THURSDAY, MARCH 12, 1908.

## THE FIRST NILE CATARACT.

*A Description of the First or Aswan Cataract of the Nile.* By Dr. John Ball. Pp. 121; with 13 maps and plates, and 20 illustrations in the text. (Cairo: National Printing Department, 1907.) Price 200 milliemes.

AMONG the numerous valuable memoirs that have issued from the Egyptian Survey Department under the energetic administration of Captain Lyons, none is likely to prove of greater general interest to the public than this work of Dr. Ball. The easy accessibility of Aswan to visitors sojourning at Cairo, the wealth of objects of antiquarian interest in its neighbourhood, and the existence of that great engineering feat—the Nile dam—ensure the result of a constantly increasing stream of tourists to the district; and although the English, German and French guide-books to Egypt, published by Murray, Baedeker and Hachette respectively, have such a well-deserved reputation, yet the complete topographical and geological survey of the district, made by so competent an official as the author, has enabled him to supply many precise data and new observations not hitherto accessible to the writers of these guide-books. Dr. Ball, indeed, comes with excellent qualifications to the task before him; a good geologist, with special knowledge of petrography, he is at the same time skilled in surveying and engineering matters, while the account which he gives of the literature bearing on the district (pp. 15–20) shows that he has not been unmindful of the importance of this branch of knowledge in connection with a country having such a past as Egypt.

At the outset, the author has to correct the popular misconceptions concerning the nature of the Nile "cataracts." He writes:—

"There is nothing about a Nile cataract in any way resembling Niagara, nor even the Falls of the Rhine at Schaffhausen. The total fall of the water-surface at the First Cataract (between Philæ and Elephantine) is only about 5 metres in a length of about 9 kilometres; and although the greater part of the fall is concentrated within a fraction of this total length, it is only sufficient to give rise to rapids, and not to a waterfall in the ordinary sense of the term. The obstruction to navigation offered by a Nile cataract is in fact due, not so much to the velocity of the water, as to the irregularity and conflicting nature of the currents caused by the narrowness, winding nature and rocky state of the channels."

Aswan was always a place of great importance. Under its ancient name of "Syene," it is constantly mentioned by the writers of antiquity, including the prophet Ezekiel, and many of the Greek and Roman authors. It formed the limit between Egypt and Ethiopia (Nubia), and observations made on the shadows cast by gnomons erected at Syene and Alexandria respectively were employed by the early geographers in determining the size of the earth and the obliquity of the ecliptic. Although Syene was regarded as situated on the tropic of Cancer, yet, as Dr. Ball points out, Aswan is really 37′ 57″ (71 kilometres) north of the tropic; and the period at which, by the secular variation of the obliquity, the site of Aswan coincided with the tropic was about 3500 B.C. Besides the gnomon, there were deep vertical wells sunk at Syrene, the bottoms of which were illuminated by the sun at midday at the summer solstice. These wells are mentioned by many ancient writers, including the geographers Strabo, Pliny, and Ptolemy.

The geological survey of this very interesting district was, of course, facilitated by the numerous excavations made during the construction of the great dam. But, on the other hand, the non-existence of any accurate topographical map of the district presented a difficulty which could only be got over by a complete survey of the whole area round the cataract. The line laid out for the dam by the engineers afforded Dr. Ball an excellent base-line, and from this a network of triangles was measured with a good theodolite, the details being filled in with sufficient accuracy by means of the plane-table. Heights were measured from the mean Nile level by the theodolite. This map, which is in six sheets, is a great improvement on any previous one, and has been issued by the Survey Department, its scale being $\frac{1}{10000}$, but a reduced copy forms plate i. of the work before us.

The geological formations present in the district as shown by the geological map (plate ii.) are:—

(3) Recent deposits, including those formed by the wind (desert sands) and those deposited by the river (Nile muds and sands).

(2) Nubian sandstones and clays, which cap many of the hills.

(1) Metamorphic and igneous rocks, constituting the foundation of the whole country.

The observations of the author on the chemical composition of the Nile muds and sands, and on the nature and form of the mineral particles present in them, are of great value and interest, and are illustrated by some excellent drawings, reproduced in collotype in plate iii. It appears both from recent analyses made in Cairo, as well as from the earlier work of Hofmann, that the Nile sands contain only small amounts of the hydrated aluminium silicates (kaolin, &c.), but consist mainly of finely comminuted felspars and other minerals, but little altered.

The work of the geological survey seems to have demonstrated that the Nubian sandstones in this district are wholly of Cretaceous age, although in the Sinaitic Peninsula there are Carboniferous sandstones of very similar appearance.

In opposition also to earlier statements made to the contrary, it is shown that the igneous intrusions are confined to the metamorphic rocks and that they are all older than the Nubian sandstone.

Aswan, or Syene, is of interest to petrologists from the circumstance that a large and important class of rocks derives its name from this locality. The name "Syenite" was first applied to the granitic rocks which were so familiar to the ancients from the circumstance that they were the materials of the great Egyptian monoliths (obelisks, statues, &c.). In 1788,

Werner restricted the use of the term by making the hornblende-orthoclase rock of the Planenschen-grund, near Dresden, the type of the class; and now geologists are agreed in retaining the term for rocks with granitic structure but of intermediate composition, containing little or no free quartz, and having orthoclase as their predominant felspar. Rocks of this class do occur at Aswan, as shown by Dr. Ball, but they appear to be in all cases subordinate to the true granites with which they are associated.

The chief rocks quarried at Aswan, both in ancient times and also recently, for the construction of the dam, are these granites, sometimes coarse-grained and porphyritic, at other times fine-grained. Both hornblendic varieties and types of these rocks rich in mica occur, and by the diminution of proportion of the quartz and the increase in abundance of the subordinate plagioclase, the rocks pass locally by insensible gradations into syenites and diorites.

Full descriptions with excellent figures (plates iv. to xi.) are given by Dr. Ball, not only of these plutonic types, but also of the various metamorphic rocks, and of the rocks that form dykes cutting through both metamorphic and plutonic masses. The survey has, of course, given the author abundant opportunities for collecting specimens, of which he has made ample use. Like Prof. Bonney, who examined a series of the Aswan rocks collected by the late Principal Dawson in 1886, Dr. Ball is struck with the general resemblance of the metamorphic and igneous rocks, both of Upper Egypt and the Sinaitic area, to the Archæan rocks of North America, and he suggests that they may not improbably be of the same great antiquity. The crushing and faulting of these rocks with the intrusion of various dykes took place, the author of this memoir argues, at a date long subsequent to their formation, and this action continued quite down to Cretaceous times, when the Nubian sandstone was deposited quite unconformably on their greatly denuded surfaces. Near the cataract of Aswan no remains of the Eocene clays and limestones, found in other parts of Upper Egypt, occur —they have probably been removed by denudation. Subsequently to the Eocene period, there has been elevation and great denudation. At this period of elevation most of the faults which play such an important part, as shown in this memoir, in producing the general features of the cataract area were formed. By the denudation the older metamorphic and igneous rocks were exposed, and the escarpments and outliers of Nubian sandstone formed.

In the concluding pages of this interesting memoir the author adduces evidence to show that the ancient course of the Nile lay in a broad valley east of the present river, and he discusses the problem of the causes which have led to important changes in the course of the river and the effects of these changes on the character of the country. We must wait for the extension of the geological survey of Egypt, to districts which at present remain untouched, for a full solution of these problems. It is interesting to learn that, although the site of the great Nile dam was determined prior to the execution of the geological survey, Dr. Ball is of opinion that the line actually chosen for it was a satisfactory one, and that the results of the survey do not indicate that any better site could have been selected for it; and, further, that the straight form, finally adopted for the dam, has been at least equally successful in avoiding the difficulties presented by crushed and decayed rocks as would the curved form originally suggested.

J. W. J.

## *THE "HISTOIRE INTIME" OF NITROUS OXIDE.*

*Das Lachgas: eine chemisch-kultur-historische Studie.* By Prof. Ernst Cohen. Pp. iv+99. (Leipzig: W. Engelmann, 1907.) Price 3.60 marks.

*HABITUÉS* of the Royal Institution, and especially those who have interested themselves in its early history, are aware of the existence of a characteristically coarse caricature of Gillray's entitled "Scientific Researches! New Discoveries in Pneumaticks! Or an Experimental Lecture on the Powers of Air," which first appeared in 1802, and is stated by Wright and Evans, who published in 1851 a descriptive account of Gillray's cartoons, to represent Dr. Garnett, the first professor of chemistry in the Royal Institution, administering, with the aid of his assistant, Humphry Davy, what is presumably laughing-gas to Sir John C. Hippesley, a noted patron of the Institution and prominent as a manager, with results disquieting to his "internal economy," and disastrous to "That garment 'twere rude to do more than allude to," as Thomas Ingoldsby says.

This print is hardly so rare as Prof. Cohen would seem to imply, and it has already done duty in connection with the early history of the Royal Institution. It—or rather what Prof. Cohen styles the *right* half of it—is reproduced in Thorpe's biographical account of Davy, published some years ago by Messrs. Cassell. Prof. Cohen, apparently on the sole authority of Pictet, who visited London in 1801, and contrary to all contemporary evidence and the testimony of the editors of Gillray's works, inclines to the opinion that the person administering the nitrous oxide is Thomas Young, who is styled professor of chemistry in the Royal Institution, a position he never held. Of course, a caricaturist like Gillray, who allowed himself unlimited licence, and was bound by no rules either of decorum or probability, might, in portraying a wholly imaginary incident, commit any anachronism he pleased. But there was no reason at the moment why Gillray should be guilty of the anachronism of putting Young into a position he never occupied, since Garnett was the actual professor of chemistry when Davy was assistant, and the humour of the incident —such as it is—is in no wise dependent upon what lecturer is behind the table. Pictet was certainly present at a symposium on a certain Saturday evening at the Royal Institution in the early summer of 1801, when, to quote from a letter from Davy to his friend King at Bristol, "there was respiration, nitrous oxide, and unbounded applause. To-morrow, a party of philosophers meet at the Institution to inhale the joy-inspiring gas. It has produced a great sensation

—*Ça ira.*" It was no doubt this "great sensation" that provoked Gillray's cartoon.

But who the lecturer may be would be a matter of small importance except for the circumstance that Prof. Cohen devotes much of his space to a somewhat laboured commentary on the print.

The caricature constitutes, in fact, as he explains in his preface, the *motif* of his little book—a fascimile reproduction of it is given as the frontispiece—and it was the chief inducement which led him to put together at such length the *histoire intime* of laughing-gas.

Such a book is probably not intended to be a serious contribution to historical chemistry. From the fact that it is dated from Zandvoort-Bad in the August of last year—that "summer of drear and dour, implacable rain"—we incline to the opinion that it was a holiday occupation imposed by the tedium of a particularly dolorous time.

With the aid of much "process work" and a wealth of classical allusion, Dr. Cohen has managed to pack within the compass of 100 pages the results of a considerable amount of bibliographical research on matters of no very great importance. Like the famous Cid Hamet, he is the most diligent searcher after the minutest circumstances, "even to the very atoms of his true history," and everything relating to laughing-gas—at least as regards its *histoire intime*—is set down with the most painstaking particularity. The history opens with Mitchill in America and his "oxide of Septon," passes on to Beddoes of Bristol and his Pneumatic Institution; the engagement there of Davy, and his discovery of the physiological effect of the respiration of nitrous oxide, which he prepared by the decomposition of ammonium nitrate in the manner first described by Berthollet and La Place, and, apparently independently, by Deiman and Paets van Troostwijk. There is, of course, no reason why chemistry should not have its Captain Gronow or its Greville memoirs, and, incidentally, Prof. Cohen has much to say of the personal history of certain of those whose names are connected, however slightly, with the *histoire intime* of nitrous oxide. The manner, for example, in which he runs his countryman Adriaan Paets van Troostwijk to earth is characteristic of your born commentator.

Davy's rhapsodical description of his sensations on breathing nitrous oxide is naturally given at length. Next we have a series of portraits, with here and there slight personal touches, of distinguished individuals who have breathed nitrous oxide, or who have seen others breathe it. They range from Southey and Coleridge in England to Fourcroy, Vauquelin, Thénard, Orfila, and Proust in France, and Pfaff and Wurzer in Germany. Indeed, the wealth of pictorial illustration of the *histoire intime* of nitrous oxide which Dr. Cohen's industry and perseverance have enabled him to accumulate is quite remarkable. The only omission we have been able to discover is a representation of a dentist's chair.

Davy's connection with the place, together with Gillray's caricature, is, of course, the main reason why Prof. Cohen devotes so much of his space to the early history of the Royal Institution, which *pace* Gillray and the symposium already referred to had very little to do with laughing-gas. To what extent the gas entered into its history may be seen from Pictet's lively account, published in 1802. Dr. Cohen, as becomes the true commentator, displays much erudition and no small amount of acumen in expounding the true inwardness of Gillray's drawing. The meaning is not very cryptic, after all. According to our author, the caricature must be regarded as directed against Rumford; it is, in fact, a satire on the Count, and incidentally on the Institution which he founded. Possibly this surmise is true, but the manner in which it is reached is even more humorous than the cartoon itself. So far as we are aware, no one has been at the pains to put forward any other interpretation—certainly none which would conflict with the view which Prof. Cohen has taken, and we are therefore content to be of his opinion, since "'tisn't worth while, it would seem, to dispute, when we know the result immaterial."

We congratulate Prof. Cohen on his interesting brochure. It is an elaborate trifle which may serve to beguile and amuse the tired researcher in his hours of ease. But if the *histoire intime* of chemical compounds, in general, say even of such things as arsenic, prussic acid, calomel or Epsom salts, were to become fashionable, what a literature we should have!

## TRITUBERCULISM.

*Evolution of Mammalian Molar Teeth, to and from the Triangular Type.* (Biological Studies and Addresses, vol. i.) By H. F. Osborn; edited by W. K. Gregory. Pp. ix+250; illustrated. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1907.)

A QUARTER of a century ago next April, the late Prof. E. D. Cope, struck by the remarkable fact that the molar teeth, both upper and lower, of all the mammals from the Puerco or lowest Eocene horizon of North America carry three cusps arranged in triangular form, proposed what was practically the germ of the now well-known tritubercular theory. Briefly stated, this theory is to the effect that in the ancestors of all existing mammals each upper molar carried a triangle of cusps with the apex pointing inwards, while the corresponding lower teeth had a similar triangle with the apex directed outwards; and that from this primitive type have been evolved all the various modifications of molar structure, in most cases by the addition, but in certain instances by the subtraction, of cusps. The exponent, and to a great degree author, of the theory in its present form is Prof. Osborn, who has done well in laying before the scientific world the evidence for and against this fascinating doctrine.

For it has to be acknowledged that while the tritubercular theory was received with acclamation when first promulgated in its full development by the author of the volume now before us, there has of late years been a certain reaction in this respect as the result

of hostile criticism and alternative hypotneses furnished by anatomists and microscopists of great scientific repute. Prof. Osborn is, however, fully convinced of the ultimate triumph of the theory; and, indeed, goes so far as to state that, in his opinion, "the evidence in favour of it is so overwhelming that primitive tritubercuIy is no longer an hypothesis or a theory, but an established fact."

That a theory, although established on what appears to be a firm basis of fact, may require revision in certain details is a matter of everyday experience, and our author is fully prepared to admit such emendations in this particular case so soon as the necessity can be proved to be imperative. One of the points against which criticism has been concentrated is the author's view that the apex of the triangle in both the upper and the lower molars represents the single cone of the ancestral reptilian tooth. In the case of the lower teeth, embryological evidence coincides with Prof. Osborn's theoretical view; but as regards the upper molars the testimony of embryology points to the conclusion that, at least in many groups, the antero-external, in place of the internal, is the primitive element. The author meets this and other objections by the candid statement that the five great principles on which the theory was originally based "do not stand or fall together"; one or more may go, or have to be modified, without imperilling the hypothesis as a whole; and even if the cusps ultimately prove not to be strictly homologous with one another in different groups, "the homological nomenclature should be retained for convenience because it has found its way so largely into literature."

The homology and origin of the cusps are, however, by no means the sole object of attack on the part of critics. Among other objections, reference may be made to the multitubercular theory, according to which molars have tended to simplify rather than to grow more complex. This hypothesis is met by the author, and we think rightly, with a direct negative, and certain other objections receive equally summary treatment.

As regards the plan of the work, it is important to notice that the contents are in the main formed by separate papers on tritubercuIism, which have been arranged in chronological order, and, where necessary, brought up to date by intercalary notes. This plan has its advantages and disadvantages. Its advantages are that the history of the controversy is easy to follow, while the disadvantages are manifest in the shape of a considerable amount of repetition. We are also left in doubt at the end of the volume as to what the author's present views really are with regard to several points on which his theory has been challenged.

To do anything like justice to the work demands much more space than can be given to it in this notice. All that can be done is therefore to direct attention to its importance and interest, and at the same time to express the opinion that the author has succeeded in placing tritubercuIism on a much more secure and unassailable basis than it ever previously occupied. R. L.

## OUR BOOK SHELF.

*Nature and Development of Plants.* By C. C. Curtis. Pp. v+471. (New York: Henry Holt and Co., 1907.)

THE author of this book has set himself a definite task, namely, to give an account of plant life, with special reference to that aspect which presents it as a working organism. Dr. Curtis is to be congratulated on the success with which he has achieved his object, for he has produced an excellent and readable book which may be confidently recommended for the use of junior classes in this country. Naturally, some of the actual examples may prove unfamiliar to the student, but the majority of the plants chosen for illustration are readily accessible to all.

The "nature of the plants" occupies the first part of the book, and it is this portion which strikes us as especially good. The second part is devoted to the development, meaning thereby the phylogenetic classification of the vegetable kingdom; and here again Dr. Curtis has, we think, contrived to sustain the interest in a branch of botany which, as treated in elementary works, is often intolerably dull. He has introduced a certain amount of advanced work in this part of the book, though with a judicious absence of unnecessary detail.

Perhaps a degree of emphasis, rather greater than is warranted by our knowledge, is laid on the relation between alternation of generations and chromosome reduction. The discussion also as to the meaning of unit characters and the method of their inheritance strikes us as too formal and dogmatic to be very useful. But these are small blemishes in a work where there is so much that merits praise.

The numerous and excellent illustrations form a distinct feature of the book, but we note two amongst them which might well be replaced. Fig. 43, and the text which accompanies it, represent a very diagrammatic and not very normal mode of secondary thickening, whilst Fig. 85 certainly ought to be redrawn. A seedling castor-oil plant is not the furry object there represented. J. B. F.

*The Diseases of Animals.* By Nelson S. Mayo. Third edition. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1907.) Price 6*s*. 6*d*. net.

THIS work, which purports to be one of popular advice on the care and common ailments of farm animals, is written entirely from the American point of view, and deals with American methods principally, in most distinctly American orthography. It cannot be doubted that its usefulness to the British rural public, not less than the pleasure of reading it, are considerably lessened thereby. It is decidedly irritating to readers on this side of the Atlantic to see such abominations as "sulfur," "esophagus," "sulfate," "mold," and others of a similar kind. There is, nevertheless, a good deal of useful and practical information on the care of animals and farm stock which the farmer would do well to know, no matter in what part of the world he carries on his occupation. In fact, that portion of the book which deals with feeding, watering, exercise, and the hygienic care of domestic animals, both stock and pets, is in our opinion by far the most useful to the general reader. In this section dogs, cats, rabbits, hares, guinea-pigs, and poultry are dealt with, in addition to the farm animals proper.

The photographic illustrations of the animals themselves are good, but some of those representing morbid conditions are of little value, for example, that of tuberculosis of the lung (p. 380), which could give no assistance to the non-expert.

In a work of this kind it is doubtless difficult to

deal satisfactorily with the pathological side, and it is a question whether such morbid processes as those of tumours would not be better omitted. In any case, we cannot agree with such statements as:—"True cancers are not common to animals," and, further, that cancers "are most frequent on the head and lower part of the legs." In the section on tuberculosis, the author is satisfied to leave the question of the identity or otherwise of human and bovine tubercle with Koch's original statement of non-communicability, ignoring all that has been done on the subject since that statement was made. Some other conditions, for example, rickets, are very inadequately described.

So far as this country is concerned, there is still room for a good up-to-date popular scientific work which will give the farmer such simple knowledge of the breeding, accidents, and diseases of his animals as will show him the occasion and the wisdom of consulting the skilled veterinarian. G. L.

*Traité de Chimie analytique qualitative, suivi de Tables systématiques pour l'Analyse minérale.* By Louis Duparc and Alfred Monnier. Second edition. Pp. viii+374. (Paris: Félix Alcan; Geneva: Librairie Kündig, 1908.)

THE first edition of this book on analytical chemistry appeared in 1900. In the present, second, edition there has been added a preliminary theoretical portion with the object of giving an insight into the reactions which take place during the analytical operations; this new portion gives an account of the atomic theory, the theory of solutions, and the theory of chemical equilibrium. Then follows the usual description of apparatus, reagents, and methods of manipulation. The main portion of the book is occupied by an enumeration of the reactions of the bases and acids, including the more common organic acids, and more briefly of the rare metals and alkaloids. In each case the reactions which take place are expressed by chemical equations. The book is intended to be a laboratory companion and work of reference not only for the student but also for the analytical chemist. Its value, however, for reference purposes is much lessened by the want of an index, though a full table of contents is given at the end of the volume.

*Actualités scientifiques.* By Max de Nansouty. Pp. 316. (Paris: Schleicher Frères, 1907.) Price 3.50 francs.

THIS volume is the fourth issue of an interesting and useful annual publication which on previous occasions we have commended to the notice of science students. Now that ability to read French is expected of science graduates in the University of London, books which provide means for a student to enlarge his vocabulary and at the same time to improve his knowledge of science should be very popular. The selection of subjects is very wide; *e.g.* articles are included on colour photography, the extraction of gold from the sea, spontaneous combustion, laughing, and artificial flowers.

(1) *California and the Californians.* Pp. 48. (2) *The Alps of King-Kern Divide.* Pp. 22. By President D. S. Jordan, Stanford University. (San Francisco: A. M. Robertson, 1907.)

THESE are two readable essays, the first of which appeared in the *Atlantic Monthly* ten years ago, while the other is reprinted from "Out West." The booklets should be read by visitors to California, and they may be commended also to the general reader, to whom the excellent illustrations will be an interesting feature.

## LETTERS TO THE EDITOR.

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

### The Isothermal Layer of the Atmosphere.

THOSE who, like myself, have followed with interest, but at a distance, the attempts made during recent years to obtain direct information as to the meteorological conditions of the upper atmosphere, cannot but have felt a curiosity on some points which Mr. Dines's letter in NATURE of February 27 serves to deepen. To one who has had experience of the vagaries of self-recording instruments, the first question that suggests itself is what degree of reliance can be placed on the results obtained during *individual* ascents, whether of kites or of balloons. Supposing a temperature of −70° F. recorded, the total range of temperature between the ground and the "isothermal layer" will usually have exceeded 100° F.; thus a 3 per cent. or 4 per cent. error in the scale—an amount not infrequently exceeded in ordinary thermographs limited to ordinary surface temperatures—would suffice to give an uncertainty of 3° F. or 4° F., which seems all that Mr. Dines is prepared to allow. But, apart from mere scale errors, is it certain that there are no other sources of uncertainty in meteorograph records from kites or balloons even when these are sent up after nightfall?

Before attempting to explain such large differences as Mr. Dines mentions between the temperatures in the "isothermal layer," shown by meteorographs sent up on the same day from stations only a few hundred miles apart, one would like to know exactly what the evidence is that the temperatures recorded differ at most only 3° F. or 4° F. from the true ones. The following questions naturally suggest themselves:—

(1) Are the instruments tested over the whole range encountered in the atmosphere, both before and after an ascent?

(2) Has it been a frequent practice to send up two or more thermographs with the same balloon, or with separate balloons, but at the same station and at the same time, and if so, have they always given closely accordant results?

(3) Has it been established by actual trial that the different types of meteorographs, English and foreign, when sent up at the same time from the same station, give a satisfactory agreement?

Mr. Dines mentions a case when the temperatures found for the "isothermal layer" at three English stations on the same day varied from −42° F. to −74° F. An uncertainty of ±4° F. could account for only a quarter of this, but an uncertainty of ±8° F. might account for a half, and an uncertainty of ±16° F. for the whole. Now is there conclusive evidence that uncertainties of the order ±10° F. are quite out of the question?

March 3. CHARLES CHREE.

### The Solidification of Helium.

IN the telegram from Prof. Kamerlingh Onnes announcing the solidification of helium, the statement is made that "the last evaporating parts show considerable vapour pressures as if liquid state is jumped over"—in other words, it apparently sublimes.

I have for a long time expected that this would be the case. When the boiling points and melting points of the non-valent elements are plotted against their atomic weights the curves nearly meet, the two points for argon being very near to one another. By a slight extrapolation they may be made to meet, and they then do so for an atomic weight much higher than that of helium. Now if an element corresponded to the meeting point its triple point would be given by the temperature at the join. Elements of lower atomic weight would sublime instead of melting. This is apparently the case for helium, and it is a moot point whether or not it will be found to be also so for neon. The uncertainty arises from the rapid drop in the curves in passing to the row of elements N, O, Fl, to which neon belongs. Each curve can be represented very nearly by a parabola. ALFRED W. PORTER.

University College, London, March 6.

### Disease-resisting Sugar-canes.

IT is observed in your issue for November 7 last in the article entitled "Immunity to Disease among Plants," being an abstract of a letter delivered before the British Pharmaceutical Conference at Manchester by Prof. F. E. Weiss, that the following statement occurs:—

"In the West Indies, the Bourbon cane has been given up on account of disease, but very useful and disease-resisting hybrids have been produced by crossing the valuable but easily attacked Tjeribon cane with the resistant Indian Tschan cane."

The latter canes are not known in the West Indies, and it is desirable, therefore, that the actual facts be placed on record.

When the Bourbon sugar-cane had to be abandoned in the West Indies on account of its susceptibility to fungus disease, its place was generally taken by the White Transparent—an introduced variety. Since then the latter is being largely replaced by seedling canes. These seedlings have been produced in some instances from the Bourbon cane, and, recently, almost entirely from the better of the newer seedling varieties under experiment. It may be of interest to mention that in British Guiana the area under cultivation with varieties of sugar-cane other than Bourbon is about 30,000 acres, and the greater portion of this area is occupied by seedling canes. In the island of St. Kitts about 71 per cent. of the sugar-cane acreage is occupied by seedlings. Seedling canes are also being largely planted at Barbados, Antigua, St. Lucia, and Jamaica. Many of the newer seedlings appear to be immune to some of the fungus diseases that affect the sugar-cane in these colonies, and the efforts in the direction of producing seedling canes by artificial cross-pollination give promise of success.

In Java the circumstances are also somewhat similar. The Cheribon cane had to be abandoned on account of its being liable to the "sereh" disease, and amongst the foreign varieties introduced to take its place was the East Indian cane Chunnee. In 1894 it was found that the Cheribon cane bore a large proportion of infertile pollen with a normal ovary, while the Chunnee produced a very large quantity of fertile pollen. Advantage was taken of this to plant the two varieties side by side in the hope of producing hybrids by natural means. Considerable success has been attained, for a very large number of seedlings was obtained by sowing seeds from the "self-sterile" arrows of the Cheribon, many of which combine the high sugar content of the Cheribon with the disease-resisting power of the Chunnee. Other introduced canes have also been used in these experiments, and somewhat similar experiments are in progress in the West Indies.

A *résumé* of the "Improvement of the Sugar-cane by Selection and Hybridisation" (with coloured plates) was presented by Mr. F. A. Stockdale and myself at the conference on genetics held in London in August, 1906, under the auspices of the Royal Horticultural Society. The society issued a full report of the conference in February, 1907. The paper referred to has since been reproduced in the *West Indian Bulletin* (vol. vii., No. 4).

Barbados, February 14. D. MORRIS.

### Modern Views of Electricity.

To avoid misunderstanding, I write to say briefly, in connection with a review by "N. R. C." on p. viii of the supplement to NATURE of March 5, that I have never supposed space to be a conductor, but have always taught the opposite view; and that I have never imagined unmodified ether to be subject to gravitation, or to be other than the vehicle of that property of matter. If any phrases in my book suggest the contrary they are examples of faulty expression. But I would add, parenthetically, that I should not scruple to speak, untechnically, of the centre of gravity of a surface. OLIVER LODGE.

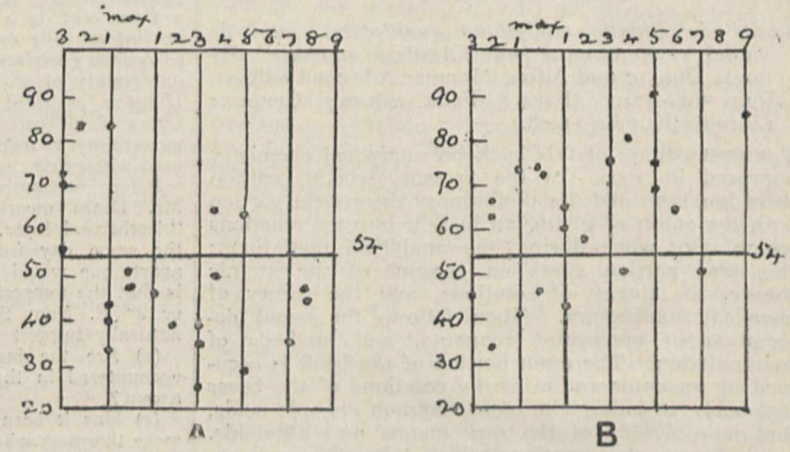
### Rothesay Summers and Greenwich Winters.

LAST summer at Rothesay (N.B.) was very wet, with 14·8 inches (average, 11·3 inches). The current winter season at Greenwich may now be pronounced a mild one.

It is a curious fact (whatever the explanation) that a very wet summer at Rothesay tends to be followed by a mild winter at Greenwich, and a very dry summer by a severe winter. This is connected, I believe, with the fact that the rainfall of Scotland and the winter cold of Greenwich both exhibit pretty clearly the influence of the sun-spot cycle.

Suppose we pick out the twenty-two wettest and the twenty-two driest summers at Rothesay in the sixty-six years 1841–1906 (*i.e.* a third in either case). The former group range from 19·1 inches down to 12·6 inches; the latter from 5·9 inches up to 10·7 inches. Next, consider what sort of winter at Greenwich followed each of these (say, how many frost days in the period September to May).

These winters may be represented as in diagrams A and B, where a dot indicates by its position both the number of frost days of one winter and its position in the sun-spot cycle.




The scale of frost days at Greenwich is shown on the left, and that of the sun-spot cycle at top of each diagram. A, Winters after very wet summers. B, Winters after very dry summers.

It will be seen that the twenty-two "very wet" Rothesay summers were followed by fifteen mild and seven severe winters at Greenwich (A), and the twenty-two "very dry" Rothesay summers by fifteen severe and seven mild winters at Greenwich (B). The contrast is still more pronounced if we confine attention to the period of *decline* of the sun-spots.

These diagrams seem to warrant two practical rules, which may be thus stated:—

During decline of the sun-spots, if summer rainfall at Rothesay exceeds 12·6 inches, a mild winter at Greenwich is highly probable (say, 6 to 1), and if during the same period the Rothesay summer rainfall is under 10·7 inches a severe winter is highly probable (say, 3 to 1). In the former case a very severe winter, and in the latter a very mild winter, would seem to be excluded.

We are at present close to a maximum (1905 or 1907?), and have to do with diagram A, which shows no severe winters for the corresponding position in the cycle.

ALEX. B. MACDOWALL.

### The Possibility of Life in Mars.

AT the risk of being thought by your correspondent, Mr. C. O. Bartrum, an "anthropomorphist," I consider that Prof. Lowell in his admirable investigations of the markings of Mars is quite reasonable in ascribing the change of colour to the presence of a vegetation containing a substance allied to, if not identical with, chlorophyll. I do so because the spectroscope has shown that, not only the solar system, but the whole universe, is built up of inorganic elements similar to those found on the earth. If we find unity of plan pervading the structure of the most

distant stars, surely it is not beyond credibility to assume that the organic worlds may have a like relationship to each other when other circumstances are favourable.

Hove, March 3. W. AINSLIE HOLLIS.

### The α Particles from Radio-active Substances.

THE experiments of Rutherford and Hahn have shown that the ratio $e/m$ has the same value, $5 \times 10^3$, for α rays, no matter from what source the rays are derived. They are, however, taken alone, incapable of deciding whether the particles are hydrogen molecules carrying the usual ionic charge, or helium atoms with twice that charge. In a recent paper in Roy. Soc. Proc., Prof. Townsend has shown that the positive ion produced by Röntgen rays has twice the ionic charge at the moment of formation. If his further experiments prove this true generally, then the question whether the α rays are hydrogen or helium must be definitely decided in favour of the latter, and the association of this gas with radio-active substances is accounted for. R. S. WILLOWS.

Cass Institute, E.C.

## *ANCIENT EGYPTIAN BURIAL CUSTOMS.*[1]

WE have had to wait some little while for Prof. Garstang's publication of his discoveries in the necropolis of Beni Hasan during the years 1902–3–4. However, "better late than never." The publication is issued under the auspices of the University of Liverpool, in which Mr. Garstang now professes the methods and practice of archæology. We must congratulate Prof. Garstang on his appointment. As a professional excavator of untiring industry and "go," he has been known to the archæological world for some years; and he has been a lucky excavator also. Nobody knows better than the digger that luck, no less than a keen eye and "sense of the probable," knowledge of the appearance of disturbed and undisturbed land, &c., is an important ally to him; and the discoverer of the other half of the Menes tablet at Nagada should gratefully admit his obligations to Dame Fortuna.

No such stroke of luck marked the excavations at Beni Hasan. The results were all what might have been expected and predicted of a necropolis of the eleventh and twelfth dynasties. Except for a few more than usually elaborate models and some very fine cartonnage mummy-coverings of a type not previously noted, they are not new. As always in tombs of this date, we have little but the rectangular coffins and models of workmen, slaves, boats with their crews, granaries, and so forth, which are well known in our museums. A large number of tombs was discovered, and the number of objects found in them was enormous. How to publish this huge mass of material, mostly of types already well known, was a difficult question.

To publish everything scientifically, in the manner of the Egypt Exploration Fund, would have been a most expensive task, as well as (since the antiquities found are mostly of a kind well known already) an unnecessary one. A scientific publication of similar type, but containing only the most important finds, would have been the expedient which most archæologists would have adopted. Prof. Garstang has, however, chosen rather to adopt a novel plan; he has written simply a description of the burial customs of the Egyptians under the Middle Kingdom, illustrated by typical examples of the objects found at Beni Hasan. Whether this decision was wise or not it is difficult to say. As a matter of personal opinion, the other alternative of a modified publication on the lines of one of the annual volumes of the Egypt Exploration Fund would seem preferable. The result of Prof. Garstang's decision is that we have here a book which is at once a more or less popular work on the burial customs of ancient Egypt, but only deals with this subject in part, and a scientific report of the results of the excavations at Beni Hasan which is of unhandy form, and is written and illustrated in an inconvenient way. The book is too heavy as well as too expensive for a popular treatise, while for a scientific work the larger format of the Fund's publications is infinitely preferable. The treatment of the subject-matter is too general and scrappy for a scientific report, and the illustrations, being scattered throughout the text instead of concentrated in plates, may be appropriately arranged for a popular book, but are most ill designed for reference by the scientific student. On the whole, we think Prof. Garstang's decision unfortunate, and we hope that in future he will publish his discoveries in the admirable manner of his former publications, with their large, thin format and groups of plates at intervals throughout the volume. Let him keep his strictly scientific publications and his *œuvres de vulgarisation* entirely apart. A popular book from his pen on the burial customs of ancient Egypt which should really cover the whole subject would be most welcome.

FIG. 1.—Position of the Pit Tombs below the Gallery.

In spite of its defects, however, the present volume is a most interesting contribution to archæological literature. As specimens of the admirable photographs with which it is illustrated, we here reproduce in Fig. 1 a view showing the position of the pit-tombs excavated by Prof. Garstang in relation to the gallery-tombs of the princes of Beni Hasan, which are so well known to every visitor to Egypt; in Fig. 2 a view of the interior of a tomb as discovered and after removing the *débris*, which shows how the coffins and models of boats, &c., are found, and incidentally shows how thorough Prof. Garstang's archæological methods are in respect of complete photographic recording; and Fig. 3, a model of a group of two officers playing draughts on board ship, showing the cabin against which are propped their great shields and arrow-cases. This is a very interesting specimen of the numberless models found, which give us so complete an idea of what the

[1] "Burial Customs of Ancient Egypt." By Prof. J. Garstang. Pp. xv+250. (London: A. Constable and Co., Ltd., 1907.) Price 1*l.* 11*s.* 6*d.* net.

Egyptians looked like in the third millennium B.C. Of no other people at so remote an age do we know so much, and we may well bless that pious care for the ancient dead which provided them with these little representations of their life on earth.

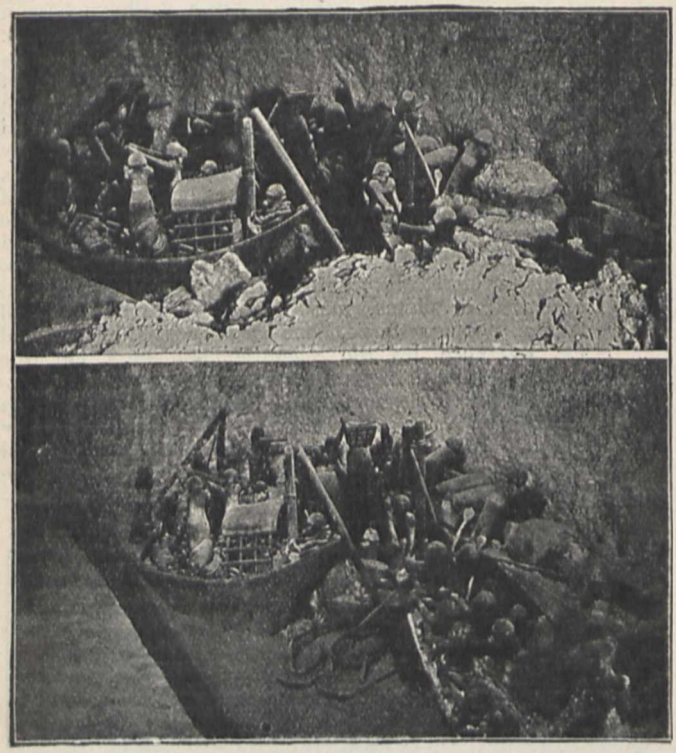


FIG. 2.—(*a*) Interior of Tomb as discovered. (*b*) The same after removing the Débris.

Very few slips of any kind have crept into the text, but we notice one on p. 169, in which it is said that the names of the vases and other offerings painted on the coffins illustrated in Fig. 171 "are given in difficult hieratic writing." The names shown are in linear hieroglyphics, and are quite easy to read. The only unworthy photograph in the book is Fig. 4, in which the cliffs illustrated are by no means clear.

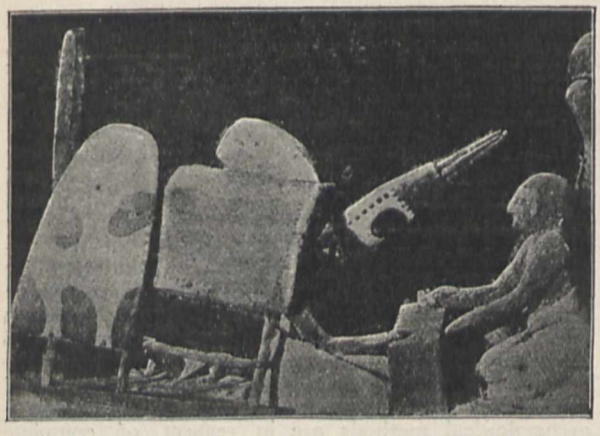


FIG. 3.—Officers playing Draughts on board ship. Model from a Tomb.

At the end of his preface, Prof. Garstang says that his assistant, Mr. Harold Jones, is now leaving him, to pursue an independent path as a painter. This is to be regretted from the point of view of archæology, as Mr. Jones would, as his work with Prof. Garstang has shown, have been a valuable recruit to the ranks of the excavators. H. R. HALL.

## SLEEPING SICKNESS.[1]

WHEN the campaign against malaria was commenced, our knowledge of the parasitic agent of that disease was practically complete, and in no essential particular has our knowledge of the mode of transmission changed since the discovery of the anopheline-malarial cycle. But when we consider sleeping sickness the matter is very different. Our knowledge of trypanosomes is even yet in its infancy. It has, for instance, been asserted over and over again that sexual differences exist in trypanosomes, and on this basis have been constructed developmental cycles which indeed may exist, but in proof of which the evidence hitherto adduced has been practically nil; and indeed two of the latest observers, Moore and Breinl, not only find no evidence of this sexual difference, at least in the blood, but describe two new phases of trypanosomes, viz. a so-called minute latent form, which comes into existence mainly when the ordinary forms from one cause or another have disappeared from the peripheral circulation, and resistant cystic forms, which appear when an animal is treated with atoxyl.

We have, according to these authors, a cycle of the trypanosome going on in the body hitherto unsuspected, and we also have encystment of trypanosomes under injurious influences. If this be true, it shows that, unlike malaria, we know but little of the complete life-cycle of trypanosomes, for of these forms we know so far only of their bare existence. This discovery, then, opens the whole question of the life-cycle of trypanosomes, including the question also whether there are sexual forms or no. There are further questions which are equally obscure. While, in the case of malaria, shortly after the discovery of the all-essential importance of some of the anophelines in its transmission close attention was paid to the habits of these mosquitoes, in the case of tsetse-flies we know about their habits comparatively little. It is perhaps an exaggeration to say that we know now no more about tsetse-flies than we did when Bruce discovered that *Gl. morsitans* transmitted the trypanosome (*T. brucei*) of ngana, but at any rate we can sum up in a few words what we know of the habits of the fly:—(1) The only place so far discovered where the tsetses deposit their larvæ has been among the roots of banana-trees; (2) they haunt the scrub or bush along the margins of lakes and rivers, and are seldom found far from water. The reason for this distribution is unknown, though one might conjecture that it has something to do with their food supply. (3) The sources of their food supply are also very imperfectly known. Is blood a necessity for their existence in nature? That they pursue man voraciously is known, but what other animals do they feed on? Koch recently has confirmed the observation that they suck crocodiles' blood, and holds that this is their main if not sole food; and has even gone so far as to suggest that the destruction of crocodiles would cause the disappearance of the fly. The

[1] Proceedings of the First International Conference on the Sleeping Sickness held at London in June, 1907; and further paper respecting the Proceedings of the Conference.

destruction of crocodiles is a comparatively easy matter, as the eggs, sixty or seventy, can be collected from the nests, the sites of which are well known to the native. Possibly, however, aquatic birds would still furnish them with blood. The duration of their life, their breeding habits, the habits of different species, the conditions which give rise to "fly belts," are almost unknown. It is somewhat remarkable that so little is known, although many expeditions have now studied sleeping sickness; the fly, however, has surely been somewhat neglected. One fact of great practical importance has, however, become clear, viz. that clearing the jungle drives away the fly, and to this we shall return. When we consider next the mode by which the fly transmits the disease, we find ourselves in the midst of controversy.

One view is that the transmission is a mechanical one, *i.e.* the fly carries infection as an inoculating needle from one animal to another, and the known experimental facts entirely support this view; and, further, we have the fact that in Dourine this is the sole (? also by fleas) known method, the mechanical transmission being in this case by sexual intercourse, a method which, according to Koch, also takes place to some extent in sleeping sickness. Another view, that a developmental cycle goes on in the fly, is based mainly on analogy and on the alleged existence of sexual forms of trypanosomes in the blood, and more especially in the gut, of flies. We will not enter here into the wilderness of arguments, but point out the following facts. The tsetses used for experimental purposes have hitherto, almost without exception, been caught in nature, consequently, *ex hypothesi*, some of them must contain the trypanosome in the required hypothetical developmental stage. These flies have then been fed on infected animals, and it was found that when now fed on fresh animals the latter only became eventually infected if the period that elapsed since the last feeding on infected animals was not longer than forty-eight hours, a fact explained on the mechanical view by the statement that after this time no longer can trypanosomes be found in the proboscis. Now, if these flies, on the contrary, contained a developmental stage of trypanosome, this result is inexplicable except on one hypothesis, viz. that during the feeding on infected animals (an unnecessary procedure on this view) the flies completely get rid of all trypanosomes in the necessary developmental stages in their salivary glands (?) by the preliminary feeding on the infected animals. This objection could be met by keeping flies caught in nature for forty-eight hours more or less. If now they are capable of infecting fresh animals it would be in favour of the developmental view and against the mechanical one; if not capable of infecting it would negative the developmental view, provided, of course, sufficient experiments were made to allow for experimental error, &c.

We might point out in this connection a possible explanation of the difficulties encountered by some observers in obtaining positive results in transmission experiments. In the case of anophelines caught actually in native huts where the inmates were highly infected with malaria, we have ourselves in certain instances found only 3 per cent. of the anophelines infected with parasites, a remarkably low figure. Had these anophelines been caught in cow-houses, where they often abound, we consider that it would have been possible to dissect thousands and find none infected. Now, in the case of tsetse-flies, they are not found in houses, but live in the open, so that unless the flies have bitten man they will not become infected with the trypanosome (unless, indeed, they have bitten some other unknown host), and if the flies used in these experiments are collected from parts of the bush where they have not bitten man (or other host of the trypanosome), it would be quite conceivable that thousands of flies might be used in transmission experiments with negative result, and even if they had an opportunity of biting man it is still conceivable that the number of infected ones might be very small if we consider the fact of the low figure of 3 per cent. for infected anophelines found by us in certain highly malarious districts.

If we consider the matter from another standpoint we see that again our knowledge is wanting. What is the source of the *T. gambiense?* Is it purely a man-to-man infection, as we believe to be the case in malaria, or can the fly convey the trypanosome to man from various animals? This would seem to be likely, for experimentally the fly has been proved to transmit to monkeys, so that there seems to be no *a priori* reason against thinking that the flies can transmit not only from man to man, but from man to animals and from animals to man. If this is so (but arguments can be brought against this view), then it has an important bearing on the results of isolation of the sick, for the remaining healthy population may be still living amidst infected animals, domestic and wild.

In cattle in the Congo, in sleeping-sickness areas, it is believed that the trypanosome is a different one, viz. *T. dimorphon.* Even if other reservoirs of *T. gambiense* exist, it must be admitted that the removal of the sick would remove one important source of infection, whatever proportion these bear to other reservoirs (if existent) of *T. gambiense.*

We should consider, then, that this is perhaps the most important point which requires immediate solution, and it can be determined only by a long series of laboratory inoculations.

A further point for decision, as we have seen, is the mode of transmission, mechanical or developmental, or both. This, perhaps, is of scientific rather than of immediate practical importance. Thirdly, we require a careful extended study of the habits of the fly.

But although much investigation remains to be done, we may now briefly recount what is being carried out in the light of our present knowledge.

Sleeping sickness can be detected in its early stages, first, by the enlargement of glands, *e.g.* those in the neck, an almost constant phenomenon (and the glands on puncture show trypanosomes); and, secondly, by the method recently used by Koch of examining fairly thick stained blood films on several occasions. We have thus means at our disposal of detecting early cases even when the person is to all outward appearances healthy.

(1) *Isolation.*—The removal of infected persons so far as possible to localities free from the fly, where they may be suitably treated, is certainly imperative.

(2) *Inspection posts.*—The spread of the disease to non-infected areas where the fly exists by means of infected persons should be controlled so far as possible by medical examination at inspection posts along the main routes of traffic. Although no doubt some will escape detection, yet the method is one which enables us largely to control the spread of the disease.

(3) *Treatment of the sick.*—We have in atoxyl an arsenic compound first introduced by Thomas and Breinl, undoubtedly the best drug hitherto used in combating the disease. Undoubtedly cases of sleeping sickness in Europeans have been cured by it, and lately Koch, in an extended trial of the drug, has spoken in laudatory terms of its use. He recommends the giving of half-gram doses on two consecutive days at intervals of ten days, and continuing the treatment for long periods. The method is slightly different from that advocated by the Liverpool School of Tropical Medicine when it first distributed atoxyl throughout the Congo, but Koch has

only modified the dosage, and he adds his testimony to the great value of the drug.

This method, should nothing supersede it, will thus become almost as valuable as that of quinine in the treatment of malaria. In Koch's words, "Daraus geht doch aber mit aller Bestimmtheit hervor, dass durch eine geeignete Atoxyl behandlung sehr vielen Schlafkranken das leben gerettet werden kann."

(4) *Destruction of tsetse-flies.*—This, so far as we know at present, is not directly practicable, but the flies can be driven away by cutting the jungle. The making of clearings where the natives most frequent, such as at watering places, river fords, and around villages, will certainly be beneficial.

For the present, then, we have at our disposal methods the results of which we shall soon learn. In conclusion, it is, I think, certain that when some of the disputed points indicated above are settled the campaign against the disease will be carried out with greater efficiency because based on more certain knowledge. J. W. W. S.

## *WATER VAPOUR IN THE MARTIAN ATMOSPHERE.*

ONE of the most telling arguments which has been used against the possibility of the planet Mars being habitable has been that spectroscopists have failed to detect with certainty the presence of water vapour in the planet's atmosphere. It now seems probable that this objection will have to be abandoned, for, in a telegram recently received by Sir Norman Lockyer, Prof. Lowell announces that Mr. Slipher has got on repeated plates—specially prepared for this research—the water vapour bands *a* and near D stronger in the spectrum of Mars than in that of the moon at the same altitude.

Should Prof. Lowell's further researches confirm it, this result is one of the most important links in the remarkable chain of evidence for a habitable Mars. The photography of the canals was a great step forward, but the presence of these features was unconvincing unless it could be proved that the water to fill them in their proper seasons was available. Similarly, the seasonal increase and decrease in the dimensions of the snow-caps were thought to be conclusive evidence for the presence of water until the frozen carbon dioxide theory was advanced, although this theory left unexplained the ill-defined edges of the disappearing snowfields. But, so far as our present knowledge goes, it is difficult to see how carbon dioxide is able to produce the intensification of the water-vapour bands in the spectrum of the planet's atmosphere.

For many years, in fact since the actual existence of permanent features on the planet's surface was established, this question of water vapour—of the existence of a substance capable of producing clouds and mists—has been one of the chief points of contention among areographers. So far back as 1863 Sir Norman Lockyer, in a communication to the Royal Astronomical Society (Memoirs, vol. xxxii., p. 179, 1863), describing his observations of Mars during the opposition of 1862, stated that "although the complete fixity of the main features of the planet has been thus placed beyond all doubt, daily—nay, *hourly*—changes in the detail and in the tones of the different parts of the planet, both light and dark, occur. These changes are, I doubt not, caused by the transit of clouds over the different features." The drawings accompanying the memoir illustrated the changes mentioned, and confirmed the suspicions of cloud effects noticed by Secchi in 1858. But the assumption that these effects were caused by clouds and mists entailed the assumption of the presence of water vapour in the planet's atmosphere, and the spectroscopic evidence for this has hitherto been too indefinite. Suspected by Huggins and Vogel in 1867 and 1873 respectively, its presence was negatived by the subsequent spectroscopic researches of Campbell and Keeler, but now it appears certain, from this latest result from the Lowell Observatory, that water vapour is one of the concomitants of the Martian atmosphere.

In his recent book, "Is Mars Habitable?" reviewed by Dr. Lockyer in NATURE for February 13 (p. 337), Dr. Russel Wallace insisted on the absence of spectroscopic evidence as a strong argument against the presence of water vapour. This objection is now removed, and once more it becomes reasonable to suppose that the Martian surface is, at least to some extent, supplied with that compound which, to terrestrial minds, is one of the essentials of habitability. At the same time, the theories advanced by Prof. Lowell to explain the remarkable variety of appearances and changes from season to season, disclosed by his wonderful observations, have received support worthy of their brilliant conceptions.

WILLIAM E. ROLSTON.

## *NOTES.*

IN an announcement in last week's NATURE it was stated that Prof. Kamerlingh Onnes had succeeded in liquefying helium. It should have been stated that the gas was solidified, no intermediate liquid stage being observed. The demonstration was made in the presence of Prof. H. A. Lorentz and Prof. J. P. Kuenen, both of the University of Leyden. The method adopted is described by the Leyden correspondent of the *Daily Telegraph* (March 10) as follows, and is the same as that used with success by both Sir James Dewar and Prof. Olszewski. The only noteworthy point is the large amount of helium used for the instantaneous expansion. "To make this experiment," Prof. Onnes says, "I placed a tube with thick sides, containing a thinner one for extra protection against external warming influences, in a vessel filled with liquid hydrogen, at −434° F., and in this tube about one and a half gallon of helium was compressed under 100 atmospheres. On allowing expansion to a lower temperature a cloud appeared, which increased as the expansion *in vacuo* continued. Out of the nebulous mass a white flocculent substance gathered in the inner tube, where—although the tube was well closed—it evaporated within twenty seconds. Some solid substance, however, was left, the pressure in the tube meanwhile rising to one atmosphere, and when the valve was opened and the pressure was reduced this substance exhaled almost immediately, no sign of liquefaction being observable. The substance which remained at a temperature of −434° F. was solid helium." We are glad to be able to print the telegraphic message sent to Sir James Dewar by Prof. Onnes on March 5, and Sir James Dewar's reply to it:—Prof. Onnes to Sir James Dewar, Royal Institution, London: "Converted helium into solid. Last evaporating parts show considerable vapour pressures, as if liquid state is jumped over." Sir James Dewar to Prof. Onnes, University, Leyden: "Congratulations. Glad my anticipation of the possibility of the achievement by known methods confirmed. My helium work arrested by ill-health, but hope to continue later on."

THE council of the British Association has nominated Prof. J. J. Thomson, F.R.S., as president of the association for the meeting to be held next year in Winnipeg.

and Prof. Thomson has accepted the invitation to occupy that office.

THE third congress of experimental psychology will be held at Frankfort on April 22–25.

WE deeply regret to announce that Dr. H. C. Sorby, F.R.S., died at Sheffield on Monday, March 9, at eighty-one years of age.

PROF. E. RUTHERFORD, F.R.S., has been awarded the Bressa prize of 9600 lire (384*l.*) by the Turin Academy of Sciences.

PROF. H. POINCARÉ, professor of mathematical astronomy in the University of Paris, has been elected a member of the French Academy.

PROF. W. S. HANDLEY will deliver the Hunterian lecture on "The Natural Cure of Cancer" at the Royal College of Surgeons to-morrow, Friday, March 13, at 5 p.m.

A REUTER message from Melbourne reports the death on March 8, at seventy-seven years of age, of Dr. A. W. Howitt, C.M.G., author of "The Native Tribes of South-East Australia" and other important anthropological works.

A CELEBRATION of the jubilee of the presentation of the Darwin-Wallace joint essay to the Linnean Society on July 1, 1858, will take place on July 1 next; the details are not complete, but it is intended that an afternoon meeting and an evening reception shall take place on the day named, with the award of copies of a special medal, and subsequent publication of the proceedings of the celebration.

THE steamer *Nimrod*, of Lieut. Shackleton's Antarctic expedition, has returned to Christchurch, New Zealand, from the Antarctic. The *Nimrod* is expected to return to the Antarctic next January to fetch the expedition, and she should be back in England some time in the later part of 1909. The *Daily Mail* of March 7 contains a narrative of the expedition, so far as it has gone, by the leader, Lieut. Shackleton.

THE President of the Local Government Board has authorised for the current year the following researches, in addition to those already announced, under the grant voted by Parliament in aid of scientific investigations concerning the causes and processes of disease:—(1) further studies by Drs. Andrewes and Horder as to methods of inhibiting in the animal body the activities of infection by certain cocci; (2) a study of the various forms of pneumonia, especially in children, by Mr. Foulerton; (3) a study of acid-fast bacilli in butter, by Dr. Nabarro; (4) an investigation of the injurious gases evolved during artificial illumination, by Dr. J. Wade.

REUTER'S Agency states that the second International Conference on Sleeping Sickness met on Monday at the Foreign Office. It is understood that the chief business of the conference will be the discussion of a draft general Act dealing with measures for combating the disease which has already been drawn up by the British Government and submitted to the various countries represented at the conference. There is further to be discussed a counter-draft Act prepared by the German Government which contains some slight modification of the British proposals. The complete list of delegates of the seven countries represented at the conference is as follows:—*Germany:* Dr. Robert Koch, Herr H. de Jacobs, Dr. Steudel; *Spain:* the Marquis de Villalobar, Dr. F. Murillo Palacios; *Congo Free State:* Colonel Lantonnois, Dr. van Campenhout; *France:* M. Le Myre de Vilers, M. Ronssin, Dr. Kermorgant, Dr. Cureau, Dr. Giard; *Great Britain:* Lord Fitzmaurice, Sir W. Foster, M.P., Mr. A. W. Clarke, Mr. H. J. Read, C.M.G., Sir Patrick Manson, Dr. Rose Bradford, F.R.S., Sir R. Boyce, F.R.S., Colonel D. Bruce, C.B., F.R.S.; *Italy:* Prof. Rocco Santoliquido, Prof. Adolfo Cotta; *Portugal:* Dr. Ayres Kopke. The Lord Mayor will entertain the president and delegates of the conference at luncheon at the Mansion House on Monday next, March 16.

WE regret to read in Tuesday's *Times* that Dr. W. E. Wilson, F.R.S., died on Friday last, March 6, at fifty-six years of age. For many years Dr. Wilson gave disinterested and devoted attachment to research in astronomy and physics, and his work secured for him a high place among scientific investigators. In December, 1870, he was engaged on the total solar eclipse expedition to Oran, and in 1872 he built an astronomical observatory at Daramona, Ireland, and equipped it with a 12-inch reflector by Grubb. Nine years later this was superseded by a more completely equipped observatory containing a fine reflecting telescope of 2 feet aperture, with mounting of the most modern design. In 1891 this was re-mounted and provided with electric control for astronomical photography. With this instrument Dr. Wilson obtained some remarkable photographs of celestial objects, including the moon and many nebulæ and stellar clusters. In later years a physical laboratory and mechanical workshop were added to the astronomical observatory, and in the laboratory many important researches on radiant heat and light were carried on by him. Among the subjects of his papers read before various scientific societies are "Experimental Investigations on the Effective Radiation from the Sun." Other important publications of his are entitled "The Absorption of Heat in the Solar Atmosphere," "The Temperature of the Carbons in the Electric Arc," "The Effect of Pressure of the Surrounding Gas on the Temperature of the Crater of the Electric Arc," "The Thermal Radiation from Sun-spots," and "Radiation from a Perfect Radiator." His papers published before the year 1900 were issued separately in a volume entitled "Astronomical and Physical Researches made at Mr. Wilson's Observatory, Daramona, Westmeath," in which appear reproductions of some of his celestial photographs. Dr. Wilson's scientific work was recognised by his election as a Fellow of the Royal Society in 1896, and by the degree of Doctor of Science conferred on him, *honoris causa*, by Dublin University a few years later.

BY the untimely death, at the age of sixty-one, of Sir Denzil Ibbetson, India has lost one of her most eminent anthropologists. He joined the Punjab Civil Service in 1870, and his remarkable report on the revision of settlement in the district of Karnal, situated in the south-east of the province, led to his appointment as superintendent of the census of the province in 1881. The report on Karnal was a remarkable achievement. It was based upon a profound knowledge of the peasant classes, their mode of life, social institutions, and religious beliefs. Students of the rural classes in northern India had long been aware that their religion was to be found, not, as the Max Müller school contended, in the sacred books recorded in Sanskrit, a language familiar only to a few Pundits, but in the cults and beliefs connected with the worship of the rural "godlings," as Ibbetson designated them. But the case for this novel view of Indian popular religion was now for the first time clearly advocated in

attractive literary form, and from intimate, personal knowledge. These conclusions were repeated and extended in his census report of 1881, which, in addition to admirable chapters on peasant religion, contained a singularly elaborate account of Hindu and Mussulman castes, tribes, and sects. The weak point of the investigation was that it was purely ethnographical, and ignored the physical characteristics of the people, a subject of which the writer possessed no knowledge. This report, of which the chapters on religion and caste were reprinted in 1883 under the title of "Outlines of Panjab Ethnography," forms an excellent manual of the subject. Additions to the information contained in it have, it is true, been made in the later census reports of Messrs. E. D. Maclagan and H. A. Rose, but the substantial accuracy of Ibbetson's work remains unaffected. His reports suggested and inspired the investigations on similar lines conducted by Sir H. Risley in Bengal, by Mr. W. Crooke in the United Provinces of Agra and Oudh, and by Mr. E. Thurston in Madras. The Punjab Government would be well advised to re-publish, as the best memorial of the late Lieutenant-Governor, the reports on which his reputation as an anthropologist will mainly depend.

A FURTHER contribution to the mass of literature relating to the Mexican cotton-boll weevil is made in Bulletin No. 73 of the Entomological Bureau of the U.S. Department of Agriculture, in which Mr. W. D. Price discusses the numerous parasites preying upon that beetle.

WE have received a copy of the forty-first report of the Peabody Museum of American Archæology and Ethnology at Harvard, in which special attention is directed to an expedition recently sent to South America to procure collections. The expedition, which has been well received by the officials of the various districts visited, has already secured valuable specimens and data.

IN the eighth quarterly report on the scientific work of the Lancashire and Western Sea-Fisheries District, Prof. Herdman announces that, owing to his absence on a visit to the Ceylon pearl-oyster fisheries, the publication of the annual sea-fishes laboratory report will be delayed for a short period beyond the usual date. Plankton will form a considerable item in that report; while of more general interest will be an account, by Mr. J. Pearson, of all that can be ascertained with regard to the life-history and economic value of the edible crab.

BULLETIN No. 50 of the Agricultural Experiment Station at Storrs, Connecticut, is devoted to the rearing of young pigeons—"squabs" as they are locally called—for the market. It is generally supposed that this industry is one which can be profitably undertaken by any person with no previous experience, but this the author—Mr. C. K. Graham—shows to be an altogether mistaken idea. In a properly managed establishment each pair of pigeons ought to produce on an average five pairs of squabs annually; only a few produce more than seven pairs, and in one case where eleven were brought forth none of these were reared to maturity.

THE February issue (vol. ii., No. 4) of the *Journal of Economic Biology* is devoted to the parasitic insects of the Chermes and Coccus groups, Mr. E. R. Burdon discussing the European members of the former genus, while Mr. R. Newstead describes three species belonging to the same family as the latter found on cocoa, rubber, and other plants in western Africa. In the case of Chermes, it is stated that much investigation is still required with regard to the life-history of the European species, some of which present puzzling problems in connection with their migrations and the "intermediate hosts" they affect during their developmental cycles. The second paper deals mainly with structural details.

To the fiftieth volume, part iii., of the Smithsonian Miscellaneous Contributions, Mr. Bruno Müller contributes a long and elaborate paper on the air-sacs of pigeons, based on an investigation undertaken for the purpose of finally setting at rest the disputed question as to the function of these structures in birds generally. The author refuses to accept any one of the theories hitherto proposed, and comes to the conclusion that the air-sacs, together with the air-cavities in bones, are not to be regarded as organs with any special function, but rather as a system of empty interspaces. "Their value lies in their emptiness, that is, in their containing nothing that offers resistance or has an appreciable weight. Flying is the highest form of locomotion, and as such only possible to a body of high mechanical efficiency. Our most effective machines are by no means compact and solid, but composed of parts as strong as possible in themselves and arranged in the most appropriate manner. The interspaces between the parts are left empty and taken up by air. The Sauropsida, at the time they obtained the power of flight, became adapted to its mechanical requirements, and thereby similar to the efficient machines mentioned above; they divested themselves of all superfluous material, filling the body-space thus obtained with air sacs."

IN No. 29 of the Scientific Memoirs of the Government of India, Captain Christophers, I.M.S., discusses the disease of dogs due to the protozoan parasite *Piroplasma canis*. The symptomatology of the disease, the morphology of the parasite, and its transmission by the tick *R. sanguineus*, are fully described, and the developmental cycle of *P. canis* in the tick detailed. In the tick the parasite becomes a club-shaped body, then a zygote which breaks up into sporoblasts, and these again into sporozoites. A full bibliography of piroplasmosis in general is appended, and the memoir is illustrated with diagrams and two plates. In Memoir No. 30 of the same series, Captain Harvey, I.M.S., and Captain McKendrick, I.M.S., discuss the theory and practice of antirabic immunisation, and conclude that the methods of Höyges and of Ferrans, in which fresh material is used, present certain advantages over those in which dried or heated material is employed for purposes of antirabic immunisation.

THE geographical variation in birds, with especial reference to the effects of climatic humidity, forms the subject of a paper by Mr. C. W. Beebe in the first number of a new serial issued by the New York Zoological Society. Unfortunately, the cover and title-page are lettered *Zoologia*, whereas, as we learn from an erratum-slip, the designation should be *Zoologica*. The serial is published by the society at New York, the first number being dated September 25, 1907. Mr. Beebe attaches great importance to the effects of humidity in producing local phases in particular species, and refers to the well-known fact that while hot, damp situations tend to melanism, dry, sandy localities are equally favourable to the production of light tints. One of the most marked instances of this occurs in the pigeons of the genus Scardafella when kept in captivity in a warm, humid atmosphere. In the typical *S. inca* the whole breast is uniformly pale-coloured, but specimens kept in captivity under the above conditions assume after the first moult the characters of *S. i.*

*dialeucos*, and after the second those of the Brazilian *S. ridgwayi*, which exhibit a progressive degree of dark marking on the breast. Later on the captive birds develop dark markings unparalleled in any wild species. The author then discusses the bearing of these facts on the recognition of geographical races and species of birds, concluding, if we rightly understand his argument, that such recognition need not on this account be abandoned.

IT is a matter of considerable interest to botanists that a new edition of the "Botanist's Directory" is being prepared by Mr. I. Dörfler, of Vienna. The last (second) edition was published in 1902, and owing to the changes that take place in six years is much in need of revision. The care bestowed on the work by the publishers, and the general support accorded by botanists in all parts of the world, render the book authentic and remarkably complete.

DR. S. SCHÖNLAND contributes to the Records of the Albany Museum, vol. ii., part ii., the diagnoses of new species of Aloe, Crassula, Cotyledon, and Kalanchoe collected in various South African States. The most singular is *Crassula Engleri*, of which all the flowers examined showed stamens only and no female organs, furnishing evidence of diœcism. The same author is responsible for the first part of a list of flowering plants found in the districts of Albany and Bathurst, Cape Colony, that is supplementary to an earlier enumeration in the Records. A new species of Gasteria is recorded.

THE physiology and morphology of some Californian hepatics form the subject of a paper contributed by Mr. H. B. Humphreys to the Proceedings of the Washington Academy of Sciences, vol. x. (January). The author describes an endophytic fungus developing sclerotia that was commonly found in the vegetative parts of plants of *Fossombronia longiseta*. Fungi were also found associated with *Aneura multifida*, *Anthoceros Pearsoni*, and *Porella bolanderi*. In all these cases there was every indication that the fungus acted as a parasite. Another feature of interest examined was the development of tubers by the Fossombronia and two species of Anthoceros; these serve to tide the plants over the dry season. The author also investigated the power of plants and spores to resist desiccation. The use of Knop's solution for germinating spores is noteworthy.

A MONOGRAPH on the stem of the flax plant, prepared by Miss T. Tammes, has been published in the *Natuurkundige Verhandelingen van de hollandsche Maatschappij der Wetenschappen*, vol. vi., part iv. Certain problems connected with flax culture, such as the usual practice of importing seed from Russia, the influence of soil, dimensions of the fibres, &c., are discussed. With regard to the origin of the cultivated plant, the author sees no reason to connect it with *Linum angustifolium*, *Linum humile*, or any other wild species. It was found that the length of the fibres, varying on the average between 25 mm. and 40 mm., is greatest in long and thick stems; a maximum length of 120 mm. is recorded. The fibres increase in length from the base of the stem upwards to within a short distance below the fruit.

THE Carnegie Institution of Washington has issued an elaborate research memoir, covering 144 pages, on high steam-pressures in locomotive service, by Mr. W. F. M. Goss. The results apply to practice involving single-expansion locomotives using saturated steam. The results of the tests show that the higher the pressure the smaller the possible gain resulting from a given increment of pressure. A simple locomotive using saturated steam will render efficient service when the running pressure is as low as 160 lb. No argument is to be found in the economic performance of the engine which can justify the use of pressures greater than 200 lb.

FIVE palæontological contributions to the geology of Western Australia are contained in Bulletin No. 27 of the Geological Survey of that colony. They comprise notes on plant remains from the Collie coalfield by Mr. R. Etheridge, and on fossils from the same coalfield by Mr. F. Chapman, two reports on fossils from the Irwin River coalfield by Mr. R. Etheridge, and a report on the foraminifera from a calcareous marlstone at Gingin by Mr. W. Howchin. They add considerably to the knowledge of the organic remains of the rocks of Western Australia, and two of the contributions throw light upon the vexed question of the geological age of the Collie River Coal-measures, and are of scientific interest in their relation to the important question of the distribution of Glossopteris flora. A re-examination of two leaf fragments, previously thought possibly to belong to the Mesozoic genus Sagenopteris, proves them to belong to the Palæozoic genus Glossopteris.

THE occurrence of "black rain" in Ireland on October 8–9, 1907, is reported by Dr. O. Boeddicker in *Symons's Meteorological Magazine* for February. On the afternoon of October 8 a dark cloud approached Birr from the S.E., and "black rain" was reported from several places. A letter addressed by Lord Rosse to the *Irish Times* brought a large number of replies, showing that the fall of soot was greater to the S.E. and E. of Birr than to the N.W.; the deposit was considerable in Westmeath, Meath, and Monaghan, and was also traced to the west of Mayo. The evidence seems to show that the cloud originated in South Wales, crossed the Irish Channel and the whole of Ireland, finally disgorging its soot into the Atlantic Ocean.

IN *Ciel et Terre* of January 1, M. J. Vincent gives an account of the unmanned balloon ascent of July 25, 1907, in which the extraordinary altitude of 26,557 metres was reached. The tandem balloons left Uccle (near Brussels) a few minutes before 7h. a.m. (G.M.T.), wind E.N.E., temperature 12°·1 C. The usual inversion was well shown; at 12,112 metres the fall in the thermometer, which read −57°·0 C. (−70°·6 F.), was arrested, and was succeeded by a sudden rise of 6°·7 C. between that height and 13,591 metres. An isothermal zone was then met with, followed by another rise which slowly brought the reading to −42°·2 at about 8h. 6m. a.m., the time when the upper balloon burst. The ventilation of the thermometer was sufficient during the whole of the ascent. The humidity began to decrease rapidly at 1016 metres, where it was 72, at 1690 metres it was 22, and at 6109 metres it had fallen to 9; it decreased but little after that, the lowest reading being 6. At the time of the inversion the wind changed from S.S.W. to W.; then during the slight inversion which followed up to 26½ kilometres two currents were met with, the lower from S.S.E. and the upper from E.; on descending, the S.S.E. current was replaced by a southerly wind.

A THOROUGH examination of the relative merits of the radiomicrometer, the linear thermopile, the radiometer, and the bolometer, for the measurement of radiation, has been made by Mr. W. W. Coblentz, of the United States Bureau of Standards, and is published in the January number of the Bulletin. The conclusion arrived at is that the bolometer is the quickest acting of the four, and should

be used in all cases in which there is much variation of the radiation with time. On the other hand, if the source of radiation is constant, the radiometer is the most sensitive, particularly in the infra-red. The radiomicrometer, although capable of improvement, is not likely to reach one-fifth the sensitiveness of the bolometer. The Rubens thermopile, when its heat capacity is diminished by the use of thinner wire, is as sensitive as the bolometer, and is to be recommended for the measurement of very weak radiation on account of its greater steadiness.

ACCORDING to the *résumé* of communications made to the Societé française de Physique on February 7, Drs. Hemsalech and de Watteville find the flame spectra of metals extend far into the ultra-violet, and are much richer in lines than they have been thought to be. The method used by the authors is a modification of that originally used by M. Gouy. They obtain the finely divided material to be studied, and mix it with the gases proceeding to the burner, by forming an electric arc between two electrodes of the material placed in a bulb through which one of the gases passes. If two such arcs between different metals are used, the spectra of the two metals are superposed. If the gas is filtered between the arc and the flame the lines are scarcely affected, while the continuous spectrum is very much diminished in intensity.

WE have received from Messrs. John Wheldon and Co. a catalogue of books and papers offered for sale on microscopical science in all its branches, including an important collection of works on Diatomaceæ.

A CIRCULAR has reached us referring to the issue of publications in connection with the Indian Forest Department. It has been decided that in future the forest literature shall appear in two chief forms, described, respectively, as Indian Forest Records and as Memoirs. In addition to these publications, it is proposed to issue pamphlets and leaflets on professional subjects.

THE Royal Statistical Society has issued a new catalogue, which comprises, with certain exceptions, all works included in the society's library on December 31, 1906. The number of books and separate publications is approximately fifty thousand. The general rules adopted in the compilation of the catalogue are stated with clearness, and statisticians should find the new list a great convenience.

THE Society for Promoting Christian Knowledge proposes to issue the following books on scientific subjects in May next:—"Turbines," by Engineer-Commander A. E. Tompkins, R.N., second edition, enlarged and revised; "Spinning Tops," by Prof. J. Perry, F.R.S., revised edition, with an appendix on the gyrostat and the monorail; "The Fundamental Conceptions of Chemistry," by Prof. S. M. Jorgensen, translated from the latest German edition, with additions by Mr. M. P. Applebey.

## *OUR ASTRONOMICAL COLUMN.*

THE PARALLAX OF THE ANDROMEDA NEBULA.—No. 4, vol. viii., of the *Astronomiska Iakttagelser och Undersökningar å Stockholms Observatorium* is devoted to the results of an investigation of the parallax of the Andromeda nebula. The observations on which the results are based were made in two groups, the first set of fifteen photographs being taken during the period 1902–4, the second, including forty-seven photographs, covering the season 1904–5. Dr. Karl Bohlin, by whom the investigation has been carried out, describes fully the methods employed, and finds for the parallax of the nebula the definitive value $+0''.171$.

THE ORBIT OF $\gamma$ VIRGINIS.—A re-investigation of the orbit of $\gamma$ Virginis has convinced Dr. Doberck that the differences between the calculated and observed positions of that star, when near the periastron passage, are at least partly due to the perturbations to which he recently directed attention. It also seems probable that changes in the shapes of the components, and even explosive action, may exert some influence on the orbit. Dr. Doberck suggests that spectroscopic observations of double stars should prove especially useful in cases where the orbit is very eccentric if made while the companion is close to the principal star. The elements now given show the period of $\gamma$ Virginis to be 182·30 years, and the eccentricity of the orbit to be 0·88736. The hypothetical parallax is $0''.116$ (*Astronomische Nachrichten*, No. 4235, p. 161, February 29).

THE LARGE SOLAR PROMINENCE OF MAY 21, 1907.—In No. 1, vol. xxvii., of the *Astrophysical Journal* (p. 78, January), Father Fényi compares his visual observations of a large eruptive prominence which he observed at Kalocsa on May 21, 1907, with the photographic observations of the same prominence made by Mr. Fox at the Yerkes Observatory (NATURE, p. 90, No. 1987, November 28, 1907). The visual observations give lower altitudes than the photographic, and, on comparing the sketch made at the same time as Mr. Fox's second photograph, it is seen that the forms are so different that no part of them can be identified; on the whole, the sketch more strongly resembles the first photograph made some fifty minutes earlier. The visual observations also show a much quicker ascension of the prominence material than do the simultaneous photographs, the rate being 54 km. per second instead of 30 km.; no change of form was observed visually during the time occupied in observing eleven transits. Father Fényi records that he has never observed the subsidence of a prominence of great height. With prominences of low altitudes the descent of the material is the usual occurrence, but dissipation at great altitudes appears to be the rule for those which attain great heights.

SPANISH OBSERVATIONS OF THE TOTAL SOLAR ECLIPSE OF AUGUST, 1905.—The results of the eclipse observations made at Soria, Spain, in August, 1905, by the members of the eclipse expedition from the Marine Observatory of San Fernando, are embodied in a handsome volume recently published under the direction of Captain Don Tomás de Azcárate, director of the observatory. Numerous photographs of the chromospheric spectrum and of the corona were obtained, and some of them are reproduced in the volume. Nearly five hundred lines were measured in the spectra of the chromosphere, and their wave-lengths are given, together with the probable origins and their wave-lengths as determined by Lockyer, Dyson, Evershed, and other eclipse observers. The volume also contains the results of the meteorological observations made at Soria, and the results of the observations of the contacts, &c., made at San Fernando and many other stations in Spain.

A NEW VARIABLE OF THE U GEMINORUM TYPE.—A telegram from the Kiel Centralstelle announces that the variable star 31.1907 Aurigæ was observed by Prof. Hartwig on March 6 and found to be of the irregular class, similar to U Geminorum; the magnitude was 9·0.

THE CANADIAN ASTRONOMICAL HANDBOOK FOR 1908.—The second annual handbook published by the Royal Astronomical Society of Canada contains a great deal of information useful to amateur astronomers. Ephemerides and charts for the positions of the major planets, lists of interesting coloured, variable, and double stars, and a calendar of astronomical occurrences for the current year are among the many useful data given, whilst there is also a mass of information more especially useful to Canadian observers.

## THE USE OF GYROSTATS.

AT a recent meeting of the Physical Society a model was exhibited which purported to illustrate Mr. Brennan's mono-rail railway. Prof. Perry, president of the society, made the following remarks, which he was afterwards requested to edit and publish :—

In 1874 two famous men made a great mistake in endeavouring to prevent the saloon of a vessel from rolling by using a rapidly rotating wheel. Mr. MacFarlane Gray pointed out the mistake. It is only when the wheel is allowed to precess that it can exercise a steadying effect; the torque or moment which it exerts is equal to the angular speed of precession multiplied by the moment of momentum of the spinning wheel.

It is astonishing how many engineers who know the laws of motion of translation are ignorant of angular motion, and yet the analogies between the two sets of laws are perfectly simple. I have set out these analogies in my book on "Applied Mechanics."

The last of these, between centripetal force on a body moving in a curved path and torque or couple on a body rotating about an axis, is the simple key to all gyrostatic and spinning-top calculations. When the spin of a top is greatly reduced, it is necessary to remember that the total moment of momentum is not about the spinning axis (see my "Applied Mechanics," p. 594). Correction for this is, I suppose, what introduces the complexity which scares the students of the subject of the vagaries of tops; but in all cases that are likely to come before an engineer, it would be absurd to study such a correction, and consequently calculation is exceedingly simple.

Inventors using gyrostats have succeeded in doing the following things :—

(1) Keeping the platform of a quick-firing gun level on board ship, however the ship may roll or pitch. Keeping a submarine vessel or flying machine with any plane exactly horizontal or inclined in any specified way. These were probably first described by Mr. Brennan. It is easy to effect such objects as these without the use of a gyrostat. By means of spirit levels it is possible to command powerful electric or other motors to keep anything always level. The actual methods employed by Mr. Beauchamp Tower (an hydraulic method) and by myself (an electric method) depend upon the use of a gyrostat which is really a pendulum, the spinning axis being vertical.

(2) Greatly reducing the rolling or pitching of a ship, or the rolling of a saloon in the ship. This is the problem which Mr. Schlick has solved with great success, at all events in the case of torpedo-boats.

(3) In Mr. Brennan's mono-rail railway, keeping the resultant force due to weight, wind pressure, centrifugal force, &c., exactly in line with the rail, so that however the load on a waggon may alter in position, and although the waggon may be going round a curve, the waggon is quickly brought to a position such that there are no forces tending to alter its angular position. The car leans over *towards* a sudden gust of wind or towards the centre of curvature if going round a curved rail.

(4) I need not refer to such matters as the use of gyrostats in the correction of compasses on board ship.

Problems (2) and (3) are those to which I wish to refer. It is to be remembered that without gyrostatic apparatus a ship is necessarily stable, a mono-rail waggon is unstable.

Mr. Schlick uses a large wheel of ten or twenty tons revolving about an axis EF (Fig. 1), the mean position of which is vertical. Its bearings are in a frame EFCD, which can move about a thwartship axes CD. Its centre of gravity is below this axis. Let the ship have rolled through the small angle R from its upright position; the axis EF has precessed through the angle P from a vertical position. Let $\theta$ stand for $d/dt$. Let the moment of momentum of the wheel about its axis be $m$. Now if the ship were held fast so that she could not roll, we might study the vibratory motion P. The effect of the roll is merely to introduce a term $m\theta R$ increasing P. Thus we have

$$I_1\theta^2P+f\theta P-m\theta R+bP=0. \quad . \quad . \quad . \quad . \quad (1)$$

where $f\theta P$ is a fluid friction introduced by dash pots acting at A and B, $bP$ is the righting moment of the frame, and $I_1$ its moment of inertia about the thwartship axis. Now write out the usual equation of motion of the ship vibrating about a longitudinal axis through its centre of gravity, its moment of inertia being I, but introduce a moment $m\theta P$ tending to diminish R.

Then we have

$$I\theta^2R+F\theta R+m\theta P+a(R-\alpha)=0. \quad . \quad . \quad . \quad (2)$$

if $\alpha=\alpha_0 \sin qt$ is the thwartship inclination of the *sea* to the horizontal, and $a$ is the righting moment of the ship per unit angle, being the weight of the ship multiplied by the metacentric height. $F\theta R$ is the moment due to friction against the sea.

Solving these equations just as if $\theta$ were a constant, we have from (1)

$$P=\frac{m\theta R}{I_1\theta^2+f\theta+b},$$

so that (2) becomes

$$\left(I\theta^2+F\theta+a+\frac{m^2\theta^2}{I_1\theta^2+f\theta+b}\right)R=a\alpha. \quad . \quad . \quad . \quad (3)$$

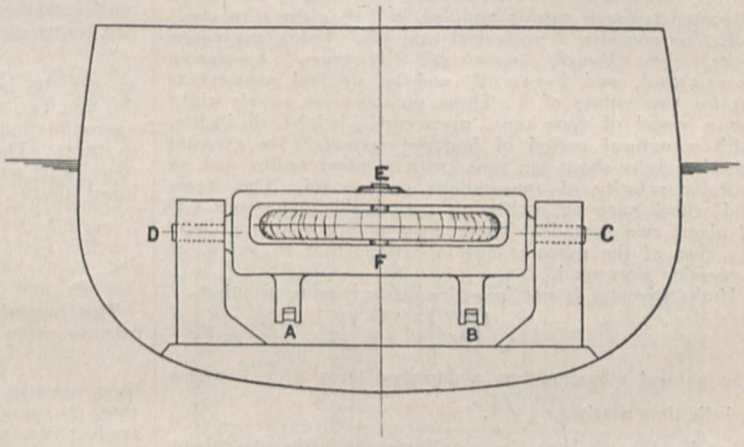



FIG. 1.

Clearing of fractions we find

$$\{II_1\theta^4+(FI_1+fI)\theta^3+(aI_1+bI+m^2+Ff)\theta^2+(bF+af)\theta+ab\}R=(I_1\theta^2+f\theta+b)a\alpha. \quad . \quad . \quad . \quad (4)$$

Replacing $\theta^2$ by $-q^2$, and $\theta^4$ by $q^4$ (see my "Calculus for Engineers," p. 237), we can at once express $\frac{R_0}{\alpha_0}$ if $R_0$ is the amplitude of the roll, and, of course,

$$P_0=\frac{mqR_0}{\sqrt{(b-I_1q^2)^2+f^2q^2}}. \quad . \quad . \quad . \quad . \quad . \quad (5)$$

I am here studying the forced vibrations, and not the natural vibrations. In any particular case it is quite easy to calculate $R_0/\alpha_0$ for a number of values of $q$, and information is obtainable which is quite different from what comes from a study of the natural vibrations (that is, taking $\alpha=0$). Besides, it is the very easiest kind of arithmetical calculation, replacing rather troublesome mathematics. To many, indeed I may say to all students, the calculation of the unreal roots of a biquadratic is troublesome, and this must be done if the natural vibration is to be studied. It is obvious that the real parts of the roots of the resulting equation in R (when $\alpha$ is 0) are negative, and therefore the motion is stable.[1]

If, however, we make $a$ of (2) negative, as it is in the

[1] The well known conditions that the real parts of all the roots of $\theta^4+a\theta^3+b\theta^2+c\theta+d=0$ shall be negative, are that $a$, $b$, $c$, and $d$ shall be positive, and also that $abc-c^2-a^2d$ shall be positive.

Brennan case, it will be found that the motion is not stable. Even without friction the vibration would become greater and greater, and friction makes matters worse. Indeed, no form of the Schlick method can be applied to the Brennan waggon. But to return to the ship.

It will be found that the amplitude of P is much greater than that of R, and in practice it is necessary to have stops to prevent P becoming too great. Of course, when further increase of P is prevented by a stop, the roll proceeds as if the wheel were not spinning.

I have not seen it mentioned, but I should think that Mr. Schlick would let his wheel revolve like Mr. Brennan's, in a very perfect vacuum inside a case, because the power wasted in friction of a wheel against an atmosphere is proportional to the density of the atmosphere. I have found that the best shape of wheel is one like a fly-wheel with a thin disc inside the rim instead of arms; there is more moment of momentum per pound to be obtained in this way than by building up a wheel like a compound disc, as a gun is built up of tubes shrunk on; and also it is much better than the form of wheel adopted by Laval in his turbine. I need not say, also, that the moment of momentum per pound of steel is proportional to the radius of the wheel; the greater the radius, therefore, the better.

It is assumed that by the use of bilge keels and rolling chambers, and as low a metacentric height as is allowable, we have already lengthened the time of vibration and damped the roll R as much as possible. Using (2) or (5), we find P if R is known, and usually the quick vibration is much more magnified in P than the slow one.

Let us consider a numerical example. Using engineers' units, let $I=10^8$, $a=2\times10^7$, $I_1=7000$, $b=70{,}000$, $m=2{\cdot}5\times10^6$, and $F=4\times10^6$, and let us find answers to (4) for two values of $f$. These numbers are nearly right for a vessel of 6000 tons, metacentric height 18 inches, with a natural period of fourteen seconds. Its gyrostat wheel weighs about ten tons, with a 6-feet radius and an angular velocity of 100 radians per second. The frame and wheel have an oscillating period about the axis CD of about two seconds. These answers are compared with the case of the gyrostat not in action, that is, $m=0$, or precession prevented.

If the gyrostat is not in action, it is easy to see that

$$R_0=\alpha_0\div\sqrt{\left(1-\frac{I}{a}q^2\right)^2+\frac{F^2}{a^2}q^2}. \quad . \quad . \quad . \quad (6)$$

The natural vibration has a damping term $\varepsilon^{-Ft/2I}$ with a periodic time nearly $2\pi\sqrt{\frac{I}{a}}$.

I take F such that the amplitude diminishes by about 25 per cent. in one period (about fourteen seconds). It will be noticed that the F term of the formula (6) is important only near the critical $q$ or $q=0{\cdot}4472$. It will be found that the F term in (4) is of insignificant effect.

Again, the values of $\frac{R_0}{\alpha_0}$ get large for large values of $q$, because there is a quick natural vibration as well as a slow one. I have not thought it worth while to tabulate these higher values.

| T | $q$ | Values of $R_0/\alpha_0$: Gyrostat not acting, $f=5\times10^4$ | Gyrostat acting, $f=5\times10^4$ | Gyrostat acting, $f=15\times10^4$ |
|---|---|---|---|---|
| 630 | 0·01 | 1·0 | 1·0 | 1·0 |
| 63 | 0·1 | 1·05 | 1·1 | 1·1 |
| 31·5 | 0·2 | 1·25 | 1·61 | 1·32 |
| 21 | 0·3 | 1·82 | 5·57 | 2·77 |
| 15·7 | 0·4 | 4·64 | 1·96 | 1·75 |
| 14 | 0·4472 | 11·19 | | |
| 12·6 | 0·5 | 3·71 | 0·76 | 0·73 |
| 11·42 | 0·55 | 1·92 | | |
| 10·5 | 0·6 | 1·25 | 0·55 | 0·351 |

It is interesting to calculate $P_0\div\alpha_0$ for all values of $q$, and especially for the larger values of $q$.

*Free Vibration.*—Using the above numbers and $\alpha=0$, so that the ship is gradually coming to rest, we are led to

$$R=Ae^{-0{\cdot}02t}\sin 0{\cdot}447t \quad . \quad . \quad . \quad . \quad (7$$

if the gyrostat is not acting. This is a periodic time of fourteen seconds, and the damping is such as to reduce the amplitude of roll by 25 per cent. in each complete period.

When the gyrostat is acting and $f=50{,}000$, we are led to

$$R=Ae^{-0{\cdot}02\,5t}\sin 0{\cdot}324t+Be^{-3{\cdot}573t}\sin(2{\cdot}519t+\epsilon) \quad . \quad (8)$$

We may neglect the quick vibrations of 2½ seconds' period, which are damped out very rapidly. The slower have a period of nineteen seconds, the amplitude of roll being diminished by 30 per cent. in every complete period. Note that $P_0=50\,R_0$ if $q=2{\cdot}519$, and $P_0=11{\cdot}3\,R_0$ if $q=0{\cdot}324$.

When the gyrostat is acting and $f=3\times10^5$, or six times as great, we are led to

$$R=Ae^{-0{\cdot}02t}+Be^{-42{\cdot}2t}+Ce^{-0{\cdot}204t}\sin 1{\cdot}703t, \quad . \quad (9)$$

so that the slower periodic motion has disappeared, and the quick one, the period of which is nearly 3·7 seconds, is rapidly destroyed. For both (8) and (9) it is interesting and easy to calculate P.

In solving the biquadratics which lead to such answers, let it be noticed that we are led usually to roots $-\alpha\pm\beta i$ and $-m\pm ni$, where $i=\sqrt{-1}$, $n$ and $m$ being much smaller than $\alpha$ and $\beta$. If we leave out the last two terms of

$$\theta^4+a\theta^3+b\theta^2+c\theta+d=0 \quad . \quad . \quad . \quad . \quad (10)$$

we get the larger roots, approximately; if we leave out the first two terms we may not get $m$, but we get a good approximation to $n$, and it is $n$ which it is most important to know. The following is a quick method of finding the roots with any amount of accuracy that is required. We know that

$$a=2(\alpha+m),$$
$$b=\alpha^2+\beta^2+m^2+n^2+4\alpha m,$$
$$c=2m(\alpha^2+\beta^2)+2\alpha(m^2+n^2),$$
$$d=(\alpha^2+\beta^2)(m^2+n^2).$$

The numerical example given above, where $f=5\times10^4$, requires us to solve

$$\theta^4+7{\cdot}16\theta^3+19{\cdot}42\theta^2+1{\cdot}83\theta+2=0.$$

First assume that $m=0$, so that $\alpha=3{\cdot}58$. We see then that the sum of $\alpha^2+\beta^2$ and $m^2+n^2$ is 19·42, and their product is 2, so that we can find them.

$$x^2+19{\cdot}42x+2=0$$
$$\text{gives } \alpha^2+\beta^2=19{\cdot}42,\ m^2+n^2=0{\cdot}103.$$
$$\text{Then } 0{\cdot}915 \text{ or } \tfrac{1}{2}c=19{\cdot}42m+3{\cdot}58\times0{\cdot}103$$
$$\text{or } m=0{\cdot}0282.$$

Secondly assume that $m=0{\cdot}0282$, so that $\alpha=3{\cdot}5519$; taking $x^2+19{\cdot}02x+2=0$ we get $\alpha^2+\beta^2=19{\cdot}02$; $m^2+n^2=0{\cdot}10515$, $\frac{1}{2}c=0{\cdot}915=19{\cdot}02m+3{\cdot}553\times0{\cdot}105$ gives $m=0{\cdot}0285$.

Assuming $m$ to have this value, we may proceed to a third calculation. In this way we get closer and closer to the true value of $m$, and therefore to the true values of $\alpha$, $\beta$, and $n$. In practice I find that the two calculations such as I give here are sufficient.

It may be taken as roughly true from (4) that the effective moment of inertia of the ship is increased from I to $I+\frac{m^2}{b^2}$, so that the time of a slow vibration is multiplied by

$$(1+m^2/Ib)^{\frac{1}{2}}.$$

If all ships and their gear are similar, it will be found that $m^2/Ib$ is inversely proportional to the dimensions. Thus if a 100-ton boat has its period increased by 50 per cent., then a perfectly similar ship of 2700 tons will have its period lengthened by only 19 per cent.

It may be, however, that the proportions should be different in vessels of different size, and it is not fair without further experience to make a comparison which seems so unfavourable to the method. Besides, experience alone can show how the dash-pot friction may depend

upon the size of the ship. Probably, too, large ships may be regarded as being steady enough already.

If we apply the Schlick method to Mr. Brennan's car, as $a$ of (4) (putting $\alpha=0$) is negative, there is instability of motion whether there is or is not friction. We may,

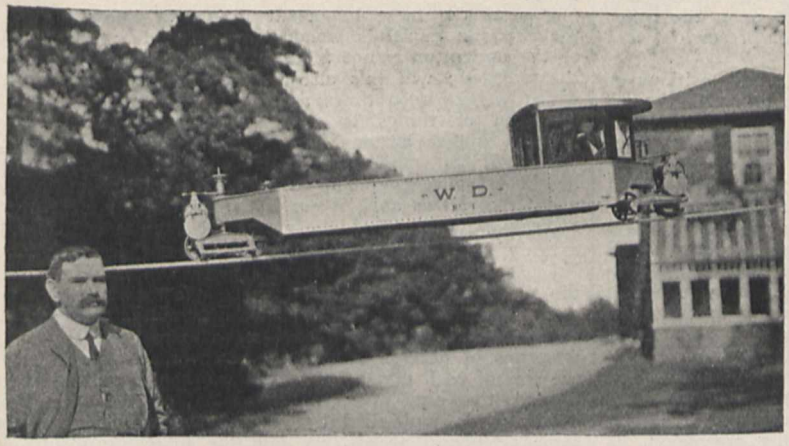



FIG. 2.

however, do as the exhibitor of the model (at the Physical Society meeting) has done—make $b$ also negative. That is, make the gyrostat frame unstable by having the centre of gravity of the frame EAB above the axis DG. In this case, if there is absolutely no friction either of the $f$ or F kind, there will be steady vibrations about a mean position, but any friction will cause the swings to get larger and larger. It is to be noticed that even without friction there will be instability if $m$, the moment of momentum of the fly-wheel, is less than a certain amount. Mr. Brennan's method of working is quite different. Fig. 2 shows his model car (about 6 feet long). It is driven by electric accumulators carried by the car. His gyrostat wheels are driven by electromotors, not shown in Fig. 3; as they are revolving in nearly vacuous spaces they consume but little power, and even if the current were stopped they would continue running at a sufficiently high speed to be effective for a length of time.

It will be found that energy is wasted by friction, and also work has to be done in bringing the car to a new position of equilibrium, and all this is supplied by the electromotors. Should the gyrostat really stop or reach a certain low speed, two supports are automatically dropped, one on either side of the car; each of them drops until it reaches the ground, one of them dropping perhaps much farther than the other.

The real full-size car which Mr. Brennan is now constructing may be pulled with other cars by any kind of locomotive, using electricity or steam or petrol, or each of its wheels may be a driving wheel. He would prefer to generate electric power on his train, and to drive every wheel with an electromotor. His wheels are so independent of one another that they can take very sharp curves and vertical inequalities of the rail. The rail is fastened to sleepers lying on ground that may have sidelong slope. The model car runs on an iron gas-pipe; the ground is nowhere levelled or cut, and at one place the rail is a steel wire rope spanning a gorge (Fig. 2). It is interesting to stop the car in the middle of this rope and to swing the rope sidewise, watching the perfect automatic balancing. The car may with confidence be left here for hours, balancing itself with nobody in charge. If the load on the car—great lead weights—be dumped about into new positions, the car effects balance with no apparent effort. But if, the car not running but merely balancing itself, a person standing on the ground pushes against it, the car will push in opposition, and by pushing judiciously a person can really disturb the car's vertical position considerably; it is as if an indignant animal were resisting the push. Left to itself now, the car quickly rights itself.

The car is supported by a mono-rail bogie at each end; each bogie has two wheels pivoted vertically and horizontally, so that curves may be very sharp and the ground may be uneven.

Fig. 3 is a diagrammatic representation of Mr. Brennan's pair of gyrostats in sectional elevation and plan. The cases G and G′, inside which the wheels F and F′ are rotating *in vacuo* at the same speed and in opposite directions (driven by electromotors not shown in the figure), are pivoted about vertical axes EJ and E′J′. They are connected by spur-toothed segments JJ and J′J′, so that their precessional motions are equal and opposite. The whole system is pivoted about C, a longitudinal axis. Thus when precessing so that H comes out of the paper, so will H′, and when H goes into the paper, so does H′.

When the car is in equilibrium the axes KH and K′H′ are in line NN′ across the car in the plane of the paper. They are also in a nearly horizontal line which is at right angles to the total resultant force on the car. I will call this the mid-position.

Let $\frac{1}{2}m$ be the moment of momentum of either wheel. Let us suppose the car to tilt so that the shelf D comes up against H, the spinning axis (or a roller driven by

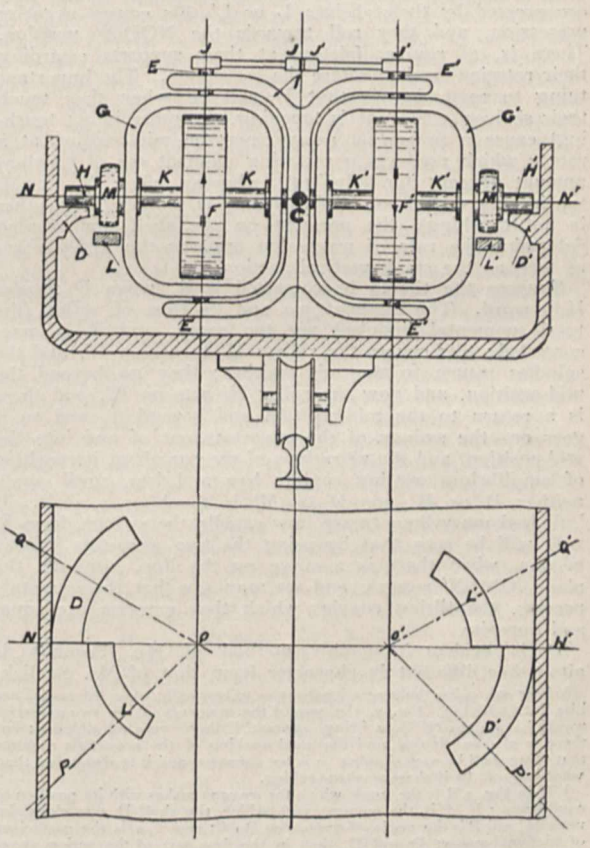



FIG. 3.

the spinning axis) of the gyrostat. H begins to roll away from me, and if no slipping occurred (but there is always slipping, and, indeed, slipping is a necessary condition) it would roll, that is, the gyrostats would precess with a

constant angular velocity $\alpha$, exerting the moment $m\alpha$ upon the shelf D, and therefore on the car.[1]

This precession continues until the roller and the shelf cease to touch. At first H lifts with the shelf, and afterwards the shelf moves downwards, followed for some distance by the roller. If the tilt had been in the opposite direction, the shelf D would have acted upon the roller H′, and caused just the opposite kind of precession, and a moment of the opposite kind.

We now have the spindles out of their mid-positions as OQ, O′Q′. How are they brought back to NOO′N′ with H permanently lowered?

It is the essence of Mr. Brennan's invention that, after a restoring moment has been applied to the car, the spindles shall go back to the position NOO′N′ with H permanently lowered, so as to be ready to act again.

He effects this object in various ways. Some ways described in his patents are quite different from what is used on the model, and the method to be used on the full-size waggon will again be quite different. I will describe one of these methods. Mr. Brennan tells me that he considers this old method to be crude, but he is naturally unwilling to allow me to publish his latest method.

D′ is a circular shelf extending from the mid-position in my direction; D is a similar shelf extending from the mid-position into the paper or away from me. It is on these shelves that H′ and H roll, causing precession, as I have just described. When H′ is inside the paper or when H is outside the paper they find no shelf to roll upon. There are, however, two other shelves, L and L′, for two other rollers, M and M′, which are attached to the frames concentric with the spindles. They are free to rotate, but are not rotated by the spindles. When they are pressed by their shelves L or L′ this causes negative precession, and they roll towards the NOO′N′ position. There is, of course, friction at their supports retarding their rotation, and therefore the precession. The important thing to remember is that H and H′ when they touch their shelves (when one is touching, the other is not touching) cause a precession away from the mid-position at a rate $\alpha$ which produces a restoring moment $m\alpha$ of constant amount (except for slipping), whereas when M or M′ touches its shelf L or L′ (when one is touching the other is not touching), the pressure on the shelf and friction determine the rate of precession towards the mid-position as well as the small vertical motion.

Suppose the tilt to be corrected is R, when D presses H upward. The moment $m\alpha$ and its time of action (the total momental impulse) are too great, and R is over-corrected; this causes the rollers M′ to act on L′, and the spindles return to the mid-position; they go beyond the mid-position, and now the roller H′ acts on D′, and there is a return to the mid-position and beyond it, and so it goes on—the swings of the gyrostats out of and into the mid-position, and the vibrations of the car about its position of equilibrium getting rapidly less and less, until again neither H or H′ nor M or M′ is touching a shelf. It is indeed marvellous to see how rapidly the swings decay.[2]

It will be seen that by using the two gyrostats instead of one, when there is a curve on the line, although the plane NOO′N′ rotates, and we may say that the gyrostats precess, the tilting couples which they exercise are equal and opposite.

It is evident that this method of Mr. Brennan is altogether different in character from that of Mr. Schlick.

[1] I am supposing the precessional angles to be small; when the angles are like NOQ, N′O′Q′. Fig. 3, the sum of the moments of the two gyrostats would be $m\alpha \cos$ NOQ, $\alpha$ being constant, if there were no slipping; but there is always slipping, and the good working of the apparatus requires that there shall be such slipping. $\alpha$ is not constant, and it is always less than what it would be if there was true rolling.

[2] If in Fig. 3 R is the angle which the waggon makes with its position of equilibrium; if M is the moment with which the shelf D acts clockwise upon H, and P is the angle of precession QoN; and if $\mu$ is the coefficient of friction between D and H, then in the first part of the action above described $I\theta^2R+m\theta P-M=0$, $m\theta R-\theta^2P+\mu M=0$, $(I_1\theta^2-hw)R+M=0$, if $I_1$, I and $\frac{1}{2}i$ are moments of inertia of the waggon about the rail, of the frames about C, and of the frame G about EJ; $\frac{1}{2}m$ is the moment of momentum of either wheel. These equations are easily solved on the conditions that at $t=0$, $R=R_0$, $\theta R=0$, $P=0$, $\theta P=0$. Assuming no play, that is, that as soon as H leaves D, M′ touches L′, we can now find the return to the mid-position from a new set of equations. Friction retards the return, it must be remembered. The motions are exceedingly interesting when numerical values of $I_1$, I, $i$, &c., are taken, but the practical man will find it more interesting to make an experimental study of what happens.

Work is here actually done which must be supplied by the electromotors. The restoring moment applied to the car may be made as great as we please by increasing the diameter of H. It is true that we cannot in this way alter the total momental impulse, and this is the important thing.

One of the most important things to know is this: the Brennan model is wonderfully successful; the weight of the apparatus is not a large fraction of the weight of the waggon; will this also be the case with a real car which weighs 1000 times as much? If at any instant a condition of things is suddenly produced so that the waggon makes an angle $R_0$ with its position of equilibrium, if its weight is W, its centre of gravity at the height $h$ above the rail, if $I_1$ is its moment of inertia about the rail as axis, if $\frac{1}{2}m$ is the moment of momentum of each gyrostat wheel, the momental impulse $mP_1$ ought, roughly, to be equal to $CR_0\sqrt{I_1Wh}$, where C is a constant.

I use $P_1$ for the total angular precession at first. Now the tilt to be corrected, $R_0$, may be due to wind pressure, to a sudden shifting of the centre of gravity, or to centrifugal force, and it is not easy to compare these things in waggons of different sizes. If, however, we take it that the size of each dimension of the waggon is multiplied by $n$ and the size of each dimension of the gyrostatic apparatus is multiplied by $p$, and the wheels have the same peripheral speeds, we find the following results:—For wind, $R_0$ is proportional to $n^{-1}$. For centrifugal force it seems reasonable to take the speed of a waggon as proportional to $n$, and mean radius of rail curves proportional to $n^2$. In this case the result is again that $R_0$ is proportional to $n^{-1}$. As for a possible accidental shifting of the centre of gravity because of the displacement of part of the cargo $w$ through the distance $d$, if we take $w \propto n^2$ and $d \propto n$, we find with greater and greater accuracy as $w$ is a smaller fraction of the whole weight, $R_0 \propto n^{-1}$.

Taking $P_1$, the maximum angle of precession, to be the same in all cases, the above relation leads to the result that $p=n^{\frac{2}{3}}$, or that the fractional weight of the apparatus as compared with that of the waggon is proportional to $W^{-0.125}$, where W is the weight of the waggon. Thus, if we take $n=10$, that is, every dimension of the model multiplied by 10 or its weight by 1000, then $p=7.5$, so that the weight of the gyrostat apparatus is only multiplied by 420. If in the model the apparatus was 10 per cent. of the whole weight, in the large waggon the apparatus is only 4 per cent. of the whole weight. In fact, the larger the waggon the less proportion of its weight and volume is occupied by the apparatus, a result which must be very satisfactory to Mr. Brennan.

In the cases both of Mr. Schlick and Mr. Brennan, it has to be remembered that if the diameter of the wheel be increased in greater proportion than the dimensions of the ship or waggon, or other dimensions of the wheel, the proportional weight of the apparatus may be diminished. A wheel of twice the diameter, but of the same weight, may have twice the moment of momentum and may be twice as effective. I assume the stresses in the material to be the same.

## *ON THE PHYSICAL ASPECT OF THE ATOMIC THEORY.*[1]

THE lecture began by setting out a physical reason *a priori* why matter should be constituted of discrete particles instead of being continuous. The requirements of physics demand an æther to serve as the means of communication between portions of matter out of contact with each other, and space can hardly be conceived as *fully* occupied simultaneously by two media, matter and æther; hence the matter must be constituted of discrete centres, or nuclei, determining permanent collocations of energy in the æther, which are, in fact, primordial atoms and their fields of force. The feasible problem of atomic physics is to build up an adequate idea of the dynamic constitution of these æthereal fields of force; there is the problem

[1] Abstract of the Wilde Lecture of the Manchester Literary and Philosophical Society, delivered on March 3 by Prof. J. Larmor, Sec.R.S.

beyond, to determine the intrinsic constitution of the central nuclei to which they are attached, which may remain permanently beyond our ken. The expansion of our ideas about the atoms, and their structural connection with the æther, was traced from their origin in Descartes, through Huygens and Newton, down to the more definite modern types of representation, as regards various essential features, that are afforded by the vortex atom and the electron.

In the hands of the physicists, especially Newton and Young, the atom had already become a complex structure, capable of definite, inherent, periods of free vibration, but, so far as physics was concerned, the same substance might include various kinds of atoms. The fundamental advance of Dalton, which assured an adequate domain to chemistry as an exact science, was the proof that each compound substance is definite as regards its molecule, and that all atoms of the same elementary body are identical. Whether this absolute identity points to the atom of each chemical element being a dynamically balanced structure of primordial atoms, one of a limited number of possible definite types of structure—which would be a perfectly reasonable way of accounting for this remarkable identity—remains an open question. The periodic relations of the elements, connected most closely with the name of Mendeléeff, certainly indicate that, whatever may be the case as regards the kernel, the outer structure of the atom, so to speak, which is the link through the æther between the nucleus and the outside world, is constituted on the basis of a common ultimate element which may be the electron.

The remark of Maxwell seems still to retain its force, that the mechanism of biological evolution could hardly reside in atoms, primordial or other, which had not much vaster underlying complication than is needed for their purely physical relations. The facts of biology may possibly demand a hypothesis such as the above, that atoms not in intimate contact interact through the æther according to general physical laws, in the manner required to constitute the physical cosmos, but that there may also be a closer interpenetration of atomic nuclei in which far more complex agencies are involved.

The mechanical atom of the earlier physicists, considered in this physical aspect, as an unknown core determining the field of activity in the surrounding æther, has had, since Faraday's discoveries in electrolysis, to take on a more definite form as the electrical atom. The result had been fully reached by Faraday himself, though it needed to be enforced later by Helmholtz, that the energies which have play in chemical combination are of electrical origin, implying thereby, according to Maxwell's interpretation, energies of intrinsic stress and motion brought to bear from atomic stores located in the adjacent æther. This doctrine has led on to the modern theory of purely electric atoms, which was already demonstrable on theoretical grounds, of course in a way less definite than we now know it, before the very remarkable discovery of electrons actually free had been reached, through the phenomena of radio-activity either electrically induced or spontaneous. Here again there is the same choice of points of view open to tentative development. We may proceed on a limited hypothesis as if the electrons are the sole primordial atoms; or we may assume that there are various ultimate atoms which have existence and structure of their own, of type largely unknown and independent of the æther, and that the electrons which are associated with them, whether temporarily or intrinsically, form merely one feature of their constitution, viz. their means of communication with the æther, and through it with other atoms at a distance to form an ordered universe.

In any case we are right in following out the hypothesis, there being, in fact, none other open to us, that the purely physical manifestations of atoms—those, namely, that, owing to the simple interconnection involved in their common seat in the æther, aggregate into the definite physical qualities of matter in bulk—are in the main or in most circumstances practically a group by themselves, and that they are thus capable of being investigated on these broad, simple principles of dynamics, which Newton definitely formulated as a suitable foundation for the analysis of general physical activity, as it presents itself in the universe. This so-called mechanical hypothesis has been eminently the fruitful one; it pointed the way to the principle of the conservation of energy, and is now elucidating the wider principle of its definitely limited availability; it gave a rational explanation of the spectrum and of radiation in general, which has proved a trustworthy and precise guide to investigation of phenomena far below the surface, such as the selective dispersion of light and the magnetic action on radiation; it reduced electrical phenomena to order and control, and connected them with light. It must therefore be presumed to be available as the clue for the further elucidation of pressing problems, such as the nature of the transmission of gravitation and of the intimate operation of chemical affinities.

The tendency to reject dynamical analysis as artificial in such subjects as electrodynamics, which received some stimulus from the theoretical writings of Hertz, seems to overlook the fact that it was precisely as a compact working basis suitable for the formulation of experience in its more general aspects that the Newtonian scheme of dynamics was put forward by its author. In the course of time that scheme has become wider and more elastic through the generalisations of Lagrange and Hamilton, expounded forcibly on the physical side by Kelvin, Helmholtz, and various others. But to take over the final results, and dress them in new language devoid of the dynamical implication, seems to involve a misreading of scientific evolution.

This position may be enforced by a quotation from the final exposition of Newton's views on the scope of natural philosophy in general, inserted by himself at the end of the famous "Queries," in "Opticks," ed. 3, p. 377:—"To tell us that every Species of Things is endow'd with an occult specifick Quality by which it acts and produces manifest Effects, is to tell us nothing: But to derive two or three general Principles of Motion from Phaenomena, and afterwards to tell us how the Properties and Actions of all corporeal Things follow from those manifest Principles, would be a very great step in Philosophy, though the Causes of those Principles were not yet discovered: And therefore I scruple not to propose the Principles of Motion above mention'd, they being of very general Extent, and leave their Causes to be found out." Then he proceeds to associate his laws of motion with an atomic theory.

A review of the electrical side of the atomic theory requires a consideration of the phenomena of ionisation in solutions. The theoretical difficulties which have presented themselves in this subject were discussed, in particular the nature of the energy changes which must occur when a salt is dissolved and thus split into separate ions. Reasoning from the processes of the voltaic cell, as expounded after Faraday by Helmholtz, the view is advanced that an equivalent of purely local potential energy of affinity with the solvent must be exhausted in order to provide for the separation of the ions, but without much violent motional disturbance such as would diffuse partially away into the form of heat. This absence of such motional dissipation of the energies of affinity, as indicated, for example, by their almost complete mechanical availability in a Daniell's cell, is perhaps connected with the intimate contacts in confined spaces which are characteristic of the processes at the electrodes by which the chemical change is effected. It is suggested that a similar mode of explanation applies to the very high, sometimes nearly complete, mechanical availability (Berthelot) of the energy of chemical transformations in dense media such as liquids and solids, as contrasted with dilute systems such as gases, which the recent work of Nernst and his pupils has brought again to the front.

The lecture passes on to touch on those extensive branches of chemical physics to which the constitution of the atom is not essential, where only a statistical grasp of the molecular associations and dissociations that are taking place is required. The quantitative theory of chemical equilibrium and of progress of chemical change as regards dilute systems comes under this head, of which the prototype and the most highly developed example is the kinetic theory of gases. The modern theory of electrodynamics, as based on the displacements and motions of electrons, is in the main analogous, and the theory of

gravitation, when it comes to light, will be of the same kind.

In particular, the molecular aspect of reaction in gases is passed under review. Reasons are brought forward for holding that in gases all ultimate reactions are of necessity mono- or bi-molecular. If this be so, the important work now proceeding with regard to the effect of impurities in promoting or inhibiting gaseous reactions must lead to fuller knowledge of the transient molecules or radicals which are formed in the destructive encounter of a pair of the reacting molecules, and are the carriers or intermediaries leading finally to poly-molecular change; while the same transient combinations may be approachable independently from another side as affording the interpretation of the complex banded spectra of emission or absorption in gaseous media.

The very remarkable and most fruitful and prophetic symbolic theories of molecular structure, especially for the complex molecules of organic chemistry, have not yet proved capable of dynamical interpretation; it seems necessary, however, to admit, on account of the wide range of physical properties that are nearly atomically additive, that stereochemical collocations do represent in some real way the actual aggregation of the atoms instead of mere symbolical representation of it. Recent investigation appears to bring out in certain cases a somewhat definite relation between the configuration of the molecule and the crystalline form of its physical aggregations, which, though reasonable, could not have been foreseen *a priori*; exact crystallographic measurements may thus in time afford another intimate clue to the molecular structures in related series of compounds.

## A NEW METHOD OF STEREOSCOPIC PHOTOGRAPHY.

AN entirely novel suggestion for the production of stereoscopic photographs is proposed by Prof. G. Lippmann in the current number of the *Comptes rendus* of the Paris Academy of Sciences (March 2). Let a lens be constructed of a material possessing a refractive index $n$, the segments forming the front and back of the lens having the same centre of curvature and the ratio of the radius of curvature of the front segment to that at the back being $n-1$. The front surface is the receiving lens, and corresponds to the lens of the eye; the back surface is covered with the sensitive emulsion, and corresponds to the retina. Owing to the chosen relation between the curvatures of the two faces an image of a point is formed by the front surface on the back one. The system is reversible; a ray of light proceeding from any point of the receiving surface will pass out at the front over exactly the same path as that taken by the incoming light in acting on the sensitive film, and this will be true in spite of any imperfection of the lens surfaces.

Prof. Lippmann now imagines a material such as celluloid moulded back and front, so that the whole surface is covered with microscopic cells, each of which is an elementary cell possessing the properties of the single lens described above. The whole film resembles the compound eye of insects. This plate, sensitised, is exposed in full daylight to the objects to be represented, no photographic lens being required. The result of the operation would be a series of microscopic images fixed each on the "retina" of one of the cells. Seen from the side of the sensitive layer, the whole plate would present a uniformly grey appearance. But seen from the front and illuminated from behind the plate (supposed converted into a positive), the photograph would appear, and would possess the following peculiarities. It would appear in true relief, exactly as in nature, and shifting the eye about would produce a change in the photograph seen, the effect being as if the observer stood in front of a window. By stepping from side to side, in the latter case, fresh portions of the landscape would come into view, the whole always being bounded by the four sides of the window. In the case of such a plate as that described, the effect would be precisely similar.

As the author remarks in the paper, the technical difficulties in the preparation of such a plate would be very great. The chief difficulty would be the fulfilment of the condition necessary for the clear definition of each image in each elementary cell; the ratio of the radii of curvature must be equal to $n-1$. Considering the thickness of the film, this difficulty would appear to be insuperable, but it is to be hoped that an attempt will be made to put this idea into practice, however imperfectly.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—During the last four years the average income of the botanic garden has been 1708*l.*, to which the University chest has contributed 1175*l.*, the rest being made up of money from trust funds and from rents. The botanic garden syndicate now points out that the income is no longer sufficient to cover the expenses. The syndicate estimates that in future, if the gardens are to maintain their high position amongst kindred institutions, some additional income must be found, and it is recommended that the present grant from the University chest to the botanic garden be increased by the sum of 220*l.* per annum.

The next combined examination for sixty-seven entrance scholarships and a large number of exhibitions at Pembroke, Gonville and Caius, King's, Jesus, Christ's, St. John's, and Emmanuel Colleges will be held on Tuesday, December 1, and following days. Mathematics, classics, and natural sciences will be the subjects of examination at all these colleges. Some of the colleges allow candidates who intend to study mechanical sciences to compete for scholarships and exhibitions by taking the papers set in mathematics or natural science. The colleges desire it to be known that any candidate for a scholarship may signify in writing his wish not to receive the emolument of the same if elected thereto, and that such candidate may be elected to a scholarship which may be honorary only and without emolument, but shall carry with it all other privileges attached to the position of a scholar. The amount thus set free will serve to increase the number of scholarships or exhibitions open to other candidates.

GLASGOW.—Among the honorary degrees to be conferred by the University on April 22 are the following:—*LL.D.*: Mr. G. T. Beilby, F.R.S., chairman of the governors of Glasgow and West of Scotland Technical College; Colonel David Bruce, C.B., F.R.S.; Dr. J. J. Dobbie, F.R.S., director of the Royal Scottish Museum, Edinburgh; Mr. R. Kidston, F.R.S.; and Dr. J. C. McVail, county medical officer, Stirlingshire and Dumbartonshire.

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DR. R. STEWART MACDOUGALL, on his appointment to the lectureship in botany in Edinburgh University, has resigned his position as biologist on the staff of the Edinburgh and East of Scotland College of Agriculture.

MR. A. L. BOWLEY, reader in statistics in the University of London, will give a course of ten lectures on elementary applications of mathematics to statistical data at the School of Economics, at 7 p.m., on Thursdays, March 26 and April 2, resuming after the Easter vacation on May 7, and continuing thereafter for seven consecutive Thursdays.

THE Earl of Rosebery will visit University College on the afternoon of Thursday, March 26, and will formally open the new libraries and the new south wing, which includes lecture-rooms for the faculty of arts, the departments of geology, hygiene, and experimental psychology, also large extensions of the departments of applied mathematics, of mechanical, electrical, and municipal engineering, and accommodation for the new hydraulic laboratory.

THE first volume of the report of the U.S. Commissioner of Education for the year ending June 30, 1906, has been received from Washington. In addition to chapters summarising the progress made during the year under review in the various departments of American education, the report contains a series of excellent articles on educational administration in various European and other countries. A useful summary of the different sections of the report is provided in the commissioner's introduction,

and from this digest we notice there were, during 1905–6, 622 institutions of higher education reporting to the Washington Bureau of Education. The total number of professors and instructors in these institutions reached 23,950, and the number of students 258,603—an increase of 9430 on the preceding year. The value of the property possessed by the 622 institutions amounted to 110,815,400*l.*, of which 49,686,100*l.* was the amount of productive funds. The aggregate income of these institutions for the year was 8,956,700*l.* The total value of all gifts reported amounted to 3,543,300*l.*; Harvard University received 443,600*l.*; Yale University, 229,100*l.*; Columbia University, New York, 210,000*l.*; the University of Pennsylvania, 109,000*l.*; and the North-Western University, Illinois, and Princetown University, New Jersey, each received about 105,000*l.* In this report, for the first time, the number of students in schools of technology is not given separately, because, as the commissioner points out, there has been an erroneous opinion in Europe and elsewhere that there is no higher technical training in America outside the schools of technology, whereas the ordinary universities grant nearly twice as many degrees in science as the technical colleges, and are doing excellent work in pure and applied science generally.

WE have received a couple of pamphlets (Leipzig: Verlag der Durr'schen Buchhandlung) which indicate the continued interest of the German public in both sides of the question of school reform. One of these pamphlets ("Die Stadt Berlin und das Reformgymnasium") is a reprint of a strenuous argument, which was originally delivered by Stadtschulrat Dr. Carl Michaelis in 1904, against tampering with the school system of the capital. Dr. Michaelis has brought the statistical portion of his address up to date, and finds in recent educational history nothing to weaken his former contention that the establishment of a Reformgymnasium in Berlin is demanded neither by the success of the reform movement generally nor by the specific educational conditions of the city. Further, while he makes it clear that he is far from opposed to well-considered changes in other directions, he defends the old gymnasium against the reformers as an indispensable part of the school system. In particular, he criticises the contention that the lower classes should be preparatory equally to all the recognised forms of secondary school, partly on the ground that the advantage which this arrangement is alleged to give the parent in selecting the school suitable to the abilities of his child is illusory, partly on the ground that no plan devised on these lines can accord with the necessary conception of a gymnasial education. Many of these arguments appear also in the second pamphlet ("Mathematik und Reformgymnasium"), in which Dr. H. Vogt endeavours to show that the teaching of mathematics suffers in respect both of the time given to the subject and of the value of the instruction where it is attempted to superimpose the gymnasial classes upon a foundation common to all the higher schools. The same firm of publishers has reprinted the address delivered in the University of Erlangen by Dr. Richard Falckenberg on the occasion of the centenary of the death of Kant (February 12, 1904).

THE second annual report, dealing with the year 1907, of the president and treasurer of the Carnegie Foundation for the Advancement of Teaching has reached us. It will be remembered that Mr. Carnegie's gift of two million pounds sterling was intended to serve primarily in the establishment of retiring allowances for teachers in the institutions of higher learning in the United States, Canada, and Newfoundland, but that he left it to be administered for this purpose in such a manner as the trustees might decide to be wise. The fears expressed in some quarters that such a gift in the hands of a limited number of men might prove a centralised power which would hinder rather than aid the progress of education do not seem to have been well founded. Since the inauguration of the foundation down to September 30 last, grants have been made to 166 persons (eighteen of whom died during the period), involving an annual budget of 46,032*l.* Of this amount, 20,230*l.* was devoted to retiring allowances in accepted institutions, and 17,702*l.* to retiring allowances made to individuals. In the group of retirements on the basis of age an interesting comparison is made; the number of allowances granted on this basis to professors not in accepted institutions before October, 1906, was eighteen; since then only eight similar allowances have been made. This indicates that the number of aged professors whom on account of their distinguished merit alone the trustees would be likely to add to the holders of allowances is rapidly diminishing. It is also interesting to note that retiring allowances to professors in State universities are made only when the services rendered to learning by the applicant have been of great distinction. As indicative of the number of applications made to the trustees, it may be stated that the files of the foundation show that 500 applications have been refused. It is satisfactory to learn that when once the principles of award have been decided upon finally, the trustees will see that the retiring allowance comes to the recipient "as a right, not as a charity; as a thing earned in the regular course of service, not a courtesy."

## SOCIETIES AND ACADEMIES.

### LONDON.

**Physical Society**, February 14.—Prof. J. Perry, F.R.S., president, in the chair.—Annual general meeting. Address by the newly elected president, Dr. C. **Chree.** Dr. Chree referred to the magnetic results obtained by the National Antarctic Expedition of 1901–4. The expedition was furnished with magnetographs, and the reduction and discussion of the curves has been done by the National Physical Laboratory. Before describing the results, the president spoke of the nature of the preparations that might be made in any future national scientific expedition. The observers should have a preliminary training lasting over some months, and should be practised in the use of instruments. These instruments ought to be ready for use and fully tested months before the date of the expedition. A programme should be got out in good time, so as to admit of rehearsals by the observers. An inquiry, after the return of the expedition, into the value of the results obtained might be useful in securing that meritorious work in science would not be overlooked. Lantern-slides relating to the diurnal inequalities of the magnetic elements in the Antarctic were exhibited and described. Slides of corresponding Kew results were shown for intercomparison. The president dwelt on the relatively highly disturbed nature of the Antarctic records. In the Antarctic, the declination and horizontal force magnets were practically never at rest. So large and incessant were the disturbances that no idea of the nature of the regular diurnal inequality was obtainable from inspection of individual curves. Diurnal inequalities, however, derived from the curves of single months, and still more of a whole season of the year, proved to be of a comparatively smooth character.

**Royal Meteorological Society**, February 19.—Dr. H. R. Mill, president, in the chair.—The formation of "snow rollers" observed at Ryton on Dunsmore, near Coventry, on January 29–30, 1907: C. **Browett.** It seems that the flakes of a light fluffy layer of surface snow are made adhesive by a rise in the temperature of the air above the freezing point, while the under snow remains cold and dry, and the particles of damp surface snow are enabled to adhere to each other, but not to the dry under snow. A strong wind may then push over little projections of the surface snow and start them rolling, when, of course, they will travel and grow until the resistances overcome the propelling power of the wind. These "snow rollers" vary in size, some being only a few inches in diameter, while at times others have been seen 2 feet or more in length.—Comparison of ships' barometer readings with those deduced from land observations: E. **Gold.** This paper contained the result of a preliminary investigation undertaken at the Meteorological Office into the relation between the barometer readings taken on ships during their passage across a line between Falmouth and Brest, and the readings deduced for the ships' positions from the observations at these places and the trend of the isobars, on the assumption of regular pressure changes. Taking into account the various causes which can appreciably

influence the height of the barometer on board ship, it appears that until the two chief ones—the wind and the vertical acceleration effects—are eliminated, it will be impossible to draw any satisfactory conclusions regarding the relative values of atmospheric pressure over sea and land. It can be said in general that there appears to be a tendency for the barometric pressure to be lower between Falmouth and Brest than would be expected from the land observations.

**Geological Society**, February 19.—Sir Archibald Geikie, K.C.B., Sec.R.S., president, in the chair.—The two earth-movements of Colonsay: W. B. **Wright.** The supposed Torridonian rocks of Colonsay exhibit in their folding and cleavage the effects of two movements analogous in their results to those proved by Mr. Clough in the Cowal district of Argyll. Not only the planes of the first or slaty cleavage, but also the quartz veins formed along them, have been folded by the second movement, and may be observed to be crossed at considerable angles by the cleavage produced during this second movement. An extensive series of lamprophyre dykes, obviously later than the first cleavage, are found to be folded and cleaved by the second movement. Moreover, some of these dykes traverse and are chilled against a mass of syenite, which can also be proved to be later than the first cleavage. The distinctness of these two movements is, therefore, considered to be completely established. The second cleavage being of the nature of strain-slip, its development along the axial planes of the folds is of interest, and is briefly discussed.—Notes on the River Wey: H. **Bury.** The part of the River Wey within the Wealden area is divided into six sections:—(1) the consequent river cutting the Chalk at Guildford; (2) the subsequent stream coming in from the east at Shalford; (3) the western subsequent stream parallel to the Hog's Back; (4) the continuation of the last westward (the Tilford River), rising at Selborne and receiving many tributaries, including the Headley River, from between Blackdown and Hindhead; (5) the short obsequent section from Farnham to Tilford (the Waverley River); and (6) the portion above Farnham coming from Alton and beyond (the Farnham River). Part i. deals with the relation of sections (6), (5), and (4) to the Blackwater; part ii. with the Palæolithic Gravels of Farnham; and part iii. with the Farnham branch of the Wey and the Alton district, which is remarkable in that there is a complicated series of Chalk valleys, which spread over some fifty square miles of country and discharge their waters into the Wealden area.

**Royal Microscopical Society**, February 19.—Mr. A. N. Disney in the chair.—An improved type of mercury vapour lamp for use with the microscope: J. E. **Barnard.**—Eye-pieces for the microscope: Mr. **Nelson.**—Results of observations, extending over a period of four years, on a rare protophyte: Rev. E. **Tozer.**—Dimorphism in the recent foraminifer *Alveolina boscii*: F. **Chapman.**—*Biddulphia mobiliensis*: Mr. **Nelson.** The author described some exceedingly minute secondary markings in the primary areolations of this diatom, discovered by him.

**Faraday Society**, February 25.—Dr. T. M. Lowry in the chair.—Hydrolysis as illustrated by heats of neutralisation: V. H. **Veley.** It is pointed out that a correlation of hydrolysis values and basic constants deduced therefrom with those of heats of neutralisation presents important issues. Determinations by an accurate method at different temperatures are required to test the validity of Nernst equation $Q = RT^2\epsilon \frac{d}{dt}\log^{10} K$. Relationships of a general character are discussed for the hydrochlorides of nitrogen bases, also of certain sodium salts of phenols and organic acids. The effect on thermoneutrality and basic constants by the introduction of a second amino-grouping is considered. Finally, it is pointed out that determinations are required of hydrolysis values at considerable dilution of certain metallic chlorides.—A study of the sulphur anion and of complex sulphur anions: Joseph **Knox.** The solubility of HgS, red and black, in $Na_2S$, $K_2S$, and BaS solutions has been determined, and has been found to depend on the formation of the complex anion $HgS''$. By its greater solubility in these solutions the black modification of HgS has been shown to be the less stable form. The constant for the formation of the complex anion from the ions $Hg^{\cdot\cdot}$ and $S''$ is

$$k = \frac{[HgS_2'']}{[Hg^{\cdot\cdot}][S'']^2} = 5{\cdot}1 \times 10^{54}.$$

From saturated solutions of $Na_2S$ and HgS a crystalline double sulphide of sodium and mercury, $2NaS,5HgS,3H_2O$, has been isolated. From the study of the complex formation between HgS and $Na_2S$ it is concluded that $Na_2S$ is almost completely hydrolysed into NaOH and NaSH.

**Royal Anthropological Institute**, February 25.—Mr. A. L. Lewis in the chair.—Montenegrin manners and customs: M. Edith **Durham.** An account was given of the people's beliefs in spirits and fabulous serpents, with their marriage arrangements and funeral ceremonies. All cousins, to whatever degree, are considered as blood relations, and marriage between them is prohibited, and it is interesting to note that godfatherhood is also a recognised relationship, a godson becoming of blood kin to all his godfather's relations.

CAMBRIDGE.

**Philosophical Society**, January 27.—Dr. Hobson, president, in the chair.—(1) Exhibition and description of a portion of a fossil jaw of one of the Equidæ (British East Africa); (2) exhibition of zebra skins (thirteen) and skulls (four) from British East Africa, with special reference to the problem of the centre of distribution of the three species of zebras: Prof. **Ridgeway.**—A new genus of Ixodoidea, together with a description of eleven new species of ticks: Prof. **Nuttall** and C. **Warburton.**—(1) Report on the brain of a microcephalous idiot; (2) description of a microcephalous new-born pig: Dr. **Duckworth.**

February 10.—Mr. S. Ruhemann, vice-president, in the chair.—The nature of $\gamma$ rays: Prof. J. J. **Thomson.** The author supported the view that the $\gamma$ rays have a structure similar to that ascribed to the Röntgen rays in his "Discharge of Electricity through Gases," consisting of small pulses of electric force, the pulses having a very small area as well as being very thin. These pulses form a system made up of separate units, which may be at considerable distances from each other. Each of the units possesses mass, momentum, and energy. It was shown that all the properties of the $\gamma$ rays could be explained on this view without the introduction of the somewhat far-fetched hypotheses which are necessary if the view that the $\gamma$ rays are combinations of positive and negative ions is adopted.—The velocity of kathodic secondary radiation: Prof. J. J. **Thomson.** A method of measuring the velocity of secondary kathode rays from gases was described, and by the use of this method it was shown that the maximum velocity of the secondary rays is independent of that of the primary rays. Cases were described in which the velocity of the secondary rays was greater than that of the primary rays from which they originated, showing that the secondary rays result from a kind of explosion of the atoms of the gas through which the primary rays pass.—The spectrum of the discharge from a glowing lime kathode in mercury vapour: F. **Horton.** The discharge tube used had a kathode consisting of a strip of platinum foil covered with lime or a mixture of lime and baryta. This could be heated by means of an electric current. The anode was either aluminium, platinum, or mercury. The spectrum showed the lines of the residual gas and those of mercury. On pumping out the residual gas its spectrum gradually disappeared and the mercury spectrum increased in brilliancy, and, at the same time, three new lines appeared in the orange and two new lines in the red. These lines were quite sharp and bright, and are not given in the ordinary tables of mercury lines. Experiments showed that these lines were not due to calcium or barium, but were connected with the presence of mercury vapour in the discharge tube. It seems probable, therefore, that the method of producing the ionisation used in these experiments gives rise to spectral lines which do not occur in the ordinary vacuum tube, arc, or spark spectra of mercury.—An example of complex double integration: Dr. A. C. **Dixon.**

DUBLIN.

**Royal Dublin Society,** February 18.—Prof. Sydney Young, F.R.S., in the chair.—*Spongospora Solani*, Brunch.: Prof. T. **Johnson.** The author gave an account of a scab which he found last summer doing much harm to the potato crop along the west coast of Ireland. The scab is caused by *Spongospora Solani*, Brunch., a slime-fungus allied to Plasmodiophora. The author describes the germination of the spores, as well as the resting plasmodium, and concludes that Spongospora agrees in its mode of reproduction with Ceratiomyxa, as described by Jahn, not with the other Myxomycetes. The author had the opportunity, through the kindness of Colonel Prain, F.R.S., the director of the Royal Gardens, Kew, of examining the spore-balls of *Sorosporium scabies* (Berk.), Fisch. d. Wald., which agree with those of *Spongospora Solani*. He expresses the opinion that *S. scabies* may prove to be, not a member of Ustilaginaceæ, but identical with *Spongospora Solani*, a slime-fungus.—The radium content of deep-sea sediments: Prof. J. **Joly.** The paper is a record of experiments on material kindly supplied by Sir John Murray, F.R.S. The quantity of radium is found to increase with distance from land, the central Pacific oozes (Radiolarian ooze and Red Clay) rising above $50 \times 10^{-12}$ grams radium per gram. Manganese nodules, Globigerina ooze, and Blue Mud were also examined. The Blue Mud is poorer in radium than many terrestrial sediments.

PARIS.

**Academy of Sciences,** March 2.—M. H. Becquerel in the chair.—Some phosphorescence spectra: Henri **Becquerel.** A comparison of the phosphorescent and flame spectra of various specimens of fluor-spar, apatite, and scheelite from different localities. The bands cannot be wholly attributed to the traces of rare earths present in these minerals.—Reversible photographs: G. **Lippmann** (see p. 452).—Machines for driving away hail: J. **Violle.** So far as can be settled by direct experiments, a single detonation is practically without effect on a storm cloud. The effects of volleys from a large number of hail cannon seem to be capricious; a violent storm is practically unaffected by them, but a slowly moving cloud approaching the district by a known path may be diverted successfully.—Lithium in active minerals: Sir William **Ramsay** and Alex. **Cameron.** Referring to the results of Prof. McCoy and of Mlle. Gleditsch on the presence of lithium in certain radioactive minerals, it is pointed out that lithium is not regarded as the sole product of change when copper salts are treated with the radium emanation; other members of the alkali group may also be produced (see NATURE, March 5, p. 412).—The direct hydrogenation of the aromatic quinones: Paul **Sabatier** and A. **Mailhe.** With reduced nickel at 100° C., quinone is converted nearly quantitatively into hydroquinone. At higher temperatures products of decomposition, phenol and benzene, are found. The reaction also applies to toluquinone, paraxyloquinone, and thymoquinone.—Surfaces with coincident lines of curvature: L. **Raffy.**—The case of reduction of the differential equations of the trajectory of an electrified corpuscle in a magnetic field: Carl **Störmer.**—Electrical measurement of small lengths: A. **Guillet.**—The voltaic arc working in an enclosed space limited by a thick wall: Adolphe **Minet.**—The heat of vaporisation of propionic acid: A. **Faucon.** This constant, measured with the Berthelot apparatus, was found to be 90·4. This gives a Trouton constant of 16·2, lower than the normal figure of 20 to 21. Formic and acetic acids show the same abnormality.—The determination of the atomic weight of europium: G. **Jantsch.** The purity of the europium preparation and its freedom from samarium and gadolinium was proved by superimposing the arc spectra of all three on the same plate. The only lines common to the three were the parasitic lines from the arc, belonging to iron, silicon, and magnesium in the carbon electrodes. The ratio $Eu_2(SO_4)_3,8H_2O : Eu_2O_3$ was determined experimentally, and gave an atomic weight of 152 (O = 16). This is in close agreement with the number previously found by MM. Urbain and Lacombe.—The oxidation of platinum: C. **Marie.** Evidence has been obtained that a minute amount of an oxide of platinum can be produced by the action of various oxidising agents at the ordinary temperature.—A new type of combination of sulphur with certain iodides: V. **Auger.** The preparation of the following compounds is described:—$CHI_3.3S_8$, $C_2D_4.4S_8$, $AsI_3.3S_8$, $SbI_3.3S_8$. All these are well crystallised, and have been analysed.—Syntheses by means of the mixed organometallic derivatives of zinc. Ketone alcohols: E. E. **Blaise** and I. **Herman.** The ketone alcohol $C_2H_5.CO.C(CH_3)_2.OH$ has been obtained by the action of $C_2H_5.Zn.I$ upon $CH_3.CO.O.C(CH_3)_2.COCl$, and subsequent saponification with cold dilute caustic soda solution.—The preparation and characters of crystallised *d*-talite: Gabriel **Bertrand** and P. **Bruneau.** A detailed description is given of the improvements in E. Fischer's method of preparing *d*-talite, by means of which, starting with galactonic acid, 7·5 per cent. of the re-crystallised substance is obtained instead of 1 per cent. of the carbohydrate in the form of syrup. The physical and chemical properties of the crystallised product are given.—Physico-chemical researches on soaps considered as colloids: André **Mayer,** Georges **Schaeffer,** and E. F. **Terroine.**—The sorting of minerals by the electromagnet: A. **Chevallier** and L. **Vérain.**—The application to thoria of a general method of synthesis of fluorides and silicates: A. **Duboin.**—The existence of cephalic glands in *Machilis maritima*: L. **Bruntz.**—A Lepidoptera (*Zeuzera pyrina*) causing damage to the cork tree in Algeria: P. **Lesne.**—Spectroscopic examination of the bile: A. **Auché.** The method is based on the production of a characteristic absorption spectrum by bilirubin when oxidised under certain conditions which are defined.—Some new work on kala-azar cultures: inoculation of the dog: etiology: Charles **Nicolle.**—The rocks and Permian strata at Châtillon-sur-Saône (Vosges): A. **Doby.**—The existence of a Permian fauna and flora at Madagascar: Marcellin **Boule.**—The infra-Lias of Hodna (Algeria): J. **Savornin.**

CALCUTTA.

**Asiatic Society of Bengal,** February 5.—Hindustani-English glossary of birds, chiefly from Jerdon: Lieut.-Colonel D. C. **Phillott** and Pandit Gobin Lal **Bonnerjee.**—Notes on the pollination of flowers in India. Note No. 5. Some autumn observations in the Sikkim Himalaya: I. H. **Burkill.** The observations were made above 7000 feet in the autumns of 1904 and 1906, on two journeys from Darjeeling along the Singlela ridge. The climate of the ridge is a very moist one, and an unusual percentage of flowers are pendent, possibly profiting thereby because their honey escapes dilution and their pollen injury from the rain. Bombi visit many of the flowers, even working in the rain, and are found at all elevations; a long-tongued Bombyliid fly of the genus Lycastris is frequent about 8000 feet to 9000 feet. The trees of the ridge are almost all spring-flowering, and the flowering plants of the autumn flora are almost all herbs.—Notes on the pollination of flowers in India. Note No. 6. The spring flora in the Simla Hills: I. H. **Burkill.** Observations made in the end of April and beginning of May, 1906 and 1907, are recorded. The flora and fauna are very European in character, but the flora is of a much more specialised type than is the spring flora of, for instance, the Grampians of Scotland. The weather in May is generally dry, and pendulous flowers are not very numerous.—Fat of the Himalayan bear: D. **Hooper.** Analysis of the fat of *Ursus torquatus* as used medicinally in the Himalaya.—Monograph of sea-snakes: Captain F. **Wall.** A full and illustrated account of the sea-snakes of the world based on study in several museums.—A note on the calm region in the atmosphere, which in the neighbourhood of Calcutta, during the cold season, is at a height of 3000 feet to 4000 feet: C. **Little.** The object of the note is to make known the existence of the calm region at almost a uniform height throughout any one cold season, as well as from year to year. The information has been collected by observing paper balloons of different sizes, some filled with coal gas and some with hydrogen, and brief details are given of the method of observation. The altitude and azimuth of the balloon were noted at intervals of two minutes, and at the same time the diameter of the image of the balloon in a 3-inch telescope of 42 inches focal length was measured by a micrometer. Assuming this last measurement to be *x* thousandths of an inch, the

distance would be $126,000/x$ feet, the balloon being 3 feet in diameter. From these measurements the position of the object in space is determined, and consequently the air movements at the different levels to which the object rises, assuming the air movement to be horizontal. With a 3-feet balloon filled with hydrogen gas, or with one of 6 feet diameter filled with coal gas, the greatest elevation attained varies from 7000 feet to 10,000 feet. It has been found in all cases that up to 4000 feet the air movement is quite different from what it is above that level, and that in passing from the lower to the upper layer of air the balloon passes through one that has very little motion.

## DIARY OF SOCIETIES.

*THURSDAY*, MARCH 12.

ROYAL SOCIETY, at 4.30.—Description of the Brain of Mr. Charles Babbage, F.R.S.: Sir Victor Horsley, F.R.S.—The Origin and Destiny of Cholesterol in the Animal Organism. Part II., The Excretion of Cholesterol by the Dog: C. Dorée and J. A. Gardner.—On Reciprocal Innervation in Vaso-motor Reflexes and the Action of Strychnine and of Chloroform thereon: Dr. W. M. Bayliss, F.R.S.—Bacteria as Agents in the Oxidation of Amorphous Carbon: Prof. M. C. Potter.—The Life-history of *Trypanosoma equiperdum*: Prof. J. E. Salvin-Moore and Anton Breinl.

ROYAL INSTITUTION, at 3.—Early British History and Epigraphy: Sir John Rhys.

ROYAL SOCIETY OF ARTS, at 4.30.—Progress in the Native States of India during the past Forty Years: Sir David W. K. Barr, K.C.S.I.

MATHEMATICAL SOCIETY, at 5.30.—On the Projective Geometry of some Covariants of a Binary Quintic: Prof. E. B. Elliott.—On the Inequalities connecting the Double and Repeated Upper and Lower Integrals of a Function of Two Variables: Dr. W. H. Young.—On the Operational Expression of Taylor's Theorem: W. F. Sheppard.—On a Formula for the Sum of a Finite Number of Terms of the Hypergeometric Series when the Fourth Element is Unity (Second Paper): Prof. M. J. M. Hill.—Note on a Soluble Dynamical Problem: Prof. L. J. Rogers.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—America Re-visited, 1907: Sir W. H. Preece, K.C.B., F.R.S.

*FRIDAY*, MARCH 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Observations of the Transit of Mercury, 1907 November 14: T. F. Claxton.—Photometric Measurements of Saturn, 1907 August-December: J. M. Baldwin.—Reappearance of Saturn's Ring, 1908 January: R. T. A. Innes.—On the Orbits of $\Sigma$ 483, $\Sigma$ 2438, $\Sigma$ 3123, 8 Sextantis = A. C. 5, and $\Delta$ 15: T. J. J. See.—On the Lunar Inequalities due to the Motion of the Ecliptic and the Figure of the Earth: E. W. Brown.—On the Variability of the Nucleus of the Planetary Nebula N.G.C. 7662: E. E. Barnard.—Measures of Southern Binary Stars in 1907: John Tebbutt.—Double Star Observations, 1902–1907: W. H. Maw.—Further Considerations on the Correlations of Stellar Characters: Winifred Gibson and Karl Pearson.—The Perturbations of Halley's Comet, 1759–1910: P. H. Cowell and A. C. D. Crommelin.—*Probable Papers:* A Suggested Explanation of the Ancient Jewish Calendar Dates in the Aramaic Papyri, Translated by Prof. A. H. Sayce and Mr. A. E. Cowley: E. B. Knobel.—The Perturbations of Halley's Comet in the Past (Third Paper), the Period 1066–1301: P. H. Cowell and A. C. D. Crommelin.—On the Relative Numbers of Star Images Photographed in Different Parts of the Plates for the Oxford Portion of the Astrographic Catalogue (Second Paper): H. H. Turner.—Note on the Discovery of a Moving Object near Jupiter (1901 C. J.): Royal Observatory, Greenwich.

ROYAL INSTITUTION, at 9.—Transatlantic Wireless Telegraphy: Chevalier G. Marconi.

PHYSICAL SOCIETY, at 8.—On Certain Dynamical Analogues of Temperature Equilibrium: Prof. G. H. Bryan.—Experiments on Artificial Fulgurites: Miss D. D. Butcher.—The Distribution in Electric Fields of the Active Deposits of Thorium and Actinium: S. Russ.

MALACOLOGICAL SOCIETY, at 8.—Descriptions of Two New Species of Synapterpes, Pils., and a New Species of South American Strophocheilus: Hugh C. Fulton.—Description of a New Species of Plectopylis: G. K. Gude.—On the Mollusca of some Holocene Deposits of the Thames River System: A. S. Kennard and B. B. Woodward.—Note on the Radula of *Pomatias elegans*: Rev. E. W. Bowell.—The Application of Poli's Generic Names: A. J. Jukes-Browne and J. H. Ponsonby.

*SATURDAY*, MARCH 14.

ROYAL INSTITUTION, at 3.—Electric Discharges through Gases: Prof. J. J. Thomson, F.R.S.

*MONDAY*, MARCH 16.

ROYAL SOCIETY OF ARTS, at 8.—Fuel and its Future: Prof. V. B. Lewes.

*TUESDAY*, MARCH 17.

ROYAL INSTITUTION, at 3.—Membranes: Their Structure, Uses and Products: Prof. W. Stirling.

ROYAL STATISTICAL SOCIETY, at 5.

ZOOLOGICAL SOCIETY, at 8.30.—Some Observations on the Effects of Pressure upon the Direction of Hair in Mammals: Dr. W. A. Kidd.—The Rudd Exploration of S. Africa, IX. List of Mammals obtained by Mr. Grant on the Gorongoza Mountains, Portuguese S. E. Africa: O. Thomas, F.R.S., and R. C. Wroughton.—Notes upon some Species and Geographical Races of Serows (Capricornis) and Gorals (Næmorhedus) based upon Specimens exhibited in the Society's Gardens: R. I. Pocock.

MINERALOGICAL SOCIETY, at 8.—On the Occurrence of Minerals developed by Pneumatolitic Action in the Bodmin and Camelford Areas: G. Barrow and H. H. Thomas.—A Protractor for Use in Constructing Stereographic and Gnomonic Projections: A. Hutchinson.—Supplementary Notes on the Mineral Kaolinite: Allan B. Dick.—An Attachment to the Goniometer for the Measurement of Complex Lamellated Crystals: H. L. Bowman.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further discussion:* The New York Rapid-transit Subway: W. B. Parsons.

*WEDNESDAY*, MARCH 18.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Lord Avebury will deliver his Presidential Address, on Seeds, with Special Reference to British Plants.—*Exhibition:* Mounted Specimens of some of the Rarer Species of Freshwater Polyzoa: Mr. C. F. Rousselet.

GEOLOGICAL SOCIETY, at 8.—The Carboniferous Rocks at Loughshinny, (co. Dublin), with an Account of the Faunal Succession and Correlation: Dr. C. A. Matley and Dr. A. Vaughan.—A Note on the Petrology and Physiography of Western Liberia (West Coast of Africa): J. Parkinson.

ENTOMOLOGICAL SOCIETY, at 8.

*THURSDAY*, MARCH 19.

ROYAL SOCIETY, at 4.30.—*Probable Papers*:—On Scandium: Sir William Crookes, F.R.S.—On Secondary $\beta$-Rays: Prof. J. A. McClelland.—On the Measurement of the Atmospheric Electric Potential Gradient and the Earth-air Current: C. T. R. Wilson, F.R.S.—Note on the Trajectories of Rifled Projectiles with Various Shapes of Head: A. Mallock, F.R.S.

ROYAL INSTITUTION, at 3.—Standardisation in Various Aspects: (1) Mechanical Engineering: Dr. R. T. Glazebrook, F.R.S.

ROYAL SOCIETY OF ARTS, at 8.—The Navigation of the Air: Dr. H. S. Hele-Shaw, F.R.S.

CHEMICAL SOCIETY, at 8.30.—The Constitution of Electronegative "Thiocyanates": A. E. Dixon and J. Taylor.—An Improved Form of Pyknometer: W. R. Bousfield.—The Quantitative Conversion of Aromatic Hydrazines into Diazonium Salts: F. D. Chattaway.—The Action of Heat on $\alpha$-Hydroxycarboxylic Acids, Part iv., Racemic $\alpha\alpha$-Dihydroxyadipic Acid and Meso $\alpha\alpha$-Dihydroxyadipic Acid: H. R. Le Sueur.—The Spontaneous Crystallisation of Sodium Sulphate Solutions: H. Hartley, B. M. Jones, and G. A. Hutchinson.—Quantitative Relations of Salts of Thallium and its Separation from Silver: J. F. Spencer and Miss M. Le Pla.—Constitution of Hydroxyazo Compounds, Action of Diazomethane and of Mercuric Acetate: C. Smith and A. D. Mitchell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—New Alternate Current Instruments: Dr. W. E. Sumpner and J. W. Record.

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