lay great stress on the agreement between the theory and experiment—a double exponential equation can be fitted to almost anything. He was inclined to doubt whether the formula of Nernst and Lindemann was of the right form.

Prof. Bragg emphasised the corpuscular nature of other things, *e.g.* of X-rays. A number of other speakers also took part.

Dr. Lindemann, in his reply, pointed out that Pier and Bjerrum have shown that the molecular heat of the diatomic gases rises above the value $5R/2$ at high temperatures, and may be represented by the formula $5R/2+Rf(\nu,T)$, where $f(\ )$ is the same formula as that used for solids. The frequency (ν) coincides with the absorption bands in the case of some of the gases with charged ions (HCl, H_2O, NH_3, &c.). The fact that the molecular heat of hydrogen falls as low as $3R/2$ at the temperature of liquid air is far more difficult to explain even on the assumption of quanta, for the rotation takes place without potential energy in this case, and one would naturally expect the frequency to vary with the temperature, which would lead to a much more gradual diminution of the molecular heat than is actually the case. Personally he was doubtful of the validity of Poincaré's proof that one must assume a discontinuity to obtain Planck's formula. He considered it premature to construct a model; it is necessary first to find the conditions which a model must fulfil.

The most difficult fact to account for is the large conductivity for heat of crystals at low temperatures where the energy fall may be very small. Models which are based upon electrons being ejected are of no use, as they do not explain why an uncharged diamond atom does not start vibrating when struck by an uncharged helium atom. The agreement between calculation and experiment can scarcely be regarded as fortuitous, for there are no arbitrary constants in the formulæ. He did not think that the theory of free electrons in metals can be retained in its present shape. The calculation of Wiedemann-Franz's constant is based on the assumption that the free electrons have the mean kinetic energy of a monatomic gas at the same temperature. Planck's radiation formula would seem to lead to about one-third of this value, but this would make the thermal conductivity three times too small. It is noteworthy that the electric resistance appears to be very nearly proportional to the energy content, becoming independent of the temperature at low temperatures. The electric conductivity of very pure quicksilver is 100,000 times greater at the temperature of liquid helium than it is at 0° C.

If one assumes the number of free electrons to be very small, but to contain the energy of a monatomic gas, the electrical conductivity shows that the mean free path must be very large, and one comes into conflict with optical measurements, more particularly with those of Hagen and Rubens. He would be very loathe to accept the theory of corpuscular radiation. All arguments in its favour are valid also for light. The phenomena of interference show that a quantum of light might be 500,000 wave lengths or 25 cm. long. What would become of it if it were cut in two? He believes that Planck's second hypothesis of continuous absorption and discontinuous emission is able to account for the chief difficulty, viz. that a comparatively fast electron may be emitted under the influence of comparatively weak radiation.

Spectroscopy.

A third discussion was opened by Dr. J. W. Nicholson on series in spectra. The opener gave a general account of the work which has been done in the representation of spectra by formulæ, and followed with a review of the attempts made to obtain these formulæ from model atoms. He concluded that the Ritz formula cannot represent the actual facts, and that Hicks's modification and Whittaker's formula are difficult to interpret physically. A modern theory apparently must build up the atom from electrons and positive electricity—the latter, from work on radioactivity alone, being densely concentrated at the centre of the atom. The electrons must be arranged in rings to avoid excessive radiation (Schott), and the atom is Saturnian. The necessary permanence of structure can be secured by allowing expansion of electrons, or by a quantum theory, which is preferable. It has been shown that it is possible to explain the coronal and nebular spectra by simple ring systems with a quantum theory which implies a definite change of energy when an electron enters or leaves an atom. The spectra of such elements do not exhibit the usual series, but a series in which the cube-roots of the wave lengths differ by a constant amount. This is in accordance with a radiation of energy in discrete amounts proportional to the frequency. The difficulty in explaining Balmer's series is that in dynamical systems it is the square of the frequency, not the frequency itself, which is a rational function of integers. This difficulty is absent from the model of Ritz; but it is more probable that the origin of spectral series is kinematical (as Rayleigh has suggested) rather than dynamical. A process was sketched by which a series of lines

$$\lambda=\lambda_0\frac{n^2}{n^2-a^2}\ (a=\text{const.})$$

can be obtained for an atom with two rings of electrons by simple kinematical principles. If the outer ring contains only one electron the lines are doublets. The infinite number of lines is due to the infinite number of degrees of freedom of the æther.

In the discussion, Prof. Kayser said that the first thing is to get a theory—none are quite right. Ritz's is approximately right, but it cannot be the true one, because it leads to too large a number of components in the Zeeman effect. Hicks lays too much value on the accuracy of the measured wave lengths. We cannot hope to get the true wave length to one-thousandth Ångström unit. For example, some lines in the iron spectrum are variable, being different at the positive and negative poles. Their character depends upon the conditions—Fabry obtains interference effects with them, while he himself cannot. In mixtures some calcium lines have a different wave length from those of the pure substance.

Prof. Fowler added the name of Halm to those whose formulæ required recognition. With regard to accuracy, half a tenth-metre error could arise from nebulosity; this can, however, be reduced by altering the conditions.

Prof. Peddie suggested the investigation of a more complicated system consisting of a succession of shells of alternate positive and negative character. He pointed out that if you make the atom rotate you must also take into account the magnetic forces.

Lord Rayleigh said that one point that was usually omitted was the difference between the vibration in the atom and that received by the observer. He instanced the case, in sound, of a revolving vibrating cylinder. The observer receives maxima and minima as the cylinder revolves—that is, there are two vibrations giving rise to beats.

Dr. Duffield discussed the pressure effect as a means for the resolution of a spectrum into series. Photographs were exhibited showing the different behaviour of spectral lines under pressure, thus facilitating their grouping. Prof. Kayser said he doubted if it is a pressure effect. Dr. King had found that in the electric furnace he gets a double amount, which shows that other conditions enter into account. He did not think it possible so far to determine series by this

method, though certain groups are obtained. Just the same applies to the Zeeman effect.

After the discussion, Dr. Duffield also showed photographs of the arc spectrum of nickel under pressure. The effects resemble those obtained with the iron arc.

Dr. T. M. Lowry explained how he had calibrated a wave-length spectroscope in the infra-red region by aid of the fringes from a lightly-silvered etalon, using a thermopile and galvanometer instead of an eyepiece. Between λ8000 and λ17,000 the error was not more than 20 to 50 A.U.; thence up to λ20,000 the error may have amounted to 100 A.U. Prof. McLennan stated that one of his assistants had made measurements to λ21,000. Prof. McLennan gave a brief account of some measurements in his laboratory of the series lines in the arc-spectrum of mercury and on their resolution by an echelon grating. In these experiments he found that the best spectrograms were obtained with an ordinary commercial glass Cooper Hewitt mercury lamp provided with a side tube carrying a window made from a plate of crystalline quartz.

Radio-activity and Electronics.

Mr. James Robinson described his experiments on the photoelectric properties of thin metal films showing a discontinuity in the behaviour when the film attains a particular thickness. Prof. Rutherford asked whether this break in the curve implied that the total energy emitted was discontinuous. Prof. McLennan suspected the possibility of a coherer action when the thickness attained a definite limit. In reply to a query by Prof. Millikan, Mr. Robinson stated that the 6-volt electrons obtained corresponded to about the limit capable of producing ionisation. He did not think Prof. McLennan's suggestion fitted in with the facts.

Prof. Millikan summarised his already published experiments on the discharge of ultra-violet light of high-speed electrons, in which far higher velocities were found when a spark is employed from those for a mercury arc. Prof. Strutt suggested that what was required was to bridge over the gap between the arc and spark experiments, and indicated that it might be done by gradually altering the pressure of the gas in which the spark took place. Prof. Millikan replied that he had altered the conditions gradationally. He pointed out that only 1 in about 100,000 electrons have the high velocity. He also read a paper on the law of the fall of a drop through air at reduced pressures and a redetermination of e.

A law of fall of the form—

$$v=\frac{2}{9}\frac{ga^2(\sigma-\rho)}{\mu}\left\{1+A\frac{l}{a}\right\}$$

is found to hold so long as $l/a<0{\cdot}4$, but beyond that limit an extra term must be added inside the curly brackets, viz. B. exp. $(-ca/l)$, in which A, B, and c are all positive constants. If l is obtained from the Boltzmann formula, $\mu=0{\cdot}3502mn\bar{c}l$, then A=0.874, B=0·35, and $c=1{\cdot}7$. The accurate evaluation of the constant A makes possible a redetermination of e which has a probable error of no more than 1/10 per cent. This value is $e=4{\cdot}775\times10^{-10}$ E.S. units.

Prof. J. C. McLennan, on the intensity of the earth's penetrating radiation over land and large bodies of water, claimed *inter alia* to prove that the earth's penetrating radiation has practically the same intensity within a brick structure at Cambridge and a stone building in Scotland as within a brick or a stone structure at Toronto; and further to disprove the existence of a diurnal variation of this radiation at Cambridge. Prof. Strutt could not help thinking that it existed.

Prof. E. Rutherford and Mr. H. Robinson contributed a paper on the heating effect of radium emanation and its products. They raised the question as to whether the energy of the alpha particle is a measure of the heating effect produced, and came to the conclusion that there is a distinct difference between these quantities, and thence that there must be a small rearrangement of the original atom. The paper will shortly be published by the Vienna Academy of Science.

In a second paper, Prof. Rutherford discussed the origin of the beta and gamma rays from radio-active substances. The evidence used was afforded by the relations between the energies of the numerous groups of beta rays which are obtained. The simplest way of regarding these relations is to suppose that the same total energy is emitted during the disintegration of each atom, but the energy is divided between beta and gamma rays in varying proportions for different atoms. For some atoms most, if not all, of the energy is emitted in the form of a high-speed beta part, in others the energy of the beta particle is reduced by definite but different amounts (as it might be if, in escaping, it had to pass through successive rings of electrons) by the conversion of part of its energy into that of gamma rays.

Prof. F. Soddy exhibited the apparatus (as shown in his Royal Institution lecture) for drawing the curves of radio-active changes.

Mathematics.

M. Gérardin, of Nancy, described a mechanism for factorising large numbers. By means of this instrument, which is of the nature of a slide rule, factorisation is exceedingly expeditious, *e.g.* the decomposition of Mersenne's number M_{47} required only four minutes. Lieut.-Col. A. Cunningham congratulated the author. With such a machine one would be quite able to investigate the remaining Mersenne's numbers, but he was afraid that it would require to be very large.

Lieut.-Col. Cunningham himself read a paper on Mersenne's numbers. An additional prime factor has been found for M_{71}, viz. 212885833 (due to Mr. Ramesam, of Mylapore); E. Fauquembergue has confirmed that M_{89} is prime; the author has shown that $M_{173}\equiv0 \pmod{730753}$. Thereby three mistakes have now been proved in Mersenne's classification, viz.:—M_{67} proved composite, M_{61} and M_{89} proved prime.

Lieut.-Col. Cunningham, in a second paper, discussed the arithmetical factors of the Pellian terms.

Prof. E. H. Moore dealt with the theory of the composition of positive quadratic forms. The n-ary quadratic form—

$$A=\sum_{i,j=1}^{n} a_{ij}x_ix_j \quad (a_{ij}=a_{ji}),$$

with real coefficients a_{ij}, is positive if, for real values of the n variables, x_i, it takes on only positive or zero values. From two such forms, A and B, we obtain by multiplication of corresponding coefficients a third form, C, their inner composite. For this inner composition the property of positiveness is invariant, *i.e.* the inner composition is likewise positive; otherwise expressed, the class of positive n-ary quadratic forms is closed under the process of the inner composition of forms. The theorem in its generality is readily proved by consideration of the fact that a form is positive if, and only if, it is expressible as the sum of squares of a finite number of linear forms with real coefficients. Mr. Hilton suggested that the theorem might be proved by using the fact that the zeros of the characteristic determinants were real and

positive. Dr. H. B. Heywood inquired if Prof. Moore had discovered any similar results for quadratic forms other than positive ones. Such results would be of use in the theory of Fredholm's equations. Prof. Moore thought Mr. Hilton's suggestion a good one. He had not discovered any results applicable to the general quadratic form. He had been led to the theorem of his paper by his work on Fredholm's equation.

Prof. J. C. Fields gave a new proof of a general theorem relating to orders of coincidence. Major MacMahon discussed the algebraic functions derived from the permutations of any assemblage of objects. Prof. W. Peddie described an apparatus for the solution of equations of the *n*th degree, which required, however, that the equation should be prepared so that the root required lay between 0 and 1. In reply to a query, he thought that the method would be more expeditious than those usually employed.

Dr. H. B. Heywood described the use of the exponential curve in graphics. For carrying out the processes a template of transparent celluloid is used upon which is marked a graduated exponential curve. Operations of multiplication, division, evolution, differentiation, and integration are performed. The error is not greater than 1 per cent. except for differentiation.

An account was given by Dr. Nicholson of the report of the committee for the tabulation of Bessel and other functions. Four sheets of new tables of elliptic functions are given for four modular angles. These are preceded by a statement by Sir George Greenhill explaining the notation and the mode of using the tables. The report includes some tables (placed at their disposal by Prof. A. G. Webster, who has calculated them) of some *ber* and *bei* functions and their derivatives. These tables will be of especial importance to electrical engineering.

Cosmical Physics and Astronomy.

The report of the committee on seismological investigations contains a detailed account of the various seismic disturbances in the period 1904–09, thus extending the catalogue contained in last year's report. Curves are given, relating to six large earthquakes, showing the relation between the amplitudes in angular measure and the distance from the origin. Sixteen instances are given in which the azimuth of an origin determined from the maxima of the N.S. and E.W. motion approximately agrees with the azimuth as measured on a globe. In the same interval there are twenty-six instances for which no such agreement exists. The inference is that the main portion of teleseismic motion generally takes place in directions independent of the azimuth of its origin. Sections are devoted to the relative duration of two rectangular components of earth movement at a given station, megaseismic frequency in different seasons, earthquake periodicity, a new periodicity (by Prof. H. H. Turner, in which it is shown that besides the period of about fifteen months, there is also evidence that for the world as a whole seismic strain usually finds relief every fifteen or thirty days), and other matters.

Prof. H. H. Turner explained further to the section that further examination showed that some of the deviations may be due to the existence of neighbouring periodicities which have not been fully examined. But attention has been concentrated on the existence of pairs of periodicities or groups (analogous to double lines or groups of spectra) by relative work on the variations of level and azimuth of the Greenwich and Cape transit circles.

In the absence of Mr. J. I. Craig, Prof. Turner read a paper by the former showing that there is a connection between Prof. Schuster's method of analysing a series of figures for suspected periodicities and the method of correlation applied by Prof. Karl Pearson to detect hidden connections between sets of variables.

Dr. S. Chapman, of Greenwich Observatory, gave an account of an attempt to determine the total number of the stars. He also read a paper by Prof. Dyson (the Astronomer Royal) in which it was endeavoured to identify several chromosphere lines as due to radium. Considerable scepticism seemed to be shown by those present whether it was possible at present to make sure of the identity on such short spectra as are obtainable. Prof. Kayser expressed his great interest, but considered that the relative intensities which had been quoted were very uncertain because authorities differed. It was doubtful indeed whether a stated intensity had any meaning. The presence of helium seemed to be a point in favour of the author. Prof. the Hon. R. J. Strutt remarked that the spectral examination of terrestrial minerals would scarcely show the presence of radium, and asked whether the conditions in the chromosphere were such as to enhance the lines or those of allied bodies, such as barium. Prof. Rutherford said he would require very great evidence indeed before accepting spectroscopic evidence of emanation in stars. Dr. Nicholson argued that the presence of helium does not prove the presence of radium. Father Cortie and Dr. Lockyer both emphasised the shortness of the spectra.

In a paper on magnetic disturbances, sun-spots, and the sun's corona, Father Cortie examined the curves for the period 1898–1911 of mean daily disc-area of sun-spots, mean daily range of declination and horizontal force, and yearly numbers of great and moderate magnetic disturbances. There is a general accord in the curves, but also notable discrepancies. For example, the rapid fall of sun-spot curve 1909–11 was accompanied by a marked rise in declination, horizontal force and moderate magnetic disturbances.

The committee on magnetic observations at Falmouth Observatory report the following mean values of the magnetic elements for the year 1911 :—

Declination	17° 33·0′ W.
Inclination	66° 28·2′ N.
Horizontal force	0·18798 C.G.S.
Vertical force	0·43172.

The meteorological papers read have been described in an earlier article (November 28, p. 369).

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Notice is given that the Plumian professorship of astronomy and experimental philosophy is vacant by the death of Sir George H. Darwin, K.C.B.

Mr. H. C. Robson, of Sidney Sussex College, has been appointed chairman of the examiners for the mathematical tripos, part i., 1913, and Prof. Seward chairman of the examiners for the natural sciences tripos, 1913.

The professor of anatomy has appointed Mr. E. R. T. Clarkson an additional demonstrator of anatomy.

The matriculation of December 6 shows a total entry of 1156 freshmen up to the present date for the year 1912–13. This compares favourably with the similar number of last year at the same date, which was 1111.

OXFORD.—On December 10 the honorary degree of doctor of science was conferred on Prof. Ernest

William Hobson, fellow of Christ's College, and Sadlerian professor of pure mathematics in the University of Cambridge.

By special invitation of the University of Calcutta, Dr. A. R. Forsyth, F.R.S., will give a course of advanced lectures in pure mathematics early next year. His subject is "The Theory of Functions of Two or More Complex Variables." The course will consist of sixteen lectures, to be delivered late in January and in February, and the lectures will be published later.

The course of lectures on Indian sociology by Mr. T. C. Hodson will be resumed at East London College (University of London), Mile End Road, E., on Monday, January 13, at 5.30 p.m., when the subject-matter of the lectures will be tree marriage in India, its significance in non-Aryan races, and other forms of substituted marriage. These lectures are free to the public.

The Selborne Society is making a representative exhibit at the Children's Welfare Exhibition (which is to be opened at Olympia on December 31), to show what is best in nature-study and its uses to boys and girls. All who are interested in the subject are invited to communicate with Mr. Wilfred Mark Webb, 42 Bloomsbury Square, W.C., so that he may send them the outline scheme which it is intended more particularly to follow and learn what matters of value they could offer to illustrate it.

In view of the success of the first Summer School of Town Planning, held at the Hampstead Garden Suburb in August last, under the auspices of the University of London, it has been decided to hold a second summer school next year at the same centre. It will last for a fortnight, commencing August 2, and continuing until August 16, and during that time lectures and demonstrations on town planning and subjects practically connected therewith will be given by some of the leading authorities. Particulars can be obtained upon application to the hon. secretary of the Summer School, Mr. J. S. Rathbone, The Institute, Hampstead Garden Suburb, London, N.W.

A course of lectures and practical instruction on physical anthropology will be given in the anatomy departments of University College and King's College, London, by Prof. D. Waterston and Dr. D. E. Derry. The course will begin on Tuesday, January 14, at University College, and will comprise the following branches of the subject:—Cranioscopy; craniometry; osteometry; anthropometry (on the living subject); estimate of stature, age, and sex from bones; comparison with higher mammals, especially anthropoidea; and race distribution and characteristics. Further particulars may be had on application to the secretary of King's College, or to the secretary of University College.

The Eugenics Education Society has arranged for three courses of lectures upon the groundwork of eugenics, to be given at the Imperial College of Science, South Kensington, from January to December, 1913. In the spring term (January to March) there will be a course of twelve lectures on elementary biology, with special reference to the reproductive system, by Mr. Clifford Dobell; in the summer term (April to July), a course of twelve lectures on heredity, including evolution, genetics, and heredity in man, by Prof. R. C. Punnett, F.R.S.; and in the autumn term (October to December), a course of twelve lectures on statistical methods applied to some problems in eugenics, by Mr. G. Udny Yule.

In connection with the Francis Galton Laboratory for National Eugenics, a course of six lectures will be delivered at University College, London, by Prof. Karl Pearson, F.R.S. (Galton professor of eugenics), Miss Ethel M. Elderton, Dr. David Heron, and Mr. W. Palin Elderton. These lectures will be given on Tuesday evenings at 8 p.m., beginning February 11, 1913, and will deal with the following subjects:—Heredity, environment and parental habits in their relation to infant welfare; heredity of piebaldism and of albinism in man; the relation of fertility in man to social value in the parent; some points with regard to our present knowledge of heredity in cases of feeble-mindedness; the mortality of the phthisical under sanatorium and tuberculin treatments; and recent studies of heredity in dogs, and their bearing on heredity in man. The course will be open to the public without fee, but applications for tickets should be addressed to the secretary of University College.

The scheme for the rebuilding of College Hall—a hall of residence for women students of London University—has already been referred to in these columns. At a combined meeting of the trust fund committee and the executive committee of the site and rebuilding funds held last week, the chairman of the executive committee, Dr. Gregory Foster, announced that the committee, on reporting the scheme to the Queen, had obtained the gratifying response "that the object was one which met with her Majesty's entire approval," and that "so soon as the necessary funds have been raised to complete the scheme the Queen will be prepared to give her favourable consideration to the question of College Hall being named after her Majesty." With regard to these funds, it was stated that of the total sum of 30,000*l.* required, more than 9500*l.* has been obtained within the first year. It was decided to make a strong appeal, both publicly and privately, for the 20,500*l.* necessary to complete the scheme.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, November 20.—Dr. Aubrey Strahan, F.R.S., president, in the chair.—H. W. **Monckton**: The Hafslo Lake and the Solvorn Valley (Norway). The district lies north of the main Sogne Fjord and west of the Lyster Fjord. A series of valleys running from the area of the Jostedal snowfield and cutting the belt of Silurian rocks which crosses the district in a north-easterly and south-westerly direction, and a second series of valleys which run parallel to the snowfield and to the Silurian belt, are described. The valley of the Vejtestrands Lake, which belongs to the first of the above series, is traced until it reaches the Hafslo Lake, which lies at a point where the valleys of the two series intersect. The present line of drainage follows a valley of the second series from the lake to the fjord, but a disused outlet from the lake to the fjord is described belonging to the first series. While the disused outlet is probably the older of the two, reasons are given for believing that both outlets were in use during the latter part of the glacial period. Some giants' kettles, which for various reasons are believed to date from a time when the glacier extended to the places where they are now found, are described, and it is suggested that they were the work of a river flowing under the ice or between the ice and the rock.—S. **Smith**: The genus Aulophyllum. Aulophyllum is a genus belonging to the Clisiophyllid group. It is found in the upper beds of the Carboniferous Limestone Series in Britain and on the Continent. It appears in the lower part of the Dibunophyllum zone (D_1), becomes common in the middle subdivision of the zone (D_2), and is plentiful in the highest limestones investigated (D_3). The

coral was described first by David Ure, in 1793, as Fungites; the genus was established by Milne-Edwards and Haime in 1850. In this genus Thomson's genus Cyclophyllum is included. All the species previously described are regarded as variations of the same species. Many specimens of the coral display the phenomenon of rejuvenescence. The structural changes observed are described, and the nature of the rejuvenescence is discussed.

EDINBURGH.

Royal Society, November 18.—Dr. John Horne, F.R.S., vice-president, in the chair.—Prof. W. **Peddie**: The deviation of the law of torsional oscillation of metals from isochronism. It was found that, in spite of the effect of viscosity, even though that were so great as to cause, during a semi-oscillation, a fall in amplitude to one-third of the original value, the law of oscillation throughout the greater part of a semi-oscillation could be represented by a simple harmonic function.—James B. **Ritchie**: A fuller test of the law of torsional oscillation of wires and a continued investigation on the behaviour of certain torsionally oscillating wires. The investigations had been extended to brass and aluminium wires at high temperatures, and to various other wires at ordinary temperatures. The effects of quenching and of magnetisation were also studied. In the case of a copper wire on the surface of which zinc had been deposited electrolytically to various thicknesses, the parameters in the formula for relation of torsional swing to number of swings changed gradually from those characteristic of the one metal to those characteristic of the other.—J. P. **Dalton**: The energetics of the induction balance. When the arms of a Wheatstone Bridge contain capacities and inductances, as well as resistances, the formulæ appropriate to the methods for measuring capacities and inductances can be deduced from the relations between the electrostatic and electrokinetic energies.—R. A. **Robertson** and Miss Rosalind **Crosse**: Periodicity in plants. Experiments were described which proved the existence of a four-day growth rhythm of wide occurrence in plant organs. By means of a specially arranged apparatus simultaneous records were taken of the growth of the shoot and the root, and these showed a correlative affectability between the organs.—Dr. Thomas **Muir**: Theory of axisymmetric determinants from 1857 to 1880.

PARIS.

Academy of Sciences, November 25.—M. Lippmann in the chair.—G. **Bigourdan**: Fifth list of nebulæ discovered at the Observatory of Paris.—L. **Maquenne** and E. **Demoussy**: The determination of the true respiratory coefficient of plants. In a preceding communication it has been shown that the true respiratory quotient for plants is always higher than the apparent ratio given by the confined air method, and it is very difficult to apply corrections to the latter. An accurate method is described, called the displacement method, and results obtained by this and the vacuum method compared for numerous plants.—M. **Gouy**: The simultaneous action of gravity and a uniform magnetic field on an ionised gas. The apparent contradiction between the kinetic theory and Carnot's principle disappears if the ions arise on the walls of the vessel at the same time as in the body of the gas, according to a determined relation.—Serge **Bernstein**: The asymptotic value of the best approximation of analytical functions.—Rodolphe **Soreau**: The reduction of $F_{xx}=0$ to the form $f_1f_3+f_2g_3+h_3=0$.—L. **Thouveny**: The volplane. A mathematical study of the conditions under which a bird floats in the air in a wind.—M. **Mesnager**: An experimental method for determining in advance the tensions produced in buildings.—Carl **Störmer**: Remarks on a note of M. Kr. Birkeland relating to the origin of the planets and their satellites. A paper published by the author in 1907 on the movement of an electrified particle in the field of an elementary magnet can be directly applied to the hypothesis of the origin of planets of M. Birkeland.—É. **Rothé**: The reception of wireless signals by antennæ on the ground. Using a horizontal wire from 15 to 35 metres in length and supported only 15 cm. from the ground near Saint-Dié, the Eiffel Tower signals were clearly heard. The garden in which these experiments were carried out was entirely surrounded with a metallic trellis more than one metre high.—Léon and Eugène **Bloch**: The ionisation of the air by a mercury arc in quartz. A distinct ionising action of the arc on the air was proved.—A. **Henry**: A micromanometer. The manometer consists of two wide vertical tubes connected by a narrow horizontal tube. Carbon tetrachloride is used as the fluid, and a small bubble of air is introduced into the horizontal tube. Differences of level corresponding to 0·005 mm. of water are shown by the movement of the bubble. Various possible applications of this micromanometer are enumerated.—A. **Boutaric**: The critical coefficient and the molecular weight of bodies at the critical point.—Eugène L. **Dupuy** and A. **Portevin**: The thermoelectric properties of the system iron-nickel-carbon. Experiments were made with thirty analysed alloys containing varying proportions of nickel; the results are shown graphically in six curves.—M. **Hanriot** and F. **Raoult**: The chemical reactions of β-gold and crystallised gold. A study of the solution of the two forms of gold by solutions of nitric and hydrochloric acids and of auric chloride.—E. **Léger** and Ferdinand **Roques**: Carpiline, a new alkaloid from jaborandi. Details of the method of extraction and chemical and physical properties of the new alkaloid are given, together with some preliminary experiments to determine its constitution.—Aug. **Chevalier**: The introduction of the clove (*Carophyllus aromaticus*) into Gabon.—A. **Lamothe**: The gametophyte of the Marchantiaceæ and the importance of its anatomical characters.—J. **Stoklasa**: The influence of radio-activity on the development of plants. Radio-active water causes a prompt germination and a very rapid development of the leaves and roots of plants, provided that the radio-activity does not exceed a certain limit; above this limit the action is deleterious.—V. **Grégoire**: The truth of the heterohomeotypical scheme.—C. **Delezenne** and Mlle. S. **Ledebt**: New contribution to the study of the hæmolytic substances derived from serum and from the vitellus of the egg submitted to the action of cobra poison.—Henri **Iscovesco**: The physiological properties of certain lipoids. The homo- and hetero-stimulant lipoids of organs. A lipoid extracted from the ovary, injected into rabbits, produced marked hypertrophy of the ovary. The action was specific, all the other organs remaining normal. A lipoid extracted from the testicle of the horse was also found to exert a similar specific action in rabbits.—J.-P. **Langlois** and G. **Desbouis**: The duration of the pulmonary circulation. The method followed was a modification of that due to Stewart. Curves are given showing the action of varying amounts of digitalin and chloroform and ether on the duration of the pulmonary circulation.—A. **Desmoulière**: The antigen in the Wassermann reaction. Further experiments showing the constancy and high sensibility of the antigen prepared by the method described in a previous paper.—A. **Magnan**: Variations in the digestive apparatus of ducks produced by various kinds of foods.—Jacques **Pellegrin**: The ichthyological fauna of the coasts of Angola.—R. **Fourtau**: The divisions of the Eocene in Egypt.—G. **Vasseur**: The vertebrate fauna discovered in the upper Aquitanian of Agenais.

December 2.—M. Lippmann in the chair.—A. **Lacroix**: The existence of nepheline rocks in the crystalline schists of Madagascar. Details of the appearance, occurrence, and composition of a nepheline gneiss and its comparison with a similar rock of Portuguese origin.—Charles **Depéret**: The Oligocene of the Roanne basin and its fauna of fossil mammals.—Ph.-A. **Guye** was elected a correspondent for the Section of Chemistry in the place of Adolf von Baeyer, elected foreign associate, and M. **Balland** a correspondent for the Section of Rural Economy, in the place of the late M. Pagnoul.—Charles **Gallissot**: Contribution to the study of scintillation. The effect of twinkling of a star has been studied from the photometric point of view. It leads to an error in the determination of the magnitude of a star depending on the change of colour.—Patrick **Browne**: A problem of inversion proposed by Abel.—M. **d'Ocagne**: The reduction of equations with three variables to the canonical forms.—M. **Roussilhe**: The variation of levels in the Congo rivers. The Congo basin is divided into two distinct zones, in only one of which there is a clear seasonal variation, culminating at definite dates.—M. **Charcot**: Maps of the second French Antarctic expedition.—C.-G. **Darwin**: Remarks on the communication of M. Gouy on the theory of ionised gases and Carnot's principle. Reasons are adduced showing that the case imagined by M. Gouy in opposition to Carnot's principle is impossible, and that a magnetic field will not alter a statistical distribution of the ions.—L. **Houllevigue**: The reflection of slow kathode rays.—E. **Briner**: The limit of formation of endothermic compounds at very high temperatures. In the van't Hoff equation for the equilibrium of the reaction between N_2 and O_2, with production of nitric oxide, the heat of reaction is negative. If, however, the temperature of the reaction is sufficiently high to dissociate entirely the molecules of nitrogen and oxygen the heat of reaction will be negative and the concentration of NO will then diminish with rise of temperature. The increase of dissociation of the elementary molecules will thus lead to a temperature for which the concentration of the nitric oxide will pass through a maximum.—Henri **Bierry**, Victor **Henri**, and Albert **Ranc**: The inversion of saccharose by the ultra-violet rays. Experiments are described proving that the hydrolysis of the saccharose produced after irradiation either in neutral solution or slightly acid solution, in presence or absence of oxygen, is a direct product of the action of the ultra-violet rays.—Daniel **Berthelot** and Henri **Gaudechon**: The photolysis of several kinds of sugars by ultra-violet light. The gases produced by the degradation of sugars by ultra-violet light consist of carbon monoxide and hydrogen in simple proportions.—Marcel **Guerbet**: The action of caustic potash on *cyclo*hexanol; the synthesis of *cyclo*hexanyl*cyclo*hexanol and of di*cyclo*hexanyl*cyclo*hexanol.—Lucien **Daniel**: The grafting of *Nasturtium officinale* on *Brassica oleracea*. An example of the effect of modifying the habitat of one or both of the plants on successful grafting.—M. **Servettaz**: Cultures of mosses in sterilised media.—Mlle. Marie **Korsakoff**: Researches on the variation of fats, sugars, and of saponine in the course of the ripening of the seeds of *Lychnis Githago*.—Marc **Bridel**: The presence of gentiopicrin, gentianose, and of saccharose in the fresh roots of *Gentiana Asclepiadea*.—G. **Gin**: The black earths of the valley of l'oued R'Dom in Morocco.—P. **Nottin**: A study of manganese in its relation to soils. Arable earth renders manganese salts insoluble, and retains it in a manner analogous to that in which it absorbs ammonia, potash, and phosphoric acid.—Pierre **Teissier** and Pierre **Gastinel**: Reactions in human and experimental vaccine.—J. **Bergonié**: The applications of diathermy as forming part of the energy balance of the body. An account of the therapeutic action of d'Arsonval's method of using high-frequency currents of low electromotive force. Details are given of the application of this method to one case in which a marked improvement resulted.—M. **Ardin-Delteil**, L. **Nègre**, and Maurice **Raynaud**: The vaccin-therapy of typhoid fever. An account of the application of Besredka serum in thirty-seven cases. The gravity of the disease was reduced, not one death in the thirty-seven cases taking place. The number of relapses was reduced to about one-half of the average, and the duration of the disease appeared to be somewhat shortened.—Henri **Piéron**: The relation connecting the time of latency of reaction and the intensity of stimulation.—E. **Kohn-Abrest**: The action of active aluminium on alkaloidal extracts. Its use in toxicology. Amalgamated aluminium may be used for purifying visceral extracts from fatty and colloidal impurities. Certain alkaloids, such as strychnine, quinine, and cocaine, are partially retained by the aluminium, whilst nicotine is almost totally retained. Other alkaloids examined were not appreciably retained by the aluminium.—B. **Sauton**: The comparative influence of potassium, rubidium, and cæsium on the development of the spores of *Aspergillus niger*.—A. **Trillat** and M. **Fouassier**: The action of infinitesimal doses of various alkaline, fixed, or volatile substances on the vitality of micro-organisms.—H. **Agulhon** and R. **Sazerac**: The increase of activity of certain microbial oxidation processes by uranium salts.—Philippe de **Vilmorin**: Observations on the Glandinæ at Verrières-le-Buisson.—A. **Brachet**: The development *in vitro* of blastoderms and young embryos of mammals.—Charles **Jacob**: The local glacial deposits of Vercors and the neighbourhood of Villard-de-Lans.—I. **Assada**: The morphological study of the terraces in the neighbourhood of Lyons.—Alphonse **Berget**: The magnetic rôle of the oceans and the constitution of the earth's crust.—De Montessus de **Ballore**: The earthquakes of the Baltic provinces of Russia (Esthonia, Livonia, and Courland).—A. **Laborde** and A. **Lepape**: Study of the radio-activity of the Vichy springs and of some other spas.

BOOKS RECEIVED.

A Manual of Zoology. By Prof. R. Hertwig. Third American from the Ninth German Edition. Translated and edited by Prof. J. S. Kingsley. Pp. xii+606. (New York: H. Holt and Co.)

The American Annual of Photography, 1913. Vol. xxvii. Edited by P. Y. Howe. Pp. 328. (New York: G. Murphy, Jun.) 75 cents.

Mathematics from the Points of View of the Mathematician and of the Physicist. By Prof. E. W. Hobson. Pp. 24. (Cambridge University Press.) 1*s*.

Radioactive Substances and their Radiations. By Prof. E. Rutherford. Pp. vii+699. (Cambridge University Press.) 15*s*. net.

The Concept of Sin. By Dr. F. R. Tennant. Pp. v+282. (Cambridge University Press.) 4*s*. 6*d*. net.

The Geology of Soils and Substrata, with Special Reference to Agriculture, Estates, and Sanitation. By H. B. Woodward. Pp. xiv+366. (London: E. Arnold.) 7*s*. 6*d*. net.

The British Journal Photographic Almanac and Photographer's Daily Companion, 1913. Edited by G. E. Brown. Pp. 1448. (London: H. Greenwood and Co.) 1*s*. 6*d*. net.

University of California Publications in American Archæology and Ethnology. Elements of the Kato Language. By P. E. Goddard. Pp. 176+45 plates. (Berkeley: University of California Press.)

Guide to the Collection of Gemstones in the Museum

of Practical Geology. By W. F. P. McLintock. Pp. iv+92. (London: H.M.S.O.; E. Stanford, Ltd.) 9*d*.

From Pole to Pole. By Sven Hedin. Pp. xv+407+xxxix plates and maps. (London: Macmillan and Co., Ltd.) 7*s*. 6*d*. net.

The Pagan Tribes of Borneo. By Dr. C. Hose and W. McDougall. Two vols. Vol. i., pp. xv+283+143 plates. Vol. ii., pp. x+374+211 plates+4 maps. (London: Macmillan and Co., Ltd.) Two vols., 42*s*. net.

A First Class-book of Chemistry. By E. Barrett and Dr. T. P. Nunn. Pp. iv+124. (London: A. and C. Black.) 1*s*. 6*d*.

Die Elektrizität. By Prof. F. Adami. Pp. 126+4 plates+180+12 plates. (Leipzig: P. Reclam, Jun.) 1.50 marks.

Kosmologische Gedanken. By W. Baratsch. Zweite Auflage. Pp. 55+63. (Leipzig: F. E. Fischer.) 1.50 marks.

Handbuch der vergleichenden Physiologie. Edited by H. Winterstein. Lief 29. Band I. Zweite Hälfte. Pp. 321–480. (Jena: G. Fischer.) 5 marks.

Analyse des Matières Colorantes Organiques. By Dr. F. Reverdin. Pp. 56. (Geneva and Basle: Georg and Co.)

Vaccine Therapy: its Theory and Practice. By Dr. R. W. Allen. Fourth edition. Pp. x+444. (London: H. K. Lewis.) 9*s*. net.

Teacher's Manual of Biology. By Prof. M. A. Bigelow. Pp. ix+113. (London: Macmillan and Co., Ltd.) 1*s*. 8*d*. net.

A Laboratory Manual of Agriculture for Secondary Schools. By Prof. L. E. Call and E. G. Schafer. Pp. xv+344. (London: Macmillan and Co., Ltd.) 4*s*. net.

Mineralogy. An Introduction to the Theoretical and Practical Study of Minerals. By Prof. A. H. Phillips. Pp. ix+699. (London: Macmillan and Co., Ltd.) 16*s*. net.

Deutsches Museum: Lebensbeschreibungen und Urkunden. Georg von Reichenbach. By W. v. Dyck. Pp. iv+140+viii plates. (München: Selbstverlag des Deutschen Museums.)

Ueber einfache Pflanzenbasen und ihre Beziehungen zum Aufbau der Eiweissstoffe und Lecithine. By Dr. G. Trier. Pp. iv+117. (Berlin: Gebrüder Borntraeger.) 5.60 marks.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 12.

MATHEMATICAL SOCIETY, at 8.—Recent Advances in the Theory of Surfaces. Address by the ex-President (Dr. H. F. Baker), postponed from the November Meeting.—A Connection between the Functions of Hermite and Jacobi: H. E. J. Curzon.—The Equations of the Theory of Electrons Transformed Relative to a System in Accelerated Motion: H. R. Hassé.—The Convergence of Series of Orthogonal Functions: E. W. Hobson.—The Determination of the Nature of a Function from a Knowledge of One of its Derivatives: W. H. Young.—Mersenne's Primes: J. McDonnell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—A Single Phase Motor with Pole Changing Windings: J. S. Nicholson and B. P. Haigh.

ROYAL SOCIETY OF ARTS, at 4.30.—Delhi, the Metropolis of India: Sir Bradford Leslie, K.C.I.E.

CONCRETE INSTITUTE, at 7.30.—The Action of Acids, Oils and Fats upon Concrete: W. Lawrence Gadd.

FRIDAY, DECEMBER 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.—The Long Period Variable V Cassiopeiæ (Ch. 8324) in 1910–12: A. N. Brown.—Observations of the Magnitude of Nova Geminorum 2, made at the Royal Observatory, Edinburgh: H. Jameson.—Note on R Cygni: Heber D. Curtis.—The Distribution in Latitude of the Absorption Markings in Hα Spectroheliograms: T. Royds.—Baxendell's Observations of Variable Stars. Edited by M. A. Blagg and H. H. Turner. No. 1: R. Arietis.—*Probable Papers*: Note on the Cambridge Magnitude Equation: F. A. Bellamy.—Note on a New Similarity between the Variations of S Persei (and other Long Period Variables) and the Variations of Sun-spots: H. H. Turner.—Observations of the Principal and other Series of Lines in the Spectrum of Hydrogen: A. Fowler.

MONDAY, DECEMBER 16.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—From the Victoria Nyanza to the Kisii Highlands: Dr. Felix Oswald.

ARISTOTELIAN SOCIETY, at 8.—New Logic and Old: Miss E. E. Constance Jones.

ROYAL SOCIETY OF ARTS, at 8.—Methods of Economising Heat: C. R. Darling.

INSTITUTE OF ACTUARIES, at 5.—Some Observations on Currency and Credit and their Influence on Trade and Exchange: W. T. May.

TUESDAY, DECEMBER 17.

ROYAL STATISTICAL SOCIETY, at 5.—Presidential Address, The Use of the Mathematical Theory of Probabilities in Statistics Relating to Society: Prof. F. Y. Edgeworth.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further Discussion*: The Generation and Distribution of Producer-gas in South Staffordshire: H. A. Humphrey.

WEDNESDAY, DECEMBER 18.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Probable Utility of Salinity Observations in the Irish Sea for Long-date Weather-forecasting: Prof. H. Bassett.—Air Currents at a Height of 50 miles: J. E. Clark.—New Form of Standard Barometer: C. Anthony.

GEOLOGICAL SOCIETY, at 8.—The Discovery of a Human Skull and Mandible in a Flint-bearing Gravel at Piltdown, Fletching (Sussex): C. Dawson and Dr. A. Smith Woodward.

ROYAL SOCIETY OF ARTS, at 8.—The Pictorial Possibilities of Work: Joseph Pennell.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Insect Intelligence: F. Enoch.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.

THURSDAY, DECEMBER 19.

LINNEAN SOCIETY, at 8.—Experiments on the Pollination of our Hardy Fruits: C. Hooper.—The Morphology and Histology of Piper Betle, Linn: H. M. Chibber.—Some New British Plants: G. Claridge Druce.—Wild Rice, Annual and Perennial: Dr. Otto Stape.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Work of the International Electro-technical Commission: Dr. S. P. Thompson.

INSTITUTION OF MINING AND METALLURGY, at 8.

FRIDAY, DECEMBER 20.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—*Further Discussion*: Vapour-Compression Refrigerating Machines: J. Wemyss Anderson.—A Contribution to the Theory of Refrigerating Machines: J. H. Grindley.

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