THURSDAY, JULY 2, 1908.

DEVELOPMENT OF ASTRONOMY.

A History of Astronomy. By W. W. Bryant. Pp. xiv+355. (London: Methuen and Co., n.d.) Price 7*s.* 6*d.* net.

IT is somewhat difficult to decide on the attention to be devoted to a volume so small as the present one, as it is from the first apparent that as a "history" justice could only be done even to a few sections of the subject. The intention of the author appears to have been to give a more or less popular account of the evolution and progress of the chief divisions of the science, without attempting to render the story complete. Starting with a short review of the astronomical notions of the early races, in the first two chapters the various claims to priority of record are examined, the Chinese data purporting to extend back to 2500 B.C.; the Indian system has tables, &c., supposed to be based on phenomena of the year 3102 B.C.; Egypt and Chaldea are also of very great antiquity, the latter recording the eclipses observed at Babylon in 721 and 720 B.C. In chapters iii. and iv. the advances made by the Greeks and Arabian philosophers are briefly reviewed. The Arabs excelled in methodical accuracy, and modern astronomy owes them an immense debt for the introduction of the decimal notation, replacing the more cumbersome numerical notations of the Greeks and Romans.

The end of these two schools brings the record down to the fifteenth century, when the great revival of philosophical thought in Europe commenced to be widely felt. The work of Copernicus, who was born at Thorn, in Polish Prussia, in 1473, was published in 1543, and practically inaugurated a new era, in that the Ptolemaic system was shown to be inadmissible, and the new Copernican system soon forced its way to the front, as it explained many phenomena which previously gave difficulty. Copernicus, however, was but a theorist, and it was by Tycho Brahe, born of a noble Danish family in 1546, that the great observational advancement of the sixteenth century was made. The story is then continued, giving the successive advances made in turn by Kepler, Galileo, Newton, Laplace, and the seventeenth and eighteenth century early astronomers Flamsteed, Halley, Bradley, and Herschel. Up to this stage the treatment has been chronological, but from this point the author, apparently finding difficulty in correlating the overwhelming flood of new observations which marked the end of the eighteenth and the whole of the nineteenth century, takes a series of subject divisions, and gives the main features of progress in both theory and observation relating to each. This naturally leads to various redundancies, and we doubt if the non-expert reader will obtain a clear idea of the chronological progress during these later times.

Chapter xv. is devoted to the modern development of observatories and instruments, which is very interesting reading. No mention is made, however, of the great influence on instrument design which has resulted from the use of the horizontal telescope in conjunction with a moving mirror of the Foucault siderostat or Lippmann cœlostat type, as is done at Paris, London, and at several stations in America. Chapter xvii. deals with the discoveries connected with the physical nature of the sun, the periodicity of the sun-spots, faculæ, &c. In the two following chapters the spectroscopic researches in connection with the sun are related from the time that Kirchhoff made his historic observation of absorption in 1859. Naturally the enormous development of this branch of astronomy since the 'eighties has made it impossible for the author to give more than a superficial narration of the progress made, but what he has included is both useful and interesting.

Chapters xx. to xxvi. deal with the individual members of the solar system. Most of this calls for little comment; in the chapter on Mars, predominance is given to the "carbonic acid" theory of the polar caps, but as we know from the recent researches of Lowell, it is now conclusively proved that water vapour in quantity does exist on the planet, and it is therefore unnecessary to discuss the more improbable theory. The concluding remark in this chapter is somewhat ungracious in an impartial review of the history of the subject; scepticism regarding the Lowell Observatory announcements is practically non-existent in the minds of anyone competent to appreciate the work done at that institution. Although open-minded in general, remarks like this show a tendency to urge an isolated opinion on matters requiring very wide discussion. In general, it may be said that these chapters on the solar system are very well up to date, and a short *résumé* is added giving the more modern theories of cosmogony, in which the simplicity of the original nebular hypothesis of Laplace has gradually given way to more modified views, no one of which, however, is at present definitely accepted.

Comets, meteors, and the Zodiacal Light are dealt with in chapter xxvii., the various cometary theories being very ably described without introducing any technicalities. Chapters xxviii.–xxxii. are occupied with the history of stellar research. The introduction and design of star catalogues of various degrees of precision, down to the great international *Carte du Ciel*, zone work, observations of proper motion and parallax, double star systems, variable stars, clusters and nebulæ, &c., are described in their order of development. The penultimate chapter, on stellar spectroscopy, occupies but twelve pages, reviewing briefly the classifications of Secchi, Vogel, Pickering, Lockyer, and Huggins. A curious statement is that the star Sirius has but little atmosphere, as indicated by its thick hydrogen lines and thin metallic lines. Surely the opposite is the case; for the hydrogen absorption lines to be so wide requires a very extensive atmosphere, at the base of which there must be a very considerable gravitational pressure. Little mention is made of the enormous progress made during recent years by the investigations of "enhanced lines" in stellar classification, although this is now

accepted as a criterion for the differentiation of several of the stellar groups.

Approached with the above reservations the volume is certainly attractive, and the only serious omission appears to be the complete absence of references to sources of the information, so that a reader desirous of further study on any point is left entirely unaided.

The plates chosen for illustrating the volume are excellent and beautifully reproduced. The usefulness of many of them to the beginner will be somewhat impaired on account of the orientation letters being entirely omitted, and in several cases the plates are oriented differently from the majority, thereby leading to further confusion. Illustrations of many old portraits and ancient impressions of the solar and stellar systems are included, which will be the more interesting in that they are not easily available elsewhere. The index, well planned in general, contains many useless references, in some cases quoting names which, when referred to, prove to be merely names with no record of work done or other points of interest.

It will thus be evident that opinions on the volume will probably diverge along two lines; to the more advanced reader it is likely to appear superficial, as only touching with note-like brevity a few of the many chapters of the science; to the reader merely interested in astronomical development, however, it should appeal as a popular and very attractive account of many interesting sections of nature-study.

VON RICHTHOFEN'S CHINESE DIARIES.

Ferdinand von Richthofen's Tagebücher aus China. Ausgewählt und herausgegeben von E. Tiessen. Two vols., illustrated. Vol. i., pp. xv+588; vol. ii., pp. iv+375. (Berlin: Dietrich Reimer, 1907.) Price 20 marks.

WHEN Ferdinand von Richthofen's life was ended his great work on China still remained unfinished. The third volume was not only unwritten, but had become unwritable, for, besides a description of southern China, it was intended to contain an account of the culture, civilisation, and organisation of China as a whole, and, apart from the magnitude of the subject, the complete alteration in the conditions of this "unchanging" country since the date of his travels had made much of his observation and experience inapplicable to the existing state of affairs. Besides the missing volume of his great work, von Richthofen also left unfinished the popular account of his travels, a work which he regarded as a duty owed to his fellow-men by every traveller in unexplored or little-known countries, and had, indeed, nearly half completed when the publication of his great work was assured, and monopolised the whole of the time and energy which was not devoted to his duties as professor. To fill in, so far as was possible, these gaps in his published work, and to meet a generally felt wish among Baron von Richthofen's old students and friends, Herr Tiessen, with rare skill, has compounded from von Richthofen's unpublished manuscripts, his diaries, and his letters home, one of the most interesting and enlightening books of travel which have been published.

On August 3, 1868, von Richthofen left San Francisco with the deliberate intention of undertaking a geological examination of China. His hope was that if he could manage to spend a year in that country he would be able, by the importance of the results, to interest the Government and obtain from it the assistance needful for the prosecution of his purpose. This first year of work was provided for by the enlightened liberality of Californian capitalists, who foresaw the practical importance of a scientific investigation of the resources of China, and, through the Bank of California, provided funds for an expedition. Arriving in China, von Richthofen was soon disillusioned of any hope of assistance from the Government, but nevertheless, and in spite of every discouragement, determined to pursue steadfastly his resolve. After some short excursions, mostly devoted to the examination of real or reputed discoveries of coal or ores, his first important journey was the descent of the Yangtse and the examination of its banks from Hankow to its mouth. This journey was an important one in more than one way, and in none more so than in the acquisition of Paul Splingaert, a Belgian, who had acquired an intimate colloquial knowledge of the Chinese language and an insight into the character and habits of thought of the Chinese people. The value of his services appears repeatedly throughout the book, and the importance of the results of von Richthofen's travels is very largely due to the fortunate combination of the man who knew how to collect and utilise information with the man who was able to obtain it. On this journey, too, von Richthofen made the first of those observations on the loess which led to the development of his well-known and now generally accepted theory of the origin of that remarkable formation; between Nankin and Chin-kiang he found remains of Helix in the loess near the hill of Fangshan, and remarks that this discovery is inconsistent with the theories of Pumpelly, who regarded the loess as a fresh-water, or of Kingsmill, who looked upon it as a marine, deposit.

The next journey took him through the province of Shantung, where he discovered large and important coalfields, and was the first to recognise the value of Kiao-chau as a port of access to, and an outlet for, the mineral wealth of the province, a discovery of which the German Government took advantage at a later period. After a long journey through Mongolia to Pekin and back to Shanghai, he accepted a proposal from the Shanghai Chamber of Commerce for an exploration of the interior of China; and so, in spite of the failure of his hopes of Government support, von Richthofen found himself in a position to carry out the design with which he left America, and on January 1, 1870, set out from Canton on the first of his two great journeys through the heart of the Chinese Empire, which ended with his return on May 21, 1872, to Shanghai; whence, after a stay of five months, devoted to preparing a report on his travels for the Shanghai Chamber of Commerce, he returned to his native land after an absence of just over twelve and a half years.

These are the travels of which we are given a simple and straightforward account devoid of all scientific technicalities. Those who wish to make use of von

Richthofen's scientific work must look elsewhere; but in this book they will find, not only an interesting account of his journeys, but a marvellous revelation of the real China. On almost every page of the narrative stand prominent, not merely the sources of China's weakness, but also the enormous latent power of the country, and there is borne in upon one an almost oppressive feeling that a China awakened, reformed, and patriotic could set the world at nought, and a China ambitious besides would be a real yellow peril. But all those who knew the late Baron F. von Richthofen will value this book less for its description of China than as a picture of its author; on every page of the narrative his simplicity, honesty, and nobility of character stand forth, his steadfastness in pursuing the course he had set before him in spite of discouragement, the intrepidity and tact which extricated him from difficult and dangerous situations, when set upon and mobbed by the colliers in Shantung, when he visited the bitterly anti-foregn "university" of Yolushan, and especially in the extremely critical occurrence which put an end to his further travels, all stamp him as a true representative of that aristocracy, not merely of birth, but of intellect and character, which by common consent raises some individuals far above the level of the great mass of their fellow beings. No more acceptable or worthy memorial of their author could well have been contrived than these two unpretentious volumes.

THE GENERA OF FLOWERING PLANTS.

Genera Siphonogamarum ad Systema Englerianum conscripta. By Dr. K. W. von Dalla Torre et Dr. H. Harms. (Leipzig: W. Engelmann, 1900–1907.)

THE completion of the "Genera Siphonogamarum," by Drs. K. W. von Dalla Torre and H. Harms, will have been welcomed by all students of the taxonomy of siphonogams—or, as we are still used to say, phanerogams—and no doubt also by many other botanists. Invaluable as Engler and Prantl's "Natürliche Pflanzenfamilien" is as the embodiment of the most recent researches in the systematic botany of phanerogams, it suffers from one serious omission, the lack of all references to the original descriptions of the genera and their subdivisions. To fill that gap was the primary object of the publication of the "Genera Spihonogamarum." At the same time it was intended to make the synonymy of the genera as complete as possible, and give a comprehensive description, on the one hand, of their disposition within the families and the Englerian system generally, and, on the other, of their subdivisions. Lastly, the work should serve as a catalogue for those botanical collections which are arranged after the "Natürliche Pflanzenfamilien"; and there is no doubt that in most respects the problem has been solved in an admirable way.

The book consists of two parts. The first part (pp. 1–637) is headed by an "Enumeratio Familiarum Siphonogamarum," and contains the disposition of the systematic units above the rank of species, whilst the second (pp. 638–921) is taken up by an "Index Nominum." The basis of the whole work is, as indicated in the title, Engler and Prantl's "Natürliche Pflanzenfamilien"; but where the disposition or the conception of the units has been superseded by more recent monographs, or otherwise proved untenable, due notice is taken of the changes entailed thereby. The decision whether a proposed alteration was to be adopted or not must frequently have been a very difficult and delicate task for the authors; but, on the whole, they seem to have acted with much tact and sound judgment. The genera are given their successive numbers in the system in heavy type, whilst their places within the families are indicated by figures in light type. The references in the index are to both sets of numbers, which makes the index very handy as a collection catalogue. All citations are accompanied by the dates of publication, so that the settlement of questions of priority is greatly facilitated. The reference to the original publication is followed by references to Endlicher's "Genera Plantarum," Bentham and Hooker's "Genera Plantarum," and Engler and Prantl's "Natürliche Pflanzenfamilien," and by a note containing the approximate number of species known, and a very concise indication of the geographical distribution. Then the synonyms are enumerated in their chronological sequence, each starting a fresh line, and lastly we are given the disposition of the subdivisions of the genus with the corresponding synonyms.

Frequent use of the book has revealed here and there errors, almost exclusively in the reference figures, but not more than one has to be prepared for, in a work that contains almost 43,000 names, with as many references. There is, however, one weak point which cannot be passed without criticism. As the references to the two "Genera Plantarum" of Endlicher and of Bentham and Hooker stand, they suggest that a given genus admitted by the authors of the "Genera Siphonogamarum" is also admitted as such by those earlier authors, whilst in fact it merely means that they have dealt with it in some way on the page quoted, and, indeed, frequently stated that they do not consider the genus as tenable. For instance, under Ligularia we find "B.H. II., 449," but if we turn to p. 449 of vol. ii. of Bentham and Hooker's "Genera Plantarum," we find that Ligularia is there actually reduced to Senecio. Thus the impression is created that the conception which the authors of the "Genera Siphonogamarum" have of Ligularia is supported by the authors of "Genera Plantarum," whilst just the opposite is the case. The addition of "sub Senecione" in the case quoted would have been sufficient to make that clear. This is, however, practically the only serious blemish in a work which must have taxed the judgment and patience of the authors to the utmost.

The execution of the typography in a book like the present is, of course, of paramount importance, and it may be stated at once that it leaves nothing to desire, with the possible exception that the type used in the "Index" for the numbers of the genera admitted might have been a little heavier. Inconvenient is the throwing together in the index of the letters I and J,

for which there is no justification. It must lead to confusion, and the authors have fallen into their own trap, for instance, in writing Jonidium for Ionidium (ἴον-ειδ-ιον). And why Rhaphanus instead of the Linnæan "Raphanus," and on the other hand Raphia and Rigiostachys (ῥαφίς and ῥίγιος, στάχυς) instead of Rhaphia and Rhigiostachys? There is everything to be said in favour of rendering ῥ throughout by "rh"; but if this rule is not adopted, it would be better to adhere to the original spelling of the authors.

Those who have watched the nomenclatoric movement of the 'nineties and the first years of the present decade with some apprehension lest the continuity and uniformity of botanical nomenclature should be seriously impaired will be greatly relieved in finding on the examination of the "Genera Siphonogamarum" that this danger is practically averted. The book was finished up to the "Index," when, in 1905, the Vienna Congress adopted the new rules concerning the nomenclature of phanerogams; but in as far as these rules coincide in all essential points with the so-called Berlin rules which governed the nomenclature of the "Natürliche Pflanzenfamilien," the generic nomenclature of the "Genera Siphonogamarum" may well be considered as a practical and comprehensive test of the working of those rules. This being so, it is highly gratifying to see that the concord in generic nomenclature of the two leading schools of systematic botany, the older Kew school and the younger Berlin school, is practically absolute. Out of the total of, roundly, 10,000 genera, there are only 86 in regard to which the nomenclatoric standard of the "Genera Siphonogamarum" and the Kew practice, judged by Bentham and Hooker's "Genera Plantarum" and the "Index Kewensis," differ, and most of them are small genera, with few exceptions affecting none but purely scientific interests. Moreover, most of these discrepancies admit of easy correction, and where there is any serious doubt it may be left for the next International Botanical Congress to decide. This surprising concord in the generic nomenclature of the phanerogams is a veritable triumph of common sense which, it may be hoped, in the interest of science, will in time also conquer the opposition of the American school, which still holds out for a nomenclature of its own.

OTTO STAPF.

SCIENCE IN THE TEXTILE INDUSTRIES.

The Structure of the Cotton Fibre in its Relation to Technical Applications. By Dr. F. H. Bowman. Pp. xx+470. (London: Macmillan and Co., Ltd., 1908.) Price 8*s.* 6*d.* net.

THE manufacture of a textile fabric mainly consists of a series of mechanical processes whereby the raw fibrous material is transformed first into a coherent thread and finally into a complex structure. As might be expected, therefore, the introduction of scientific method into the textile industries has mainly shown itself on the mechanical side, that is, in the improvement of the machinery used in the various stages of manufacture, much of which has been developed to a high state of perfection.

There are, however, many other directions in which scientific investigation can be directly brought to bear in textile manufacture, and the author of the book under review was a pioneer in one such direction thirty years ago, when he first investigated the microscopical structure of the cotton and wool fibres in relationship to the various processes of spinning, weaving, dyeing, and finishing.

The present volume, dealing with the cotton fibre, is the first of a series of three, and those to be subsequently issued will deal with wool, silk, &c. It comprises a very full account of the origin and development of the cotton fibre, its microscopical structure, and the chemistry of cotton cellulose and its derivatives. These chapters are followed by others giving details regarding the strength and variation of the fibre and of spun yarns of various counts and twists. Other less satisfactory sections deal with the various theories of dyeing and with dyeing processes, and in a final chapter the methods of detecting various fibres and of analysing a mixed fabric are described. Of the eighty illustrations and diagrams with which the book is illustrated, many are coloured, and, like the paper and type, are excellent. An exhaustive table of contents and trustworthy index add to the value of the book, and the introduction of a glossary shows that the author has spared no trouble to make the book complete. Some of the definitions in the latter would, however, bear revision, *e.g.* "*Complementary colour*—the remaining colours in a beam of light which are necessary to make white light." "*Hydroxyl*—the substance produced by the union of a single atom of hydrogen and oxygen."

One of the first duties of a reviewer is considered to be that of pointing out errors and omissions in the book with which he is dealing. This at any rate has the advantage of indicating that he has read the book with some care; and it may be mentioned therefore that there are misprints on line 1, p. 57, and on line 4 of the table on p. 150. Also that incorrect formulæ are given for cellulose on pp. 144 and 145, and for nitrobenzoic acid on p. 407.

Perhaps the most valuable feature of the work is to be found in the record which it contains of the author's laborious and long-continued investigation of the microscopical structure of cotton both during growth (for which purpose he cultivated cotton plants in a greenhouse), when fully matured, and at all subsequent stages of manufacture. Dr. Bowman's sketches showing the structure of fibres have been long accepted as standards, and have been reproduced in nearly all modern works on spinning, dyeing, &c.

Another highly commendable feature is the insistence upon due regard being paid to the interdependence of the various processes of manufacture. This is a point the importance of which is frequently overlooked, but one which, as the author states, is essential to perfection of result.

The issue of the remaining two volumes of the series will be looked forward to with much interest.

WALTER M. GARDNER.

OUR BOOK SHELF.

The Geology of Coal and Coal-Mining. By Walcot Gibson. Pp. x+341. (London: Edward Arnold, 1908.) Price 7*s.* 6*d.* net.

THIS book is the first of a series of works on economic geology under the general editorship of Dr. J. E. Marr, F.R.S. The author is a recognised authority on the coal-bearing rocks of this country and of South Africa, and his introduction to the geology of coal is a welcome addition to technical literature that cannot fail to prove of great educational value to mining students. General principles of practical significance are dealt with in detail, and the world's coalfields are briefly described. The chemical and physical characters of coal are clearly explained, and chapters are devoted to coal as a rock, the formation and origin of coal, the distribution of coal, fossils as zonal indices, prospecting, the study of an exposed coalfield, and the study of a concealed coalfield. The coalfields of Great Britain are described in three chapters, dealing respectively with the southern, midland, and northern districts, whilst the remaining four chapters are devoted to the coalfields of Continental Europe, the North American coalfields, the coalfields of Africa, India, Australia, and South America, and the coalfields of China, Central Asia, Japan, New Zealand, and the Dutch East Indies.

The book is illustrated by eight well-reproduced plates of fossils. The palæontological chapter will undoubtedly prove most useful, as many mining engineers still fail to appreciate the value of fossil evidence, and the information given by the author will enable the student to see how far one part of the Carboniferous formation may be distinguished from the other. Besides the plates, there are in the text thirty-seven sketch-maps and sections of the various coalfields. Although somewhat crudely executed, these illustrations are clear and instructive. The least satisfactory chapter in the book is that describing the coalfields of Continental Europe, which is disfigured by a number of typographical errors, such as "Taplitz" for Teplitz, "Peckkohle" for Pechkohle, "Creusot" for Le Creusot, "Asturia" for Asturias, and by eccentricities in geographical nomenclature, such as "Pologne" for Poland, "Cracovie" for Cracow, and "the province of Oviedo in Asturia" for the province of Oviedo, or, as it was formerly termed, Asturias.

Die Vegetation der Erde. VIII. Grundzüge der Pflanzenverbreitung in Chile. By Dr. Karl Reiche. Pp. xiv+374. (Leipzig: W. Engelmann, 1907.) Price 30 marks.

THE first half-dozen volumes of the series were concerned with European regions, then followed a monograph on West Australia, after which comes the volume under notice. The State of Chile has been frequently visited by explorers, and among the early writings the histories by Padre Ovallo (1646) and von Diego de Rosales (1647) both claim attention for their phytogeographical descriptions. Subsequently the flora of the country has been studied by many scientific men, including Sir William and Sir Joseph Hooker; but to R. A. Philippi and his son must be accredited the first place in the exploration and identification of the botanical resources of the country, while in recent years the author has contributed in no small measure to a better and more accurate knowledge.

Apart from the consideration of characteristic plants arranged according to their orders, ecology is presented under the various aspects of vegetation forms, plant formations, biology and sketches of the vegetation. The latter are too detailed to convey definite impressions to the general botanist, being more suited to the traveller on the spot; but the morphological notes and catalogue of plant forms present a good idea of the most striking features met with in Chilian plants. Many of the parasites are remarkable, such as the species of Phrygilanthus and Cuscuta, and especially the unique *Pilostyles Berterii*, that lives entirely inside its host except when it thrusts out its small flowers; lianes abound, and various other climbing plants, while epiphytes are not so numerous, but the genus Tillandsia is interesting. The remarks on devices for checking transpiration are supplemented by drawings of leaf-sections, and the notes on the biology of the flowers and fruits are attractive. Comparisons are instituted with the floras of California, New Zealand, and the Argentine as a prelude to a discussion of the origin of the flora.

The author deserves a full measure of praise for the excellent and careful manner in which he has summarised the enormous amount of information contained in more than six hundred contributions. Two distribution charts and fifty reproductions of photographs add to the completeness of the work.

From a Hertfordshire Cottage. By W. Beach Thomas. Pp. viii+294. (London: Alston Rivers, Ltd., 1908.) Price 3*s.* 6*d.*

THIS recent addition to the numerous English books dealing with what has come to be known as nature-study is evidently the work of a careful observer of natural phenomena. To a first-hand knowledge of the open-air life of the country Mr. Thomas adds the power of clear and pleasing expression, and his collection of essays deserves to be read widely. The volume is in no sense a text-book; its design is rather to attract attention to the beauties and wonders of familiar natural objects. Some of the essays are sufficient evidence that scientific subjects can be described pleasingly in literary language.

The Open Air. By Richard Jefferies. With illustrations by Ruth Dollman. Pp. xii+234. (London: Chatto and Windus, 1908.) Price 5*s.* net.

ALL lovers of nature know the writings of Richard Jefferies, and admire his power of bringing a breath of country air, as it were, to accompany the reading of his essays. Many nature students, whether they have previously made the author's acquaintance or not, will delight in this volume. Miss Dolman has succeeded by her well-chosen and skilfully executed pictures in adding charm to work which was already beautiful.

School Hygiene. By Robert A. Lyster. Pp. viii+360. (London: W. B. Clive, University Tutorial Press, Ltd., 1908.) Price 3*s.* 6*d.*

THIS book "largely consists of the material of the various courses of lectures to teachers" in the West Riding and Midlands. But the chapters have none of the looseness usually associated with lectures. On the contrary, the book is succinct and well arranged. It incorporates much of the most recent work. It is well adapted for the training of teachers in school hygiene generally, as well as in the special personal hygiene that forms an indispensable preliminary to an effective system of medical inspection of school children.

The Ethics of Nature. By M. Deshumbert. Translated from the French by I. M. Hartmann. With an introduction by Henry James. Pp. 144. (London: D. Nutt, 1908.) Price not stated.

THIS little volume is filled with common-sense teaching. The morality advocated is based upon natural laws, errs rightly on the side of severity, and indicates many conflicts in which the best of men even will find effort enough necessary. Many problems are discussed which have engaged the attention of moralists in every age, and even if they are not solved, the method of dealing with them provides abundant food for thought.

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.]*

Uniformity in Lantern-slides.

IN illustrating a scientific lecture it is important that lantern-slides produced from photographic negatives should be of uniform density, and should well exhibit the details which they are intended to illustrate. To blame the lanternist for faults which are not his own may give relief to the lecturer's feelings of disappointment, but this plan does not conduce to the success of the lecture.

For some time past I have been experimenting on photometric methods of comparing exposures in printing from negatives of widely different density, and I find that if the tests are made with sufficient care the results exhibit a remarkable degree of uniformity.

A simple photometer can be made of a sheet of white cardboard folded into the shape of an isosceles prism or double inclined plane, the faces of which are illuminated by sources of light placed on opposite sides of the prism, the distances of the sources being regulated according to the law of inverse square. Now let two negatives under comparison be placed side by side in front of the two faces, and examined by the transmitted light reflected from the cardboard. Then, when the negatives look to be of the same density, their exposures will be proportional to the illuminations of the faces, and can be easily compared. If the negatives differ in contrast, this difference will be at once evident on adjusting the illuminations, and either the necessary modifications of treatment can be decided on or badly contrasted negatives can be set aside for intensification or omitted from the series. By a method identical in principle with the above I have been successful in testing the development of negatives and in calculating exposures in bromide enlarging. Two negatives exposed in succession with calculated exposures of twenty-five seconds and fifty minutes have given under similar development equally good prints of almost exactly the same darkness.

G. H. BRYAN.

A Probable New Fluting in the Spectrum of Magnesium Oxide.

THERE appears to be a well-marked, though faint, fluting in the spectrum of magnesium oxide which has not been hitherto recorded, consisting of seven principal edges and several fainter lines. No mention of it has been found anywhere, and Prof. Kayser, who has seen a photograph, says that it is unknown. If so, this is probably due to the fact that it would be quite invisible against even a weak continuous spectrum.

The wave-lengths of the principal edges have been determined by comparison with lines of zinc, cadmium, and manganese, and are approximately as follows:—4823, 4819, 4810, 4801, 4791, 4780, 4771. The first of these is very faint, and although almost coincident with the Mn line at 4823, appears to have a slightly greater wave-length, and is probably not due to Mn as impurity. The edge at 4780 is rather diffuse, and two faint lines have been measured between it and 4791. Between 4771 and 4731, five lines have been measured, which may also belong to the system.

The fluting is obviously related to that beginning at 5007; the spacing between the edges is of the same order, and it is only well seen when the latter is very intense. Although first observed about twelve months ago, it was only successfully photographed last February. Some of the negatives also show that the series of faint, fine lines on the less refrangible side of the violet magnesium triplet extends much further into the visible spectrum than catalogued by Eder and Valenta.

E. E. BROOKS.

Leicester Municipal Technical School, June 18.

The Halos round Zircons in Biotite.

WITH reference to the action of radium on glass, and its removal by exposure to sunlight, the following unintentional experiment may possibly be of interest. Many years ago I had a section of a piece of granite prepared, and then another after the stone had been made red hot in an ordinary bright fire.

In the unheated rock the zircons in the brown micas show good halos, and these have not been obliterated by the strong heating. This may be worth mentioning, as the experiment may possibly not have been attempted by anyone else, either from lack of motive or the difficulty of getting a good slice after the rock has been made brittle by the heat.

A. R. HUNT.

Southwood, Torquay, June 20.

LORD KELVIN'S PHILOSOPHY.[1]

Explanation in Terms of Force or of Motion? Action across Empty Space or through a Medium?

ONE of the most interesting and important outcomes of last year's meeting of the British Association at Leicester was the declaration by Lord Kelvin, during a memorable discussion on the constitution of the atom, in Section A, that he had found it necessary to abandon the attempt to contemplate the material universe explicitly in terms of æther and motion, and for his own part preferred to resort to the Boscovich doctrine of centres of force acting on each other according to some curiously complex law, without specific attention to the hypothetical medium in which such forces may exist.

Now undoubtedly these ancient postulates of matter and force represent the dynamical method first made feasible by Newton's achievement in celestial physics, whereby phenomena were correlated by unexplained particles of matter acted upon by unexplained forces, of statical origin and unknown mechanism, according to a specified law of distance. This was how Newton successfully solved the problems of gravitation, and constructed the working theory of astronomy; but it had been hoped, and by some is still hoped, that the time had now come for seeking to represent, in terms of something simpler and more fundamental, the nature of matter and the origin or inner mechanism of its various forces.

The most powerful and hopeful lever wherewith to attack this great philosophical problem was the kinetic theory of elasticity and rigidity, introduced by Lord Kelvin himself. By this means it has been hoped to express force in terms of the still simpler conception of motion; in fact, to explain all the forces with which physicists have to do—electrical and chemical attraction, elasticity, magnetism, cohesion, and perhaps gravitation—in terms of the internal motions of a universally connecting fluid plenum.

But now the question arises, is it at all certain that the material universe can really be understood in terms of motion alone—motion of an all-pervading continuous fluid known as the æther of space? And would such a solution be satisfactory?

To many it has seemed that this reduction to simplicity was the closest approach to ultimate explanation and unification that could be hoped for in the domain of mathematics and physics; and during the last half-century many steps, apparently in the direction of such an achievement, have been taken by the leaders in these branches of human knowledge.

The mathematical foundation was laid by Helmholtz, when he reduced rotational or vortex motion in perfect fluid under the domain of mathematics; it was followed up by Lord Kelvin's kinetic or gyrostatic theory of elasticity and rigidity; so that mathematicians, such as FitzGerald, Heaviside, Larmor,

[1] Being thoughts suggested by the meeting of the Mathematical and Physical Section of the British Association at Leicester in August, 1907; and referred to in Sir Oliver Lodge's recent Presidential Address to the Faraday Society, May 26, 1908.

Hicks, J. J. Thomson, and others, as well as Lord Kelvin himself, have, from various points of view, endeavoured to devise a scheme of spinning motion in a perfect fluid plenum which should be able to accomplish in general terms all that the æther is known to perform: more particularly that it should be able to imitate its faculty of transmitting the transverse or solid quiverings that we call light, yet without resisting the motion of bodies through it; and at the same time that it should be able to maintain its own turbulent or whirlpool motion in an unconfused and regularly stable condition throughout infinite time. And in this difficult undertaking they have from time to time seemed partially successful; at any rate, they have reached suggestive results and opened up stimulating vistas.

The ether must be incompressible, too, being perfectly continuous without breaks or any kind of atomic or granular structure, save such as may be conferred upon it by reason of its infra-material internal motion. An infinitesimally turbulent liquid of some kind seemed the desideratum, and many have been the attempts to devise such a liquid. An interlaced system of vortex fibres or filaments has to some seemed the most likely device; a similar scheme was a system of plates or laminar vortices; while a third modification conceived it as a collection of connected filaments all in a state of rapid internal motion, though stationary as regards locomotion in space;—what might be called a vortex sponge. By some such means it was hoped to be able to combine the elastic rigidity appropriate to a solid, with the penetrable unresistance to motion of solids through it, characteristic of a perfect fluid, and with the complete incompressibility of an ideal liquid. But the mathematical difficulties of all such treatment have been rather overwhelming; and an uncertainty about the stability or permanence of such a medium has always obtruded itself in a discouraging manner.

In fact, there has always been a troublesome amount of instability in all the schemes that have hitherto been devised, so that none of the expounders of the motion doctrine was able to announce a finally satisfactory result.

Still it was felt by most of those who have worked at the subject that the outlook in this direction would be so bright, if initial difficulties could be overcome, that it was worth a long-continued effort to see if a coherent scheme could be planned on these lines, so as to secure what, if it turned out to be the truth, would surely be a magnificent generalisation.

Indeed, it has sometimes seemed unlikely that a mode of explanation which offered such attractive features, and led so far in the right direction, could, after all, be a blind alley leading nowhere; or, to vary the metaphor, a mere will-of-the-wisp which it was waste of time to pursue.

What has certainly been made out is that motion of atomic structures, in an æther with elasticity postulated, supplies a complete working scheme on which we can rest without inquiring further as to the origin of this elasticity. Beyond this, the attempt to explain the material universe on a purely kinetic basis has not made much progress in quite recent years; and, to those competent to attack it, it has probably seemed better to let the problem lie dormant for a time, until future discoveries in mathematics or in physics threw more light upon the rocky path or provided us with better instruments for climbing it.

During the epoch of waiting it now appears that our venerated chief was deflected from further attempts in this direction, and directed his attention elsewhere. Other methods seemed to him more immediately hopeful; and whereas it had been hoped to explain force in terms of latent motion, Lord Kelvin in later years sought to expound motion in terms of force, giving up the kinetic unification of the material universe in favour of a conception more arbitrary and descriptive, and permitting himself to regard force as perhaps an equally fundamental, perhaps a more fundamental, conception than motion.

It may be that philosophers will concede the (to me) somewhat improbable proposition that an explanation in terms of force and action-at-a-distance will be as satisfactory as an elucidation in terms of motion and a continuous medium. To Lord Kelvin it would appear that both solutions were equally satisfactory, and that it was only a question of which was the most tractable. In any case it is noteworthy that he took up so clear and definite a position; it is the key to much of his recent work, and to the difficulties which he felt in accepting some of the hypotheses which are a natural consequence of the electrical theory of matter and of some of the facts of radio-activity. It now seems not unnatural that he should have sought to express and explain these great results otherwise. His attitude is both coherent and reasonable; though I would urge that most theoretical advance and discovery (in the hands of Maxwell and others) has been along the continuous and medium line, which, if not the line of ultimate explanation, is at any rate that of achievement.

At the same time, it must be admitted that, if a longitudinal impulse is transmitted by an incompressible medium at an infinite pace, the process becomes barely distinguishable from action at a distance, through a force varying according to a specified law. Or—putting what is virtually the same thought in another way—the influence of an electron, or matter-unit, whose field of force extends infinitely in all directions, need not be conceived as limited by some arbitrary boundary beyond which things can be said to be at a distance from it.

It will be remembered that some of the old philosophers saw great difficulties in the abstract conception of motion. It appears as a curious evanescent transition from one place to another, involving the attribute of "time"; it is indeed "not a being but a becoming," when position is taken as the primary conception.

But I urge that it is simplest to regard "position" and "distance" as secondary conceptions, subordinate to and arising out of our perception of motion. Unless motion is supposed to be a thing directly apprehended, it is truly rather an elusive idea. To me it seems a direct apprehension—direct information conveyed by our muscular sense. Space itself seems a *consequence* deduced from our perception of motion; and the idea of time follows from our direct perception of *rapidity* of motion. But probably to Lord Kelvin these things appeared otherwise.

The conclusion of the discussion on the constitution of the atom may be summed up thus:—

The internal energy of Lord Kelvin's model atom is static or potential. The internal energy of the hypothetical atom at which others are working is kinetic.

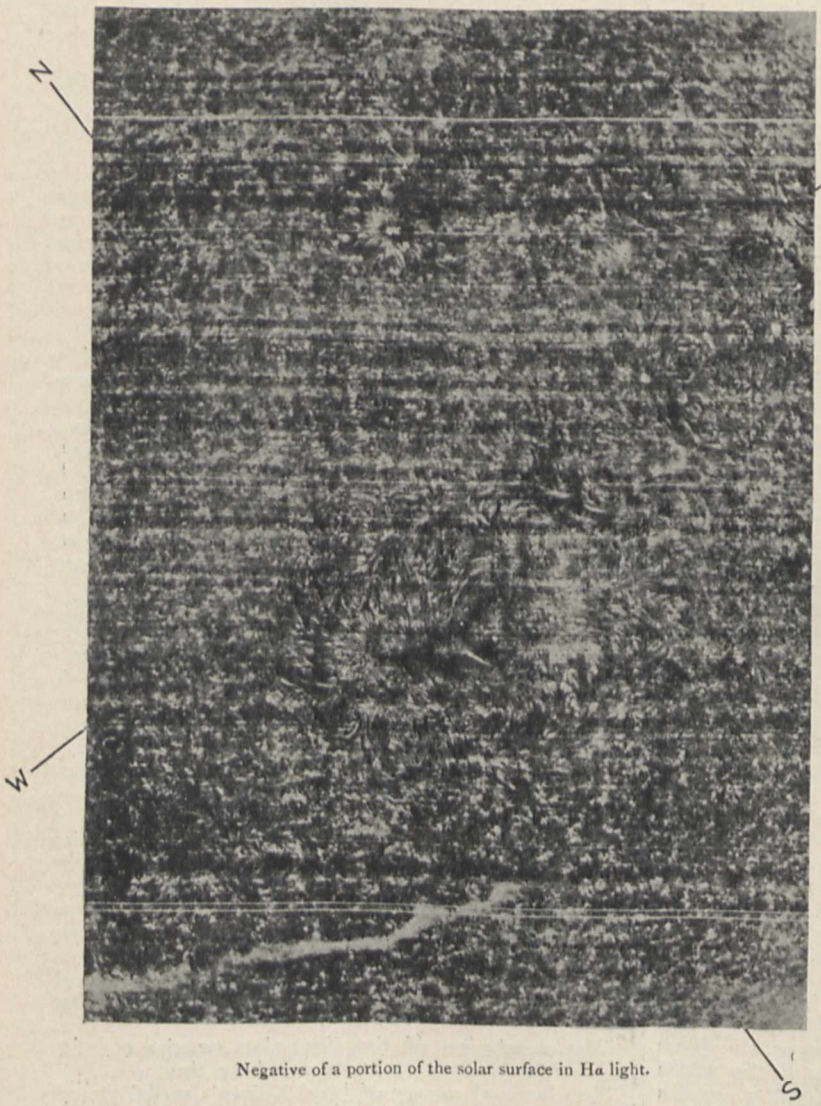
The disintegration of radium in the former case is comparable to the explosion of an unstable chemical compound, like gun-cotton. In the latter case it must be represented by something more akin to the flying to pieces of a single rapidly spinning unit, such as a fly-wheel.

And so for the present the matter stands.

OLIVER LODGE.

RECENT WORK WITH THE SPECTRO-HELIOGRAPH.

PROFS. HALE AND ELLERMAN, of Mount Wilson Solar Observatory, California, enjoying the advantages of a climate almost unrivalled and an instrumental equipment of the highest class, have already given to the world scientific results worthy even of such a combination. In connection with their more recent work we have received several photographs, one of which is reproduced here. Among the photographs are discs of the sun in the light of iron (λ 4045), and an interesting comparison of the solar surface as seen through the calcium line (H_2) and the hydrogen line (Hδ), showing in a striking manner that the regions of maximum radiation of calcium light are regions of absence of hydrogen radiation.



Negative of a portion of the solar surface in Hα light.

In obtaining photographs of hydrogen flocculi, the hydrogen line Hδ has chiefly been used. In March, 1908, it was found possible, by the use of the new "Pan-iso" plates of Wallace, to secure photographs of the sun with Hα. The comparison of the resulting photographs with those taken in Hδ showed bright flocculi peculiar to Hα, and small dark areas appearing solely in Hδ. Using the various hydrogen lines for the photography of the chromosphere and prominences, the greatest intensity and extent were found in the photographs taken with Hα. These qualities decreased through the hydrogen lines Hβ and Hγ until in Hδ only the brightest parts of the prominences were shown. Considering the integrated hydrogen light of the disc, these facts indicate an increase of relative intensity in the Hα line, or, as put in the letter accompanying the photographs, show that "hydrogen appears in contiguous regions on the sun under some of the peculiar conditions which produce differences in the relative intensities of its lines observed in nebulæ and in stars having spectra of the Wolf-Rayet and other special types."

The feature of special interest in the photograph reproduced (which is a negative of part of the solar surface taken in Hα) is the strong suggestion of the existence of vortex systems surrounding the spots. The specially extensive and well-marked phenomena near the centre of the illustration, it is suggested, show that "the prominences surrounding this area . . . are swayed towards the centre, and their appearance strongly suggests the effect of a great whirl rotating clockwise" (*i.e.* N.W.S.E.).

It is to be noticed that the dark hydrogen flocculi appear bright on the negative as reproduced. The photograph was taken on April 30, 1908, 5h. 6m. p.m., Pacific standard time. A direct photograph secured on the same date shows a group of small spots near the centre of this region, while a plate in H_2 light shows a calcium flocculus lying above the spots. Neither of the above photographs affords any evidence of whirl. The remarkable features shown in the illustration are thus apparently confined to the higher regions of the solar atmosphere, and are selectively photographed by making use of the special qualities of the hydrogen line Hα, though the general appearance calls to mind the torn edges of a sun-spot as drawn by Langley.

The picturing by spectroheliographic means of the distribution of radiating matter at various solar levels is already well known. The photograph reproduced illustrates what can be done in quite a new way by using this valuable means of acquiring information about solar circulation.

It may be pointed out in passing that the appearances in the great whirl might be explained equally well, or perhaps even better, from the fining away *outwards* of the hydrogen flocculi, as an anti-clockwise whirl outwards from the centre. Occasionally on photographs in "K" light taken at South Kensington, some suggestions of extensive whirl systems surrounding centres of activity are observed.

The relation of the photography of high-level hydrogen flocculi to the recent work of Hale and Adams on the rotational velocities in various latitudes

is full of promise and interest. It seems clear from the work up to the present that the retarding influence varying with the solar latitude felt by the spots and lower lying vapours is not operative on the high-level hydrogen.

The rainy season at Mount Wilson having ended, hopes are entertained that material for the further study of these extensive vortices may be obtained, and that the theories of Faye and Emden, both of which assign the origin of sun-spots to vortices, may be tested. T. F. C.

AN INVESTIGATION OF THE SOCIOLOGY AND RELIGION OF THE VEDDAS.

THE Veddas have long excited the interest of students, as they are generally believed to represent the aboriginal population of Ceylon, and to have remained at that low level of culture which characterises most of the hunting denizens of tropical jungles. Drs. P. and F. Sarasin first investigated the Veddas nearly twenty years ago, and published their results in an important monograph in 1892, which dealt mainly with the physical characters of the people. They put forward the view that the Veddas are the nearest living representatives of that stock from which the Australians, on the one hand, and the Dravidians, on the other, have diverged, and the term Proto-Dravidian has been applied alike to the Veddas and the race which they represent. Although a fair amount is known about the habits and material culture of these jungle-folk, it was felt that their sociology and religion should be thoroughly studied by a trained investigator before it was too late. The matter was brought before the Ceylon Council in the autumn of last year by the Hon. John Ferguson, C.M.G., and Dr. A. Willey, the director of the Colombo Museum, and a grant was made, which has since been raised to 500*l*., to enable this investigation to be undertaken. Mr. Hugh Clifford, C.M.G., Colonial Secretary of Ceylon, whose interest in the jungle tribes of the Malay Peninsula is so well known, gave the application his warm support.

Dr. C. G. Seligmann was selected to undertake this investigation, for which he was thoroughly qualified by his previous field-work in New Guinea and elsewhere. Dr. Seligmann, accompanied by his wife, arrived in Ceylon in December last, and remained there for five months. During this time only one week was so wet as seriously to interfere with work, and the only real difficulty experienced was to obtain a supply of carriers during the rice harvest, and the period immediately preceding it.

It is, of course, impossible to give even a summary of the results of the expedition until they are published, but the following information will give some idea of the scope of the inquiry. Dr. Seligmann gave most of his attention to the less advanced Veddas, those whom previous writers designate as "jungle-" and "rock-Veddas," but this distinction does not seem to be warranted. The "village" and "coast Veddas" have become so modified by contact and mixture with other races that they do not afford a favourable field for the study of "primitive" conditions. The Veddas are divided into clans, some of which are definitely of inferior status to others, and have to perform certain duties for them; this unexpected circumstance seems to be of old standing. In the majority of communities exogamy is the rule, and with this is associated descent in the female line. In other groups descent is in the male line, and in these cases exogamy no longer exists. Cousin marriages on both sides are the rule, or should be, but the children of two brothers or two sisters may not marry.

The three things that loom largest in the native mind are hunting, honey, and the cult of the dead. The last constitutes almost the whole of the religious life and magical practices of the people; it is the *motif* of almost every dance, and, indeed, Dr. Seligmann is inclined to believe it was originally the source of them all. According to most Veddas, the spirit of every dead man, woman, or child becomes a *yaka* within a few days of death. Some Veddas, however, say that when ordinary persons die they cease utterly, and only a few strong and important men become *yaka*; but in either case the basis of an elaborate system of magic is "possession" by certain *yaka*, who are considered as historical spirits, though little more than their names and, in some instances, their dwelling-places are known. Some *yaka* send success in hunting, and the Seligmanns saw the whole thanksgiving ceremony over a fine buck, in which a ceremonial arrow with a blade more than a foot long and a handle scarcely longer played a prominent part. In some communities the *yaka* beliefs are strongly tinged, if not coloured, throughout by borrowings from what appears to be a simple and probably early form of Hinduism. Dr. Seligmann could not with certainty find any magical practices that were not based on communion with the friendly dead, except those which appear to have been borrowed from the Sinhalese. It is accordingly not surprising that it is generally considered necessary to present an offering to those recently deceased. This must consist of cooked rice and coco-nut scrapings; this food is difficult for them to get, but every Vedda esteems it above all other. The "shaman," called *kapurale* or *dugganawa*, calls upon the *yaka* of the recently deceased man to come and take the offering. The *kapurale* becomes possessed by the *yaka*, who, speaking through the former in hoarse, guttural accents, states that he approves of the offering and will assist his kinsfolk in hunting, often, indeed, indicating the direction in which the next hunting party should go. This is the simplest form of death ceremony, but besides the *ne yaku*, as the spirits of the dead are called, other *yaku* are invoked in most communities. Many generations ago there lived a Vedda, a mighty hunter named Kande, who on his death became Kande Yaka, and who is constantly invoked to grant success in hunting. The majority of Veddas believe that the *ne yaku* go to Kande and become in some sense his attendants. Now Kande Yaka is usually invoked at the beginning of the *ne yaku* ceremony, and in more than one community it was pointed out that the *ne yaku* would not come to the offering unless accompanied by Kande Yaka, who was sometimes spoken of as bringing them.

The mental characteristics of these jungle-folk appear extraordinary to one conversant with Melanesians, since they are really intelligent, and, when cross-examined, are equal to a sustained mental effort that would be beyond the possibility of the brainiest Papuan. The only examples of decorative art are rough rock-paintings in caves, and the village Veddas are incapable even of this slight proficiency in pictorial art. Personal adornment is of the slightest. The absence of tales and legends is almost unbelievable. Dr. Seligmann inquired on this matter of almost every elderly and not too civilised Vedda, and he obtained merely some thirty lines of bald statements which can scarcely be dignified by the name of legends.

Readers of NATURE will remember that their attention was directed to the recent discovery of stone implements in Ceylon, many chippings and implements

having been excavated from Vedda caves. Dr. Seligmann has made collections of these, but in one cave which he excavated, out of some three hundred pieces of quartz about four per cent. presented definite appearances of having been worked. That particular cave had Sinhalese carving and stone masonry in and around it. Indeed, he has evidence that the Sinhalese were associated with so-called Vedda caves about the beginning of the Christian era. It seems that even among the "wild Veddas" there has been a much older and more intimate cultural connection with the Sinhalese than the literature of the subject would lead one to suspect.

Dr. Seligmann took a large number of photographs, many of which are very successful, but unfortunately the photographs of the dances of the least sophisticated community are not so satisfactory, as these Veddas would dance only in their usual dancing places, which are deep in the forest, where instantaneous work was practically impossible. A number of plates of the new colour process were taken out, but the results were not very satisfactory. A very complete series of phonograph records of songs were obtained, from lullabies to invocations to the dead. The great achievement of securing the songs of the women was due to the presence and cooperation of Mrs. Seligmann. An unexpected experience in working with the phonograph was its enormous popularity, not simply amazement or wonder, but sheer delight in it.

Many ethnologists have felt how desirable it is that trained women should make investigations in the field, since it was realised that information obtained by men, through men, about the practices and ideas of native women must necessarily be imperfect and biassed. The present expedition has conclusively proved the truth of this; indeed, the mere presence of a woman gave these shy and extremely jealous people such confidence that the Seligmanns were allowed to make their camps close to the Vedda caves. One of the groups of the "wildest" Veddas invited them to share the cave in which the whole community, including the girls and young unmarried women, were living; a surprising offer, as Neville, the most sympathetic of recent observers of the Veddas, records how, as a sign of extreme amity and confidence, he was once allowed to spend a few minutes in the company of the younger women of a community to whom he was well known. It is thus no exaggeration to say that had not Mrs. Seligmann accompanied her husband in this arduous expedition, the results would have been less numerous and important.

A. C. HADDON.

NOTES.

THE list of honours issued on the occasion of His Majesty's birthday includes the names of a few men distinguished for their work in pure or applied science. Baronetcies have been conferred upon Sir T. Lauder Brunton, F.R.S., and Dr. W. Watson Cheyne, C.B., F.R.S. The honour of knighthood has been conferred upon Prof. A. G. Greenhill, F.R.S., Colonel David Bruce, C.B., F.R.S., and Mr. R. A. Hadfield, president of the Iron and Steel Institute last year. Mr. W. H. Power, F.R.S., has been promoted to the rank of K.C.B., Dr. T. H. Holland, F.R.S., has been appointed a Knight Commander of the Order of the Indian Empire (K.C.I.E.), Dr. A. G. Bourne, F.R.S., a Companion of the same Order (C.I.E.), and Dr. W. F. King, chief astronomer, Department of the Interior, Canada, a Companion of the Order of St. Michael and St. George (C.M.G.). Dr. Henry Jackson, regius professor of Greek, Cambridge, is appointed to the Order of Merit, which was designed "to include British subjects who have won conspicuous distinction in the naval and military services, or in letters, art, and science." Perhaps Prof. Jackson's claims to this honour may be understood at Cambridge.

SOME reference has been made in the daily papers to the ratio of honours awarded to naval and military men, the suggestion being that the Army receives an undue share of these distinctions. With the demands of the two services for recognition we are not concerned, but the question induces us to ask what ratio exists between the award of honours to men who devote their lives to work which promotes the scientific progress of the country and those who do not? As to the relative value to the nation of scientific and party-political work there can be no two opinions; and statesmen themselves, especially when out of office, are ever ready to acknowledge the important part which scientific knowledge plays in national greatness and development. Judging from their utterances, science should be cherished above all things by the nation which desires to secure advancement; but while it is thus honoured in the abstract, it gives place to party politics when rewards for national service are being distributed. Probably the reason is that the ministers and officials who are chiefly concerned with the affairs of State and Court live in a world in which science and the results of science are almost unknown. This is really the characteristic of the official mind in England. For instance, the Court newsman in his official report of the King's garden-party states that invitations were issued to "representatives of the musical, dramatic, and literary professions." It is a striking illustration of the state of the official mind that representatives of the musical and dramatic professions should be referred to as having been invited to meet their Majesties, while science was not mentioned.

AS we went to press yesterday, July 1, the Linnean Society celebrated the fiftieth anniversary of the reading of the joint paper on natural selection by Charles Darwin and Alfred Russel Wallace. At the afternoon meeting a medal, specially struck for the occasion, was presented to Dr. Alfred Russel Wallace, Sir Joseph Dalton Hooker, Prof. Ernst Haeckel, Prof. Eduard Strasburger, Prof. August Weismann, Dr. Francis Galton, and Sir E. Ray Lankester. At the same meeting congratulatory addresses were received from British universities and British and foreign societies and academies. About a hundred of the fellows and guests of the society dined together at the Princes' Restaurant at 6.30, and later in the evening a reception was held at the rooms of the society. We hope to give a full account of the proceedings in our next issue.

M. HENRI BECQUEREL has been elected permanent secretary of the Paris Academy of Sciences for the physical sciences.

PROF. H. H. TURNER, F.R.S., has been elected correspondant of the Paris Academy of Sciences in the section of astronomy in succession to the late Prof. Vogel.

THE death is announced, at Paris, of Dr. Luiz Cruls, director of the Observatory of Rio de Janeiro.

THE annual exhibition of antiquities, from excavations in Upper Egypt during the past season, was opened at the Institute of Archæology, University of Liverpool, on Monday, June 29, and will remain open until Thursday, July 9.

THE Physico-medical Society of Vienna has made the following appointments in connection with the celebration of the centenary of the foundation of the society:—*Honorary Ph.D.*, Sir Victor Horsley, F.R.S.; *corresponding members*, Prof. J. Loeb, Dr. C. S. Minot, Prof. E. Rutherford, F.R.S., and Prof. C. S. Sherrington, F.R.S.

THE council of the Royal Society of Edinburgh has awarded the Neill prize for the triennial period 1904–7 to Mr. Frank J. Cole, lecturer on zoology, University College, Reading, for his papers entitled "A Monograph on the General Morphology of the Myxinoid Fishes, based on a Study of Myxine," published in the Transactions of the society, regard being also paid to Mr. Cole's other valuable contributions to the anatomy and morphology of fishes.

ON July 2, 3, and 4 there will be on exhibition at the Royal College of Surgeons, Lincoln's Inn Fields, W.C., a very remarkable collection of specimens illustrating the diseases, injuries, and racial peculiarities of the ancient inhabitants of Nubia. The collection was made during the archæological survey of the area which will be submerged on raising the level of the Aswan dam. The collection embraces specimens derived from cemeteries, to which Dr. G. A. Reisner has assigned dates ranging from a pre-dynastic to an early Christian period. The collection has been described and arranged under the direction of Prof. Elliot Smith, F.R.S., and Dr. Wood Jones. A report of the first results of the archæological survey of Nubia was recently published (Bulletin No. 1, Cairo, 1908), with an introduction by Captain H. G. Lyons, F.R.S.

THE fifth congress of the International Association for Testing Materials is to be held at the beginning of September, 1909, in Copenhagen, when numerous questions in connection with the testing of metals, hydraulic cements, and miscellaneous materials will be considered, and many other important technical problems will be discussed. To maintain closer contact with the members of the association in the intervals between the congresses, the council has decided to publish from time to time Proceedings of the association. Two numbers have appeared already, and the new periodical will certainly keep members informed of what is being done in the subject in which they are interested. Copies of the Proceedings may be obtained in this country from Messrs. E. and F. Spon. The price of each issue is, to non-members, sixpence.

To mark the completion of the fiftieth year of the existence of the Geologists' Association in November next, it is proposed to issue a volume dealing with the geology of the districts of England and Wales visited by the association since its foundation. The volume will consist of a series of articles by competent authorities on the various localities visited, who will deal with the geology of their district from the point of view of present-day knowledge. The book will be edited by Messrs. H. W. Monckton and R. S. Herries, be illustrated with maps and sections, and probably be ready for publication before the end of the year. We notice that the next long excursion of the association is to be to the Berwyns, from July 31 to August 7, under the directorship of Mr. J. Lomas. The headquarters of the party will be at the Wynnstay Hotel, Oswestry, and persons wishing to take part in the excursion are requested to write to Mr. H. Kidner, excursion secretary, 78 Gladstone Road, Watford.

WE learn from *Science* that an expedition, under the combined auspices of the American Museum of Natural History and the Geological Survey of Canada, is now on its way to the mouth of the Mackenzie River and adjacent country to collect ethnological and zoological material. The party is being conducted by Mr. V. Stefánsson, who is well acquainted with the Eskimos of the region, having wintered with them in 1906, and Mr. R. M. Anderson, a well-known naturalist. The expedition was organised for the purpose of making scientific studies of the Eskimos of the country, of procuring collections illustrating, not only the material cultures of the uncivilised tribes of the region, but also of the zoological conditions which prevail there, and of increasing our knowledge of the geology of the region. The expedition will commence its return journey during the summer of 1909.

THE annual general meeting of the Royal Society of Arts was held on June 24, Sir Steuart Colvin Bayley, K.C.S.I., chairman of council, in the chair. The business of the meeting was the reading the report of the council on the work of the society during the past session, the 154th since the formation of the society in 1754. In referring to the award of the Albert medal to Sir James Dewar for his low-temperature investigations, special stress was laid on the power placed at the disposal of those interested in industrial applications of science by the provision of temperatures so far below any hitherto available, and it was suggested that before long this new power would find numerous practical applications. Amongst the lectures delivered under the various trusts available for such purposes, the course of lectures on industrial hygiene, provided out of funds left some years ago to the society by Mr. Benjamin Shaw, was one of the most important. The award of a medal, under the same trust, to Prof. W. Galloway, for his researches into the action of coal dust in colliery explosions, was also recorded.

THE third international congress on the history of religions will be held at Oxford from September 15–18 next. Prof. E. B. Tylor, F.R.S., is the honorary president, Sir A. C. Lyall the president, and Prof. Percy Gardner the chairman of the local committee. The business of the congress will be conducted in nine sections, and there will be general meetings for papers and lectures of wide importance, as well as meetings of sections. In addition to the addresses by the president and by the presidents of sections, numerous important papers will be read. Among these may be mentioned that of Dr. A. J. Evans, on Cretan religions; M. E. Fourrière, on "le culte du soleil et les sacrifices humains chez les Grecs"; Miss Mary A. Owen, on the Messiah beliefs of the American Indians; Prof. A. H. Sayce, on the influence of Babylonian religion upon Asia Minor and Syria; Mr. W. W. Skeat, concerning Malay religion; and Dr. E. Wallis Budge, on some central African elements in the dynastic religion of Egypt. English, French, German, and Italian will be recognised as official languages. Representatives have been appointed already from many British and foreign universities and learned societies. Offers of papers should be sent to the honorary secretaries, Dr. J. Estlin Carpenter, 109 Banbury Road, Oxford, and Dr. L. R. Farnell, 191 Woodstock Road, Oxford.

THE report of the Rugby School Natural History Society for 1907 appears in an abbreviated form owing to the omission of the reports of the papers read, which are issued in a local journal. Steps have been taken during the year to bring the observing station up to the requirements of the Meteorological Office, and it is hoped that when the next report appears the station will have been re-accorded official recognition.

THE contents of the May number of the *Victorian Naturalist* include several papers on the local bird-fauna, one of these being illustrated with an excellent reproduction of a photograph of a black-winged gannet colony. In the course of the same paper it is mentioned that the eggs of the short-tailed petrel, or "mutton-bird" (*Puffinus tenuirostris*), are extensively used as an article of diet by the islanders in Bass Strait, and are of excellent flavour.

THE second fasciculus of vol. xxxvii. of *Travaux de la Soc. Imp. des Naturalistes de St. Pétersbourg* is devoted to the (mainly invertebrate) fauna of Turkestan, sections of which are described by specialists. An amphipod from the Issik Kul is made the type of a genus under the somewhat barbarous title of Issykogamarus. Of more general interest is an illustrated account, by Mr. V. A. Faussek, on the minatory attitude assumed by the Russian tarantula (*Trochosa singoriensis*), forming part of a paper on threatening postures in animals generally. The spider in question, which has a dark-coloured body with limbs marked by bold bands of black and yellow, is represented in a coloured plate both in its normal posture and in the threatening attitude, when the body is raised nearly vertically with the limbs extended in a radiating manner.

FOUR out of the five articles forming the combined first and second parts of vol. xxxviii. of the *Morphologisches Jahrbuch* are devoted to the anatomy of mammals, and of these four three relate to the hind-limb. The longest, and perhaps most important, is a paper by Mr. E. Loth, of Warsaw, on the morphology of the plantar aponeurosis in the Primates, in the course of which it is shown that the different types displayed by this structure accord well in the matter of their inter-relationships with the generally accepted classification of the order. In the second paper Mr. E. Glaesmer discusses the flexor muscles of the lower part of the leg and foot, while in the third Mr. G. P. Frets records the variations observable in the peroneal muscles. The sulci in the brain of the cat, and their individual variation, form the subject of the fourth paper, by Mr. E. Landau, of Dorpat, a large number of examples of the brain being figured.

AMONG several papers published in various Argentine journals, of which we have received separate copies from the author, Prof. Angel Gallardo, special attention may be directed to one published in vol. xvi. of the *Anales* of the National Museum of Buenos Aires on a remarkable case of mimicry in a caterpillar. The caterpillar, which is rather more than 4 inches in length, is the larva of *Dilophonota lassauxi*, and feeds on *Araujia sericifera*, to the stem and leaves of which it presents a most striking resemblance, both as regards form and colouring, as is shown by a coloured illustration. Pale blue in colour, with three longitudinal stripes of fawn, this caterpillar has two of the anterior segments of the thorax transversely enlarged in such a manner that they closely simulate the nodes of the food-plant. The most remarkable feature in the resemblance is, however, the development of a pair of white knobs on the second of these enlarged rings exactly matching the white knobs on the nodes of the plant, which mark the points of attachment of fallen leaves. The mimicry is one of the most remarkable that has ever come under our notice.

AN important contribution to embryology is made by Mr. B. M. Davis in his account of the early life-history of *Dolichoglossus pusillus* (a relative of Balanoglossus, and therefore a representative of the Enteropneusta), issued as vol. iv., No. 3, of the Zoological Publications of California University. The creature, which is of a brilliant orange colour, burrows in the mud on various parts of the Californian coasts, and deposits its eggs on one side of the burrow, as is shown in a coloured plate accompanying the memoir. Its breeding-places at San Pedro were recently destroyed, but the author of the paper was fortunate enough to obtain specimens of the eggs at San Diego Bay. The acquisition of these was of the greatest importance, since the only accounts—by Dr. W. Bateson—of the development of the Enteropneusta previously published are incomplete so far as the early stages are concerned. It will be remembered that certain points of resemblance between Balanoglossus and the lancelet were indicated by Dr. Bateson, and from these resemblances it has been argued that the body-cavities of these two organisms have a similar origin. Certain difficulties have, however, been expressed with regard to the acceptance of this view, and the author of the present paper points out that, if his own interpretations be correct, these difficulties are now converted into impossibilities.

ACCORDING to a note in the Journal of the Royal Society of Arts, the people of Baltimore seem to have been successful in their warfare with the mosquito. In December, 1906, an ordinance was passed by the City Council, and the sum of 2000*l.* appropriated by it, for the purpose of taking measures to exterminate the insect. The first step taken was a distribution by the police to householders of a notice setting forth the provisions of the law requiring all the cisterns, tanks, and wells to be covered with wire gauze; all pools, ponds, fountains, or other water receptacles not containing fish to be screened or covered with crude petroleum; forbidding any water to remain in any receptacle whatsoever; requiring all privy walls to be covered thoroughly with kerosene every fifteen days; and that water be turned off, and water receptacles emptied, should a house be unoccupied for more than five days. Dr. C. M. Hill, who had charge of the work, brought the matter forcibly before the public by delivering lectures explaining the mode of mosquito extermination, and cards were displayed in the tramcars directing the attention of householders to the importance of their co-operation in the work. Reporting upon the experiment, Mr. Consul Fraser says the result of it is satisfactory, and the City Council has appropriated another 1000*l.* for continuance of the work in 1908. The mosquito has hitherto been the cause of much illness and death in Baltimore.

INFORMATION regarding another new rubber plant is collated by Dr. O. Stapf in the *Kew Bulletin* (No. 5). The plant, discovered in Portuguese West Africa, receives the name of *Raphionacme utilis*—Raphionacme being a genus of the order Asclepiadaceæ—and is known in the country of origin as "ecanda" or "marianga." It is peculiar in producing a short herbaceous stem, while the latex is obtained from the tuberous root, that may attain a diameter of 5 inches. There is at present no prospect of extracting the rubber with profit.

ALTHOUGH there has been a notable introduction of new species of Primula within recent years from western China, an additional list, remarkable not only for the number of species, but also for the striking characters of certain of the plants, is chronicled by Mr. Forrest in the Notes from the Royal Botanic Gardens, Edinburgh (April). The species of Primulaceæ there described were collected in western Yunnan and eastern Tibet; they include fifteen new species of the genus, also a few species of Androsace and

Lysimachia. The species Littoniana, falling in the section Capitatæ, produces a deep spike of crowded flowers, in which the red calyces of the buds form a strong contrast to the deep purple expanded flowers. *Primula Forrestii* bears numerous flowers of a deep orange colour, and, judging from the root-stocks, continues to grow for fifty years or longer. Three of the four known species of the unique section Omphalogramma—taking their name from the oval, flattened shape of the seed—are recorded. The list is distinctly one that horticulturists will do well to examine.

THE heredity of hair in man forms the subject of an article by Gertrude and Charles Davenport in the May issue of the *American Naturalist*. Starting with the assumption that the straight, cylindrical (Mongolian) type of hair, as agreeing with that of mammals generally, is more primitive than the frizzly, compressed type characteristic of negroes, the authors discuss the Mendelian relations of these and the intermediate wavy and curly types. The results suggest that straight hair is recessive to the frizzly type, although the latter may in some instances fail to dominate. Further, wavy hair is usually, if not invariably, a heterozygous type, and not recessive to a higher (curly) and dominant over a lower (straight) stage. The paper concludes with a summary of the colour of the eyes and hair in the children of parents who are similar or dissimilar in these respects.

IN the June number of *Man* Prof. Dubois discusses Mr. J. Gray's investigations on pigmentation by the use of his newly modified Lovibond's tintometer. He accepts the suggestion that hair contains two coloured pigments, orange and black, the black pigment increasing uniformly in amount from blonde to black, the orange pigment remaining practically constant in that hair series. In the red-hair group, on the contrary, the orange pigment is predominant, its increasing amount causing the coloration from light to dark red. Finally, red hair is derived from dark hair by the conversion of more or less of the dark pigment into an equal amount of the orange. This last group, for which he suggests the name pyrrhotism (*pyrrhos* = foxy-red), he considers to result from an easily occurring chemical modification of the melanochrome into pyrrhochrome pigments. But the observed facts are inconsistent with the view of Topinard and others, that redhairedness may be regarded as having the character of a variety of atavistic origin.

IN a short article published in NATURE last March (vol. lxxvii., p. 465), attention was directed to the interesting results in reference to the chemistry of Egyptian mummies which had been elucidated by the recent work of Dr. W. A. Schmidt. His conclusions, however, do not seem to have met with universal acceptance, and Mr. F. Lucas has in particular questioned one of them (*Cairo Scientific Journal*, vol. ii., April), namely, that relating to the composition of the bath in which the ancient dead were soaked. According to Schmidt, the "natrum" bath of Herodotus consisted mainly of common salt, and not of "natrum" or crude Egyptian sodium carbonate, which is found encrusted on the bottom and sides of certain lakes in the land of the Pharaohs; if natrum was used at all, it was employed for stuffing the mummy after the pickling bath of brine. Mr. Lucas believes, on the other hand, that "natrum" was actually used in the bath, though in some cases it was applied in solid form, and that the use of common salt was not introduced until the beginning of the Christian era.

MRS. ANDREW JOHNSON sends us a diagram of a curious ring around the moon observed by her at Arundel on June 11, at 10 p.m., that is, three days before full moon. The ring was not a complete circle, but segment-shaped, corresponding to the phase of the moon at the time. Two mock moons seen respectively to the east and west of the moon itself, and a second halo touching the chord of the segment, were also similarly shaped. The diagram is unsuitable for reproduction, but the distortion of the halo and mock-moons represented by it is of noteworthy interest.

THE results of the meteorological observations on the summit of the Sonnblick (3105 metres) for the year 1907 give the mean temperature of January as 4°·6 F., of July as 30°·2; the absolute maximum was 49°·5, in August, and the minimum −18°·2, in January. The precipitation was equivalent to 65·8 inches, in 241 days, of which 5·6 inches fell as rain between May and September. Fog was observed every month, the total number of days being 262; it was least frequent in November, eleven days. The report contains particulars of several other mountain stations, including an interesting account of the Etna Observatory (2950 metres), with a photographic illustration of the volcano as seen from Catania.

AMONG the various useful articles in the Journal of the Meteorological Society of Japan for January–April (abstracts of which are now given in English), we may mention:—(1) relation between climate and tobacco cultivation, by K. Asakura, and (2) climate and rice crops, by H. Ogiwara, containing interesting particulars of the influence of rainfall and temperature on different stages of the growth of these crops; (3) a summary of the temperature and rainfall observations made during the last three years at stations in south China, by M. Ishida. The tables show that the climate there is not far different from that of the western part of Japan, except that the absolute maximum temperature in south China is more extreme, reaching at times 102°. The Yang-tse-kiang has a great influence in moderating the continental climate. Particulars are given in the April number of the journal of a new system of storm signals introduced in Japan on April 1, showing, during the day time, by means of drums, cones, and balls, the position of the storm centre, its direction of motion, speed, and other details. During the night time lights are displayed, indicating only the position of the storm centre.

THE Sierra Club Bulletin (January) contains an article by Mr. G. K. Gilbert on "Lake Ramparts." Special attention is directed to the lake ramparts in the sierra of southern Utah, and the influence of glacial action in their formation is discussed. The absence of ramparts in the lake basins forms the basis of the theory that some force has been exerted to move the boulders to their present positions on the shores. The nature of this moving agency is discussed, the suggestion that the work was carried out by aboriginal inhabitants of the country being dismissed as improbable. The theory which adopts ice as the moving force is supported by the fact that ramparts are found only in cold countries. Mr. Gilbert illustrates this theory by means of sections of sheet-ice, showing modes of cracking and the effects of thrust on the shores, and explains how this action may have transferred the boulders from the lake basins to the shores.

THE Berlin Gesellschaft für Erdkunde has issued a bibliography of geographical literature published during

the year 1904, compiled by Dr. Otto Baschin, and published under the title of "Bibliotheca Geographica" by Mr. W. H. Kühl, of Berlin. The works are arranged according to subjects included under the two main divisions of general geography and special geography, the latter being subdivided under headings dealing with different countries. In the various subdivisions the works dealt with are classified under the names of the authors, and include publications in several languages.

In an article in the *Cairo Scientific Journal* for March Captain H. G. Lyons, F.R.S., deals with "Some Unsolved Problems of the Nile Basin." Exploration in this region by geographical pioneers has extended our knowledge of its main features, but detailed surveying is needed, especially on the northern margin of the equatorial plateau and of the Abyssinian tableland. In the field of geology Captain Lyons gives a sketch of the history of the Nile Valley, and comments on the secular rise of the lower valley and its future effects on Middle Egypt. Observations are required of the underground water table, its seasonal movement, and level with reference to the river. No definite information can be obtained of the coal or other minerals of commercial value until the early geological history of north-east Africa is better known. The great meteorological problem to be solved is that of the monsoon rains of Abyssinia and the Sudan. The development of rains in equatorial regions, snowfall on the Himalayas, and high-pressure conditions in North Africa are some of the influences to be studied as possibly affecting the Abyssinian rains. Historically, the question of the change of climate in North Africa is of great interest, although other causes should be considered simultaneously in accounting for the decay of the flourishing settlements which once existed in this region. Referring to the oases of North Africa, Captain Lyons reviews briefly the evidence of underground water in the desert, and states the problems of its supply and connection with the Nile.

A good illustration of the power of the weapon which the discovery of the Röntgen rays has placed in the hands of the medical profession is afforded by an article entitled "A Study of Constipation by Means of the X-rays," by Dr. A. F. Hertz, of Guy's Hospital, which appears in the June number of the *Archives of the Röntgen Ray*. After a dose of a bismuth salt has been administered to a patient it is possible to follow by Röntgen-ray photography the passage of the food through the œsophagus, stomach, and intestines, and thus determine the position, and in some cases the nature, of any obstruction which may be present.

The *Physikalische Zeitschrift* for June 15 contains a translation of a paper by Mr. O. M. Corbino, of the University of Messina, on an arrangement for producing almost constant direct currents of high potential. It consists of an induction coil capable of giving a spark of a few centimetres the primary current of which is supplied through a Wehnelt interruptor having a very small anode. The secondary is connected to the terminals of a condenser of a few micro-farads capacity which has a resistance of about 20,000 ohms in parallel with it. Between one terminal of the coil and the corresponding terminal of the condenser a spark gap of 2 mm. is inserted. In these circumstances a direct current of about 30 milliamperes flows through the 20,000 ohms, and its magnitude seems to be little influenced by change of value of the resistance.

We have received a copy of a new quarterly journal published by the Institution of the Post Office Electrical Engineers, and entitled the *Post Office Electrical Engineers' Journal*. The new journal is chiefly devoted to technical matters of interest to Post Office engineers, the articles in the first number dealing with various telegraphic and telephonic subjects. Doubtless sufficient scope exists for such a paper amongst the large staff engaged at home and in the colonies, and if future numbers fulfil the promise of the first, it should go a long way to promote the spirit of fellowship and feeling of common interest which is one of the main reasons for its inception. It is to be hoped the editors will not be led to step outside the legitimate limits of such a more or less private journal by attempting to make it the receptacle for much original research, and thus adding one more to the already excessive number of journals which the electrical engineer must consult. The lighter and social sides also find adequate treatment in the present number, the contributions being in both prose and verse. We wish the new publication all success.

A well-known experiment in physics is to freeze water by placing under the receiver of an air-pump some water in a shallow dish supported above a large dish containing sulphuric acid. Upon exhausting the receiver, evaporation rapidly takes place and the vapour is absorbed by the acid, with the result that the temperature of the water may be reduced to freezing point. We have recently had an opportunity of seeing the Raplin Hand Ice Machine, made by the Pulsometer Engineering Co., in which this principle is put to commercial use. The apparatus consists of a large bottle containing the sulphuric acid, and connected with the air-pump and a carafe or an ice-mould by means of pipes. A wheel turned by hand serves to actuate the pump, which reduces the pressure and also rocks the acid-container, so that the acid is splashed thoroughly and the absorption of the vapour by it is thus facilitated. In three or four minutes a carafe of ice-cold water can be produced, and a block of ice weighing about 1 lb. in twenty minutes. Half a gallon of acid constitutes a complete charge, and will serve to cool from fifty to one hundred carafes of water to freezing. The machine provides an interesting and handy means of reducing temperature by rapid evaporation.

The Select Committee of the House of Commons on the question of proposed daylight saving legislation has now completed its inquiry, and agreed upon its report. The report is understood to be favourable to the principle of the Bill introduced earlier in the session on the subject by Mr. Robert Pearce. The committee is in favour of the introduction of a Bill to achieve the object in view by an alteration of clocks to the extent of one hour at 2 a.m. on the third Sunday in April and by an hour's alteration in the opposite direction on the morning of the third Sunday in September.

A very useful classified list of Smithsonian publications available for distribution has been published by the Smithsonian Institution of Washington. The volumes and pamphlets are arranged conveniently according to subjects. Applicants for these publications must state the ground of their requests, as the institution is able to supply papers only as an aid to the research or study in which the applicant is especially interested. The volumes of contributions and of miscellaneous collections are distributed only to public libraries and to learned societies. Unfortunately, we have no agency in this country which is in a position to aid the spread of scientific knowledge in a similar way and on the same generous scale as the Smithsonian Institution.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JULY:—

July 4. Opposition of Juno.
7. Uranus in opposition to the Sun.
,, Saturn. Outer minor axis of outer ring = 5″·68.
9. 12h. 57m. Minimum of Algol (β Persei).
12. 9h. 46m. ,, ,, ,,
16. 10h. 59m. to 12h. 3m. Moon occults 7^2 Aquarii (mag. 4·3).
18. 16h. 11m. Saturn in conjunction with Moon. Saturn 3° 2′ N.
22. 16h. 35m. Western elongation of Saturn's Satellite Titan.
25. 10h. Mercury at greatest elongation, 19° 50′ W.
27–31. Epoch of the Aquarid and early-Perseid meteors.
29. 15h. Vesta 0° 1′ S. of Moon.
,, Venus. Illuminated portion of the disc = 0·153.
30. 16h. Eastern elongation of Saturn's Satellite Titan.

A BRIGHT METEOR.—A magnificent meteor, with a long path and very slow motion, was observed on June 28 11h. 12m. by Mr. Denning at Bristol, and by the Rev. John Brown at Brighton. At Bristol, the apparent course was recorded as from 276°+23° to 1°+48½°, while at Brighton the object passed just under the stars β and γ of Ursa Major, and just above Cor Caroli, the direction being from β Scorpii.

Mr. Denning has investigated the real path, and found the heights eighty-seven to fifty-four miles over Dorchester, Dorset, to Kineton, Warwick. Length of observed flight 123 miles, and velocity 17½ miles per second. Radiant point 240°−20°, and about 10° W. of the usual radiant of the June shower of Scorpiid fireballs. The meteor had a bright train of sparks, and sailed along a considerable arc (70°), the duration at Bristol being estimated as seven seconds and at Brighton six to eight seconds.

COMPUTED MAGNITUDES FOR HALLEY'S COMET BEFORE PERIHELION.—In No. 4254 of the *Astronomische Nachrichten* (p. 99, June 13) Prof. J. Holetschek discusses the probable magnitudes of Halley's comet during the two oppositions which are to come before it arrives at perihelion. Monthly ephemerides show the probable positions of the comet for October, 1908, to March, 1909, according to the assumptions that perihelion passage will take place on May 16, 1910, thirty days earlier or thirty days later, and the geocentric and heliocentric distances are also shown. Then follows the table giving the probable magnitudes for the same period, and also for September and October, 1909. From this we see that for October 2, 1908, the probable magnitude is 18·2, the comet increasing in brightness until, on October 2, 1909, its magnitude should be 14·6.

THE REVISED HARVARD PHOTOMETRY.—We have just received a copy of vol. l. of the Annals of the Astronomical Observatory of Harvard College, in which is published the revised Harvard photometry. This comprises a catalogue of the positions, photometric magnitudes, and spectra of the 9110 stars, mainly of magnitude 6·50 and brighter, which were observed with the 2-inch and 4-inch meridian photometers, in all parts of the sky, during the years 1879 to 1906. Some idea of the magnitude of the work may be gathered from the fact that the observations involved a total number of 1,082,060 photometric settings. In the catalogue itself the stars are given consecutive numbers, and are arranged in order of R.A. as usual. Then follows the designation for each star in other catalogues, the position for 1900, the magnitude, the residuals, and the combination of letters and figures which denotes the spectral type. It is proposed by Prof. Pickering that the abbreviation H.R. shall be used when referring to a star's designation in the present catalogue. Several pages of "remarks" which follow the catalogue proper give valuable notes concerning stars which are in any way peculiar.

THE PARALLAXES OF NEBULÆ.—From a re-discussion of Prof. Wilsing's results for the parallaxes of the two nebulæ G.C. 4964 and N.G.C. 7027, Herr Einar Huss, of Stockholm, derives new definitive values which, in each case, show a reduction of the negative values obtained by Prof. Wilsing. For G.C. 4964 the latter observer found the parallax $-0''{\cdot}083 \pm 0''{\cdot}025$, whereas Herr Huss derives the value $-0''{\cdot}063 \pm 0''{\cdot}050$; for N.G.C. 7027 the respective values are $-0''{\cdot}172 \pm 0''{\cdot}068$ and $-0''{\cdot}119 \pm 0''{\cdot}021$. Taking into account the facts that the observations were made at about the same epoch, and that the objects are in the same part of the sky, Herr Huss considers that there is evidence that, of the two, the nebula N.G.C. 7027 is the more remote (*Astronomische Nachrichten*, No. 4254, p. 96).

OCCULTATION OF JUPITER'S SATELLITE II. BY SATELLITE I. In No. 4255 of the *Astronomische Nachrichten* (p. 119, June 18) Prof. Hartmann places on record the results obtained from observations of the occultation of J. ii. by J. i. on February 24. The observations were made with the 50 cm. refractor of the Potsdam Observatory, a power of 450 being used, and the best value for the time of the middle of the conjunction is given as 9h. 45m. 32s. ± 5s. (M.E.T.).

SOLAR PROMINENCES IN 1907.—Prof. Riccò's summary of the results of the prominence observations made at the Catania Observatory during 1907 appears in No. 5, vol. xxxvii. (p. 83), of the *Memorie della Società degli Spettroscopisti Italiani*; the usual data regarding the latitudes, heights, and extensions at the base are given, and the complete results summarised. The mean heliographic latitude, for both hemispheres, was 29°·4, being 1° less than in 1906; a notable maximum occurred in the third quarter in latitude 80°–85° south. In the northern hemisphere, for the whole year, there were two well-defined maxima (in latitudes 50°–60° and 20°–30°), and in the southern hemisphere there were three (latitudes 10°–20°, 40°–50°, and 80°–90°). During the first five months the number of prominences in the northern hemisphere preponderated, but for the last seven months the southern hemisphere showed the greater numbers; the numbers observed for the whole year were 381 and 447 respectively.

THE TEMPERATURE AND STRUCTURE OF THE SUN.—In a lecture delivered before the Philosophical Society of Washington, and now printed as a bulletin of the society (vol. xv., pp. 75–101, May), Dr. O. Lummer gave an interesting and suggestive *résumé* of our present knowledge concerning the probable temperature and structure of the sun. From a discussion of the laws of radiation as applied to the observed solar values, he arrives at the conclusion that the temperature may, with reasonable certainty, be assumed to be about 7000°. As such a temperature surpasses the critical temperature of all terrestrial substances, Dr. Lummer concludes that a sharp limit between a liquid and a gaseous mass on the sun is physically impossible. On the basis of this conclusion he discusses the probable structure of the sun's envelopes, and finds that most of the spectral phenomena observed, *e.g.* the broadening of lines in sun-spots and the distortion and displacement of various lines in prominences, can be accounted for by the assumption that they are produced by anomalous dispersion in the various layers of the sun's atmosphere.

THE ROYAL SOCIETY CONVERSAZIONE.

THE annual conversazione to which ladies as well as gentlemen are invited by the Royal Society was held in the society's rooms at Burlington House on Monday. Most of the objects of scientific interest exhibited on this occasion were the same as those shown at the conversazione in May, and already described in these columns (May 21, p. 58). A few additional exhibits may, however, be referred to here to supplement the previous article. As before, we summarise the descriptions in the official catalogue, after arranging together related subjects.

Dr. George E. Hale and Mr. Ferdinand Ellerman: Astrophysical photographs taken at Mount Wilson Solar Observatory, Pasadena, California.—*The Director of the Meteorological Office:* Zoetropic apparatus exhibiting the progress of a travelling storm-centre and the circulation of air associated therewith. By means of a series of maps, upon which the isobaric lines and corresponding steps of the trajectories are drawn, and an ordinary zoetropic apparatus, viz. a revolving drum with slits through which the

succession of maps is seen, the spectator is enabled to see both processes in progress, viz. the march of the depression and the course of the air in the various parts of the depression.—*Mrs. Hertha Ayrton:* The residual motion of water moving in stationary waves. When a liquid rises and falls in rhythmical wave motion its particles do not simply swing to and fro, returning, like pendulums, to their starting points after each oscillation, but each particle takes up a new position after each oscillation, so that it traces out a path for itself, only returning after many oscillations to the point from which it started. This general movement, which takes place in conjunction with the oscillatory movement, is called the residual motion of the liquid. It takes the form of vortices of peculiar shape, which are exactly the opposite of the ripple-forming vortices to which obstacles under the water give rise, since a single residual vortex is only completed in many oscillations, while each ripple-forming vortex is born and dies in a single swing.

Prof. A. M. Worthington, C.B., F.R.S.: Recent instantaneous photographs of splashes.—*Dr. W. J. Russell, F.R.S., and Mr. O. F. Bloch:* Photographs of flowers, &c., in natural colours (Lumière process).—*Mr. H. G. King and Mr. R. Kerr:* "Master gauges" or "standards" for extremely accurate measurements, the invention of Mr. C. E. Johansson, of Sweden. By using these gauges separately or combined together, more than 80,000 different sizes can be obtained, any of which sizes are accurate to within 0·00004 inch at 66° F. The steel is so treated as to reduce to a minimum any chance of change after being hardened. The gauges are used where extreme accuracy is required, as in the manufacture of machine parts, tools, and various instruments; also for "marking off" dies on surface plates and for testing them when machined, &c. Two of these blocks put face to face can sustain a pull of $11\frac{3}{4}$ lb., or 22 lb. to the square inch.—*Mr. Frederick Iles:* (1) "Irisographs," or chemical designs. "Irisography" is a method of producing coloured designs by means of chemical solutions applied in spots upon unsized paper, and subsequently developed by the central application of a compound solution which, spreading by capillary attraction, and coming into contact with the previously applied spots, combines with and reacts upon them to produce designs of varied outlines and colours. (2) "Caleidographs." Original designs executed by aid of the caleidograph on china, glass, paper, and on prepared glass plates. The "caleidograph" is an instrument to facilitate the working out or elaboration of simple or complex designs composed of geometrical curves and lines, either upon paper or on the actual articles of china, glass, metal, &c.

Dr. J. A. Fleming, F.R.S.: Transmission of signals by electromagnetic induction between oscillatory circuits, and their reception by means of a glow-lamp detector. At one end of the principal library a square circuit was set up in which high-frequency oscillations were created by the discharge of a Leyden jar charged by an induction coil. The coil was actuated by a coal-gas mercury break, and the spark was in a silencing chamber with air-blast arc destroyer. The oscillations were cut up into Morse signals by a punched tape and relay in the primary circuit. One hundred feet away was a similar receiving circuit, in which oscillations were created by induction transmitted from the sender, and were detected by a glow-lamp detector or oscillation valve and telephone. Messages and signals thus sent formed a small-scale exhibition of high-frequency inductive wireless telegraphy.—*Dr. Alexander Muirhead, F.R.S.:* A combined Kelvin siphon recorder and cable relay. The latest form of the Kelvin siphon recorder has been converted into a successful cable relay by simply substituting fine gold wire for the silk fibre which connects the siphon to the vibrator.

Mr. Leonard Hill, F.R.S.: (1) Self-contained diving dress (made by Messrs. Siebe, Gorman and Co., Ltd.). Air-pump, pipe, and life-line are done away with, and the diver is connected to the surface by a telephone cable only. Attached to the back of the ordinary diving dress are cylinders containing air with 50 per cent. oxygen. The oxygen mixture is delivered to the helmet by a pipe, to which a reducing valve is attached. The supply is 4 litres per minute, and lasts two hours. Two caustic soda boxes are connected by a pipe with the helmet, and by a second pipe to an aspirating arrangement placed in the oxygen delivery tube. The force of the oxygen mixture escaping through a narrow jet is used to aspirate the air in the helmet through the soda boxes, which purify it from the exhaled carbonic acid. (2) Life-saving apparatus for use in mines (made by Messrs. Siebe, Gorman and Co., Ltd.). The apparatus, perfected out of that of Mr. Fleuss, consists of a breathing bag, and cylinders of compressed oxygen, carried by straps passing over the shoulders, and so hung that the man is free to do work. The dress allows the man to be stripped to the waist in hot atmospheres.—*Prof. Arthur Gamgee, F.R.S.:* Photographs, drawings, and plans exhibiting the apparatus employed by Prof. Gamgee in his research on methods for the continuous (photographic) and quasi-continuous registration of the diurnal curve of the temperature of the animal body.

Dr. G. H. Rodman: A series of stereoscopic radiographs of molluscal shells. Prior to the application of the Röntgen rays to this branch of zoological research, it was necessary to sacrifice the specimen in order to disclose the internal anatomy of the columella and whorls—a course obviously undesirable in the case of a rare and possibly unique shell. In some of the examples shown the radiograph has been so made as to show the equivalent of both horizontal and vertical sections.—*Mr. H. S. Leigh:* Living examples of the leaf insect from the Seychelles, *Phyllium crurifolium*, Serville. The Phylliums afford one of the most striking examples of protective resemblance. The specimens are not only very similar to leaves in shape and colour, but in their peculiar movements imitate the shaking of the leaves. The resemblance to vegetable structures is carried still further, since the eggs bear a marked likeness in shape and colour to certain seeds.—*Prof. J. Cossar Ewart, F.R.S.:* Hybrid between a Prejvalsky mare (*Equus prejvalskii*) and a Highland pony. This is one of six hybrids bred from wild horses imported from Mongolia. With the exception of the one exhibited, the hybrids are out of pony mares. All six hybrids are males, and two foals out of pony mares by a hybrid bred at Penycuik in 1905 are males. The hybrids support the view that a wild horse of the Prejvalsky type took part in the making of domestic horses. Four of the six hybrids were bred at Woburn by his Grace the Duke of Bedford.—*Mr. F. Enock:* Insect intelligence, as exemplified in the life-history of the wood-boring wasps (Crabronidæ). All hymenopterous insects show a high degree of intelligence. One species of Crabro fills its cells with one, and only one, species of insect; another with one kind of beetle; a third with homopterous insects.

Dr. A. S. Woodward, F.R.S.: Photographs, by Mrs. E. von Kaufmann, of portions of carcases of a mammoth and rhinoceros found preserved in petroleum at Starunia, Galicia. These specimens were obtained in an ozokerite mine while sinking a shaft through the deposit of an old marsh which was saturated with petroleum.—*The Director-General, Survey Department, Egypt:* Plans, photographs, and objects illustrating the archæological survey of that portion of the Nile Valley which will be submerged by the Aswan reservoir when its level is raised. A detailed survey of the valley and the ancient sites is being made, and the anatomical study of all human remains found is being carried on simultaneously with the archæological investigations. Numerous pre-dynastic cemeteries have been found, and the present evidence shows that in these times Lower Nubia and Egypt formed one ethnological territory, both districts being in the same state of culture. From the first dynasty their history diverges; in Egypt the race remains unchanged, and culture shows a progressive development; in Nubia the race becomes mixed with a strong infusion of negro blood, and culture lags behind that of Egypt.—*Miss M. Helen Tongue:* Bushmen paintings copied by the exhibitor from the caves and rocks in Cape Colony, Orange River Colony, and Basutoland. The paintings, which are found on the walls or roofs of rock shelters or caves, generally in sandstone districts, have been coloured with iron oxides, or with ochres mixed with fat. The date of the work varies. In Cape Colony the latest paintings must be nearly a century old. In Basutoland there may be some of a later date; probably most are older. The pictures have been carefully traced, and the colours and background copied as exactly as possible.

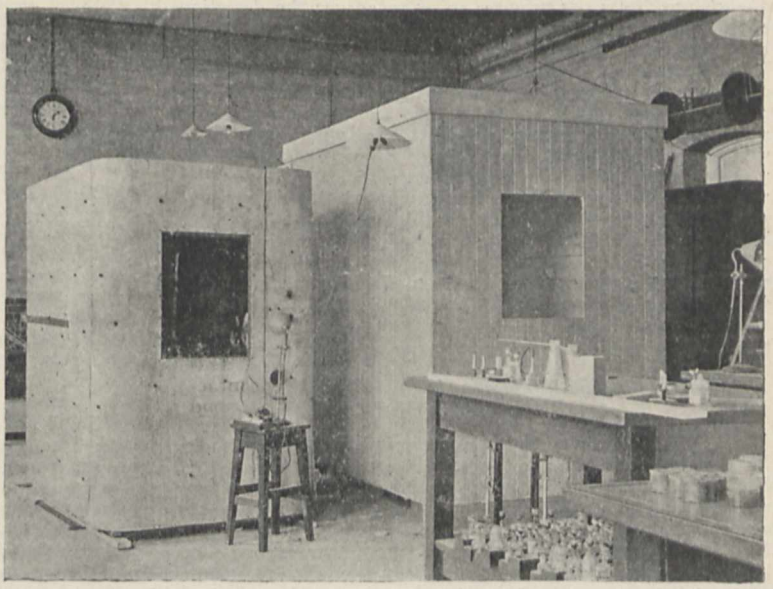
A CALORIMETER FOR DETERMINING THE RELATION BETWEEN HEAT-PRODUCTION AND MUSCULAR WORK.

IN the physiological laboratory of the University of Sheffield a calorimeter has been erected on the model of Atwater and Benedict's calorimeter, now carried by Prof. Benedict to a great state of perfection in the Nutrition Laboratory at Boston, U.S.A. The Sheffield copy is not at present a complete one, and its limitations are best detailed by a brief description of the problem in the solution of which it is hoped immediately to play some part. This problem is the nature of the physicochemical process underlying the phenomenon of muscular contraction, upon which some work has been in progress in this laboratory already along somewhat different lines.

A precise statement of the relation existing between muscular work and heat production is a necessity for the final solution of this question. Even before precision can be hoped for, additional information may be of much value in deciding the comparative value of different lines of attack. Thus, it having been already shown that the energy liberated is entirely to be assigned to the combustion of food, the question arises as to whether the contraction is the direct consequence of the combustion which takes place at the same time, or as to whether it is not rather the consequence of some preceding combustion. In the latter case there would be nothing remarkable in the proposition that the combustion responsible was in the main an occurrence taking place during a preceding contraction. Each contraction might, so to speak, wind up a spring for release in the next contraction. The usual view is that contraction and the combustion responsible for it are concomitant; the view of the Sheffield laboratory is that they are not. The second point of view can be at once supported by the well-known fact that fatigued muscle is apparently a more economical heat engine than muscle in good condition, giving off less waste heat for an equal amount of external work done. Such a fact loses all peculiarity if it is considered merely as a failure on the part of the fatigued muscle to provide for succeeding contractions. It is in the hope of collecting further data of this kind that the calorimeter has been constructed. The immediate necessities, therefore, are a calorimeter within which prolonged muscular work can be performed, and from which a complete statement of the amount of work done and heat given off can be obtained. Benedict's original instrument offers much more information than this, since it is a complete respiration calorimeter, providing by its use data for a perfect balance-sheet both of chemical material and energy. It is hoped to raise the Sheffield apparatus to the same level of perfection, so that it may be placed at the disposal of investigations of a more general kind when additional financial aid has been obtained.

The calorimeter has been constructed by Messrs. George, of Birmingham, who have followed the detailed instructions provided by Benedict in the publications of the Carnegie Institution, Washington. At one stage of construction it was examined by Prof. Benedict, and then met with his approval. He was kind enough to make important suggestions, which have since been carried out.

A small room, 8 feet by 6 feet by 5 feet, has been built of copper sheets carefully soldered together and stiffened by an external wooden framework, to which they are fixed. On the outer surface of the framework zinc sheets have been fastened, forming a second metal covering. The double-walled metal box so formed rests on rails within a double-walled wooden house enclosing it. Thus the walls, copper, zinc, wood, and wood separate three layers of air external to the chamber. The accessory arrangements of the calorimeter render it possible to maintain the zinc sheath and the two outer layers of air at the same temperature as that of the copper box, whatever that may be. Heat is thus prevented from escaping from the walls of the copper chamber. This end is secured by heating and cooling apparatus in the two outer air spaces, resistance wires and cold-water pipes. The degree to which the heating and cooling mechanism is resorted to in each of these spaces is determined by the observation of electrical currents from one hundred and fifty sets of thermocouples arranged in two series, a series indicating differences of temperature between the copper and zinc sheaths, another indicating differences between the two outer air spaces. Each series is divided into zones, so that the state of the roof, the floor, or each of three zones in the side walls can be separately observed. The heating and cooling mechanism is similarly subdivided. The observer seated outside the calorimeter can rapidly test each segment of the calorimeter in turn, and rapidly balance any difference found by adjustments of rheostats admitting more or less current to the heating wires, and taps admitting more or less water to the cooling pipes.



Calorimeter for physiological experiments at Sheffield University. The metal chamber on the left is now enclosed in the wooden house on the right. The spots on the wall of the metal chamber are tubes in which the thermocouples now lie.

The difficulties in construction up to this point lie mainly in the thermocouples and their fixation. It is a difficult matter especially to prevent risks of short-circuiting and displacement from incapacitating those placed to read differences of temperature between the copper and zinc, since the subject within the calorimeter by movements causes awkward bulgings of the metal.

A second difficulty in construction is the necessity for an absolutely air-tight copper chamber admitting no air save through the pipe provided, and allowing none to escape save through the exit tube. There are a number of apertures which have to be carefully sealed. Thus the window through which the subject enters is subsequently glazed. There is also an air lock through which material can be passed into and out of the chamber. This is guarded by a double port. There are also four tubular openings through which pass telephone wires and wires to an electromagnet and to the copper disc of a bicycle ergometer, a cable from the beam of a balance placed above the calorimeter, the entrance and exit tubes of the radiator system of water-pipes, and a lever for adjusting the position of shields covering the radiator system. All these apertures are sealed in various ingenious ways, but none too securely. Doubtless practical experience will both

provide and remove fear of defects in this direction. When to this is added the risk introduced by every screw passing through the copper, such as, for example, those necessary for the fixation of the bed, the balance beams from which the radiator system is suspended, &c., there is at present fear enough. It was in indicating points such as this that Prof. Benedict's visit was of so much value.

The heat produced within the copper box, carefully prevented from escaping from its surface in the manner described, is carried out in a stream of water constantly driven through the radiator system. The quantity of water passing is varied with the necessities of the moment, and is necessarily much greater when the subject is at work on the ergometer. The water passing is weighed on exit in a meter, and its temperature on entrance and exit observed. The former is practically constant, the latter kept as constant as possible by variation in the rate of water flow. These data form the main items in the statement of heat produced, though other important items, such as the amount of water condensing on the radiator pipes within the chamber, the water evaporated and carried through with the air leaving the chamber, are duly considered and provided for. Thermocouples are placed in the tubes through which the air finds entrance and exit, in quantity 75 litres per minute, so as to ensure the detection of any difference of temperature. Any difference found is corrected by increased heating of the entering air.

In Benedict's calorimeter the air is driven from the chamber through a closed system of tubes back to the chamber again. In this system are interpolated sulphuric acid and soda lime absorbers of a necessarily very large size, determined by the large mass of air in motion per unit of time. The oxygen consumed is made good by admission of oxygen from a cylinder of the compressed gas. In the Sheffield apparatus this will not, at first at least, be attempted. Dried air heated and passed into the chamber will be driven out through a sulphuric acid absorber, no attempt being made to do more than take a determination of the water.

RECENT RESEARCHES IN THE STRUCTURE OF THE UNIVERSE.[1]

I CONSIDER it an uncommon privilege to lecture on the structure of the universe in the country of the Herschels. Even now their celebrated gauges are unrivalled, and they still form one of the important elements on which any theory of the stellar system must be based. It is well known that the plan of these gauges consisted in directing the telescope successively to different points all over the sky, and simply counting the number of stars visible in the field.

There is one fact clearly brought out by these gauges to which I must direct your attention. It is that in the outward appearance of our nightly sky, as seen with the telescope, there is a great regularity. In the Milky Way, that belt which we see with the naked eye encircling the whole of the firmament nearly along a great circle, the number of stars, as seen in Herschel's 20-feet reflector, is enormous. On both sides this apparent crowding of the stars diminishes very gradually and regularly until, near the poles of the Milky Way, we come to the poorest parts of the sky.

Let us look at this phenomenon somewhat more closely. If we direct our telescope first towards the part of the Milky Way near Sirius, and if from there we gradually work up towards the North Pole of the Milky Way in the constellation called the Hair of Berenice, we shall clearly perceive this gradual and regular change in the number of stars. Now if we repeat the same process, beginning from some other point of the Milky Way, say in Cassiopeia or the Southern Cross, we shall find that, not only is there a similar gradual change, but we shall approximately go through the same changes.

At the *same* distance from the Milky Way we shall find, approximately, the same number of stars in the field of the telescope. Put in other words, the richness of stars varies regularly with the galactic latitude; it varies relatively little with the galactic longitude.

Imitating most of the investigators of the stellar system, we will therefore disregard the longitude and keep in view only the changes with the galactic latitude. In reality this comes to being satisfied with a first approximation. For, in reality, there are differences in the different longitudes, especially in the Milky Way itself. But even here the differences are not so great as seems commonly to be supposed. There is every reason to believe, therefore, that our approximation will be already a tolerably close one.

Real Structure.

Meanwhile, what the Herschel gauges teach us is only relative to the outward appearance of the sky. What is the real structure of the stellar world? If we see so many stars in the field, with the telescope directed to the Milky Way, is it because they are really more closely crowded there, as Struve thinks, or is the view of the older Herschel correct, who imagined that the greater richness is simply a consequence of the fact that we are looking in deeper layers of stars; that our universe is more extensive in the Milky Way than it is in other directions?

Imagine that we could actually travel through space. For instance, imagine that first we travel in the direction of the constellation Cassiopeia. If we travel with the velocity of light, not so very many years would pass before we get near to some star. Proceeding on our journey for many, many more years, always straight on, we will pass more stars by and by. How will these stars look thus viewed from a moderate distance—say, from a distance as that of the sun? Will they all be found to be of equal luminosity, as Struve practically assumed? And in this case are they as luminous as our sun, or more so, or less so? Or are they unequal? If so, how many of them are brighter than our sun, how many fainter? Or, to be more particular, how many per cent. of the stars are 10, 100, 1000, &c., times more luminous than our sun? How many are equal to the sun, or 10, 100 times fainter? In a few words: What is the nature of the mixture? or, lastly, what is the *mixture law* of the system of the stars?

Furthermore, in travelling on, shall we find the stars in reality equally thickly, or rather thinly, crowded everywhere? Or shall we find that after a certain time, which may be many centuries, they begin to thin out, as a first warning of an approaching limit of the system? Is there really such a limit, which, once passed, leads us into abysses of void space?

Herschel thought there was such a limit, and even imagined that his big telescope penetrated to that limit; that is, he assumed that his telescope made even the remotest stars visible. On this supposition is based his celebrated disc theory of the system.

Again, we may condense these questions in this single query: How does the crowding of the stars, or the *star-density*, that is, the number of stars in any determined volume (let us say in a cubic light century), vary with the distance from our solar system?

But there is more. We supposed that our journey went straight on in the direction of Cassiopeia, which is in the Milky Way. What if our journey is directed to the Pleiades, which are at some distance from that belt, or to the Northern Crown, which is still further, or to the Hair of Berenice, which is furthest of all from the Milky Way? For different regions *equally* distant from the galaxy we have seen that outward appearances are the same. We may admit, with much probability, that in space, too, we would find little difference. Summing up, the problem of the structure of the stellar system in a first approximation comes to this:—

To determine, separately for regions of different galactic latitude, in which way the star-density and the mixture vary with the distance from the solar system.

I think that there is well-founded hope that, even perhaps within a few years, sufficient materials will be forthcoming which will allow us to attack the problem to this degree of generality, with a fair chance of success. At the present moment, however, our data are yet too scanty for the purpose. Still, they will be sufficient for the derivation of what must be in some sort *average* con-

[1] Discourse delivered at the Royal Institution on Friday, May 22, by Prof. J. C. Kapteyn.

ditions in the system. The method of treatment will not be essentially different from that which will be applied later to the more general problem, but we have provisionally to be content with introducing the two following simplifications :—

(1) We will assume that the *mixture* is the same throughout the whole of the system.

(2) We will not treat the different galactic latitudes separately.

The consequence will be that the resulting variations of density to which our discussion leads will not represent the actual variations which we would find if we travelled in space in any determined fixed direction, but a variation which will represent some average of what we would find on all our travels if we successively directed them to different regions of the sky.

Our present problem will thus be confined to finding out :—

(*a*) The mixture law.

(*b*) The mean star-density at different distances from the solar system.

If time allows, I will, at the end of this lecture, say a few words on the restrictions introduced, and the way to get rid of them.

As it is not given to us to make such travels through space as here imagined, we have to rely on more human methods for the solution of our problem.

Determination of Distance.

It is at once evident that there would be no difficulty at all if it were as easy to determine the distance of the stars as it is to determine the direction in which they stand. For in that case the stars would be localised in space, and it would be possible to construct a true model from which the peculiarities of the system might be studied.

It is a fact, however, that, with the exception of a hundred stars at most, we know nothing of the distances of the individual stars.

What is the cause of this state of things? It is owing to the fact that we have *two* eyes that we are enabled not only to perceive the direction in which external objects are situated, but to get an idea of their distance, to localise them in space. But this power is rather limited. For distances exceeding some hundreds of yards it utterly fails. The reason is that the distance between the eyes as compared with the distance to be evaluated becomes too small. Instruments have been devised by which the distance between the eyes is, as it were, artificially increased. With a good instrument of this sort distances of several miles may be evaluated. For still greater distances we may imagine each eye replaced by a photographic plate. This would even already be quite sufficient for one of the heavenly bodies, viz. for the moon.

At one and the same moment let a photograph of the moon and the surrounding stars be taken both at the Cape Observatory and at the Royal Observatory at Greenwich. Placing the two photographs side by side in the stereoscope, we shall clearly see the moon "hanging in space," and may evaluate its distance.

But already for the sun and the nearest planets, our next neighbours in the universe after the moon, the difficulty re-commences.

The reason is that any available distance on the earth, taken as eye-distance, is rather small for the purpose. However, owing to incredible perseverance and skill of several observers, and by substituting the most refined measurement for stereoscopic examination, astronomers have succeeded in overcoming the difficulty for the sun. I think we may say that at present we know its distance to within a thousandth part of its amount. Knowing the sun's distance, we get that of all the planets by a well-known relation existing between the planetary distances.

But now for the fixed stars, which must be hundreds of thousands of times further removed than the sun. There evidently can be no question of any sufficient eye-distance on our earth. Meanwhile, our success with the sun has provided us with a new eye-distance, 24,000 times greater than any possible eye-distance on the earth. For now that we know the distance at which the earth travels in its orbit round the sun, we can take the diameter of its orbit as our eye-distance. Photographs taken at epochs six months apart will represent the stellar world as seen from points the distance between which is already best expressed in the time it would take light to traverse it. The time would be about sixteen minutes.

However, even this distance, immense as it is, is on the whole inadequate for obtaining a stereoscopic view of the stars. It is only in quite exceptional cases that photographs on a large scale—that is, obtained by the aid of big telescopes—show any stereoscopic effect for fixed stars. By accurate measurement of the photos we may perhaps get somewhat beyond what we can attain by simple stereoscopic inspection, but, as we said a moment ago, astronomers have not succeeded in this way in determining the distance of more than a hundred stars in all.

How far we are still from getting good stereoscopic views appears clearly from the stereoscopic maps which your countryman, Mr. Heath, constructed, making use of the data obtained in the way presently to be considered. In order to get really good pictures, he found it necessary to increase the eye-distance furnished by the earth's orbit 19,000 times. Are there, then, no means of still increasing this eye-distance?

Motion of Solar System through Space.

There is one way, but it is a rather imperfect one. Sir William Herschel was the first to show, though certainly his data were still hardly sufficient for the purpose, that the whole of the solar system is moving through space in the direction towards the constellation of Hercules. Later observations and computations have confirmed Herschel's conclusions, and we have even been able of late to fix with some precision the velocity of this motion, which amounts to 20 kilometres per second. This velocity is a 15,000th part of the velocity of light. In the 150 years elapsed since Bradley determined for the first time the position of numerous stars with modern precision, the solar system must thus have covered a distance of exactly a hundredth part of a light-year, *i.e.* we are thus enabled to make pictures of the sky as seen from points of view at a mutual distance of a hundredth of a light-year. Our eye-distance of sixteen light minutes is thus increased more than 300-fold. True, this distance falls still considerably short of that adopted by Heath, but it appears that, for a considerable part of the stars, it is, though not nearly so great as might be desired, still in a certain way sufficient.

There is, however, a difficulty in the way, which prevents our pictures from giving a stereoscopic view of the stars at all, and thus prevents the determination of the distance of any star in this manner. The difficulty is that the changed directions in which, after the lapse of 150 years, we see the stars is not exclusively the consequence of the sun's motion through space, but is due also to a real motion of the stars themselves. The two causes of displacement which, in the case that we take the diameter of the earth's orbit as eye-distance, are separable by means of a simple device, become inseparable in the present case. In order to see whether this difficulty be or be not absolutely insuperable, I will take a parallel case *on the earth*.

At a certain distance we observe a cloud of insects hovering over a small pond. In order to evaluate the distance separating the insects from our eye, suppose that we make a photograph; then, after a few seconds, a second one from a slightly different standpoint. It must be evident that even if we have used an instrument which clearly shows the individual insects, the two pictures put in the stereoscope will not furnish a stereoscopic view of them individually; on the contrary, the picture as seen in the stereoscope will be perfectly chaotic. The reason, of course, is that in the interval between the taking of the two photographs the insects have moved. Does it follow that no evaluation of the distance can be obtained?

The answer must be, of any individual insect, *no*; but of the cloud, as a whole, we can evaluate its distance provided that the cloud, as a whole, has not moved; or, expressed more mathematically, provided that the centre of gravity of the cloud has not moved, we can derive the *average* distance[1] of all the insects. We shall be sure of

[1] The expression *average distance* ought, strictly speaking, to be replaced by the distance corresponding to the *average parallax*. For clearness sake I have ventured here and in what follows to substitute one expression for th other.

the immobility of the centre of gravity if we know that the direction of the motions of the insects is quite at random; but this is by no means required. The motion may be preferentially in a horizontal plane or along a determined line, say along the longer axis of the pond, provided only that the motions in any two opposite directions are equally frequent.

Not only that, even if the cloud, as a whole, is not immovable, we are not necessarily helpless. For, if the insect cloud and the photographer were both on a sailing vessel, circumstances would be the same as on the mainland, though now the cloud is in motion. Only, instead of the absolute displacement of the photographic apparatus, we must know the displacement relative to the ship, or rather *relative* to the *insect-cloud*. This, then, finally is the real thing wanted. We may obtain the distance of the insect-cloud, or, what comes to the same, the average distance of its members, as soon as we are able to find out the displacement of our point of view with regard to the centre of gravity of the cloud.

Our case is much the same in the world of the stars.

We shall be able to determine the average distance of the members of any arbitrary group of stars provided that we can find the motion of the solar system, both in amount and in direction, relative to the centre of gravity of the group.

Now, astronomical observations such as those which led the elder Herschel to his discovery of the solar motion through space enable us to determine the *direction* of the sun's motion relative to such groups as the stars of the third, fourth, &c., magnitude. Spectroscopy enables us to determine the *amount* of that motion.

We must be able, therefore, to find out the average distance of the stars in these groups. For other groups, such as the stars having an apparent centennial motion of 10″, 20″, &c., there is a difficulty. Still, however, we have succeeded in overcoming this difficulty by a somewhat indirect process, and pressing into service the stars of which the individual distances are known. This, then, is the upshot of astronomical work on the distances.

What we know about Star-distance.

By direct measurement we know the distance of some hundred individual stars.

For the rest we know the average distance of any fairly numerous group of stars of determinate apparent magnitude and apparent motion.[1]

The question is, Can this imperfect knowledge of the distances be considered as in any wise sufficient for obtaining an insight into the real arrangement of the stars in space? I think it can, and I will now try to show in what manner.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following is the text of the speeches delivered by Prof. Love in presenting recipients of the degree of D.Sc. *honoris causa* at the Encænia on June 24:—

FULGENCE RAYMOND.

Antequam de huius viri laudibus loquar, breviter dixerim centum fere abhinc annos celeberrimam medicorum scholam Parisiis exstitisse, eandem sæculo proximo exeunte, Charcotio familiam ducente, maxima laude floruisse. Charcotio successit Fulgentius Raymond, magistro discipulus clarissimus: quo rem feliciter navante valetudinarium Salpetriense, in quo quasi in aliquo orbis terræ theatro partes primarias agit, omnium in se ora convertit. Hic excultæ sunt plurimæ rationes, quæ ex eo pendent quod hi præ se ferunt qui affirmant posse corpori ægrotantis ipsam mentem mederi: quo in genere hic noster, dum de cerebri et de medullæ spinalis natura docte luculenterque disserit, laudem maximam consecutus est. Felicissimum profecto amicitiæ inter Britanniam et Galliam reconciliatæ documentum duco, quod hic vir de medicorum apud Gallos insignissimorum usu et rationibus magno medicorum nostrorum conventu Londinii nuper contionatus est.

JETHRO JUSTINIAN HARRIS TEALL.

Descriptioni Geologicæ, impensis publicis faciendæ, quæ saxorum solo Britannico subiectorum naturam, qua vi conflata sint, quo tempore coorta exquirit, præfectus est Jethro Justinianus Harris Teall. Qui vir, quo melius rem tantam conficeret, non in uno tantum genere laudis excellit: neque enim solum rationes quæ latissime patent animo comprehendere, sed etiam minutissima quæque et observare et repræsentare miro modo potest. His artibus usus, cum saxorum diversissimorum compages scrutaretur, omnia e montibus vi ignea liquefactis exorta esse cognovit: idem mutationes quas hæc saxa patiuntur gravi pondere oppressa subtilissime enarravit. Quo ingenio, qua peritia in hoc genere usus sit declarat ille liber de Insularum Britannicarum Petrologia conscriptus, quem aureolum esse ego iure dixerim.

JAMES WARD.

Inter Psychologos nemo clarior est quam Jacobus Ward, qui Psychologiam, cuius scientiæ proprium sit singulorum sensus tractare, non ex alia scientia pendere sed sui iuris esse constanter asseverat: cuius in ore semper est vox illa "Ego sum. Nihil mihi hoc verius?" Qui vir ita priorum repertis usus est ut erroribus vitatis longius progrederetur: idem si quid boni usquam invenisset non aspernatus novam, quæ latissime pateret, rationem excogitavit et necessitudinem quandam inter mentem nostram et rerum naturam intercedere docuit. Psychologiam etiam cum aliis scientiæ generibus artissime cohærere monstravit et omnibus qui cognoscendi ratio quæ sit investigant vel hominum moribus student utilissimam esse contendit. Neque ei satis erat huic scientiæ novum quasi fundamentum præbere, sed multorum diverso in genere philosophorum opiniones reprehendit: quæ omnia in libro paucos abhinc annos edito pervulgata cum iis qui rerum naturæ investigandæ operam dant tum iis qui philosophiæ potissimum incumbunt maxime profuerunt.

MANCHESTER.—Lord Morley, Chancellor of the University, has nominated the following as recipients of honorary degrees on the occasion of his installation, which has been fixed for July 9:—the Right Hon. A. J. Balfour, Mr. E. J. Broadfield (treasurer of the University), Mr. Andrew Carnegie, Lord Courtney of Penwith, Lord Curzon of Kedleston, Sir Ed. Donner, Bart., Dr. A. M. Fairburn (principal of Mansfield College, Oxford), Sir Frank Forbes Adam (chairman of the university council), the Right Hon. R. B. Haldane, Sir H. F. Hibbert (chairman of the Lancashire Education Committee), Sir W. H. Houldsworth, Bart., Prof. Henry Jackson, Sir William Mather, Mr. J. Cosmo Melvill (donor to the Manchester Museum of the Cosmo-Melvill herbarium), and Sir Edward Maunde Thompson. In addition, the following honorary degrees will be conferred:—*LL.D.*, Mr. A. J. Evans (keeper of the Ashmolean Museum) and Mr. William Farrer (editor of the "Victoria County History of Lancashire"; *D.Sc.*, Emeritus Prof. Gamgee.

Mr. R. E. Slade has been elected to a Gartside travelling scholarship. Dr. Hans Geiger has been re-appointed to the Harling fellowship in physics.

THE Countess of Bective will present the prizes at the Horticultural College, Swanley, Kent, on Tuesday, July 14. Sir John Cockburn, K.C.M.G., will take the chair at 4 p.m.

WE are glad to be able to announce that a petition for a charter for a University of Bristol has been sent to the Privy Council. A concordat is being arrived at between University College, Bristol, and the Merchant Venturers' Society, which has for many years been identified with work of technical and secondary education in the city. The most liberal support for the University scheme has

[1] At the present moment some objection might certainly still be made against the generality of this statement. In fact, the scarcity of spectroscopic data is the cause that, though the determination of the solar motion separately for such groups as the stars of determinate magnitude and proper motion is quite possible, it has not yet been carried through. As a consequence, the results used in what follows still rest on the assumption that the centres of gravity of all the groups considered are at rest relative to each other. That this assumption must be probably true follows from the near identity of the *direction* of the sun's motions, furnished by the several groups.

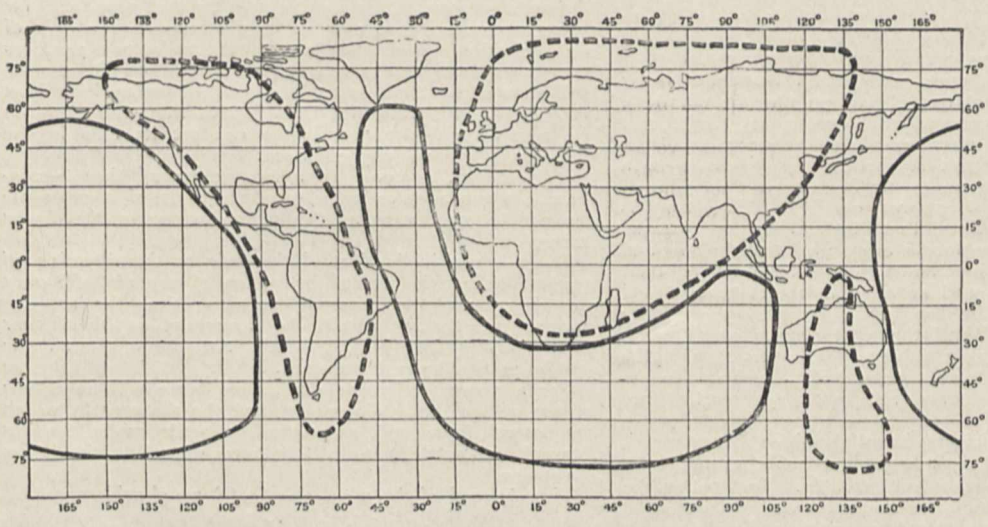
come from various members of the Wills family, no less a sum than 135,000*l.* having been promised toward its realisation by them. Of this amount, Mr. H. O. Wills has promised 100,000*l.*, Lord Winterstoke (formerly Sir W. H. Wills) 20,000*l.*, and Sir Frederick Wills 10,000*l.* More money is, however, still required to establish the University in a satisfactory manner; and it is to be hoped that other merchant princes of Bristol will follow the magnificent example which the Wills family has given them.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 30.—"Note on the Representation of the Earth's Surface by Means of Spherical Harmonics of the First Three Degrees." By Prof. A. E. H. **Love**, F.R.S.

In a previous paper the author had concluded from dynamical considerations that those elevations and depressions on the surface of the globe which correspond with continents and oceans should be capable of being represented, in respect of their main features, by means of spherical harmonics of the first, second, and third degrees. A rough spherical harmonic analysis of the



actual elevations and depressions yielded a rather imperfect representation of the surface, which nevertheless offered a general resemblance to the actual distribution of land and water. It had, however, certain definite defects. To alter the computed figure it is necessary to change appropriately the coefficients of the spherical harmonic expression by which it is proposed to represent the elevation of the surface above the mean level. In the present paper there is recorded the best of many sets of trial coefficients, and the result is shown on the accompanying chart. In this chart the fine continuous line is a rough outline of the actual land of the globe, drawn in such a way that all degrees of latitude or of longitude have the same value on the map; the heavy line is the zero line of the surface harmonic with the chosen coefficients; the dotted line is the contour line along which the computed elevation is equal to one-tenth of its maximum value.

"The Relation between the Crystalline Form and the Chemical Constitution of the Picryl Derivatives." By G. **Jerusalem** and Prof. W. J. **Pope**, F.R.S.

By a method which depends upon dividing up the space occupied by a crystalline substance into polyhedral cells, each of which is assumed to be the habitat of but one atom, Barlow and Pope have been able to determine the general relation which exists between crystalline form and chemical constitution. They conclude that the polyhedral cells, each of which represents the domain of one atom and which fit together without interstices to form the crystal structure, possess volumes which are approximately proportional in magnitude to the lowest valencies exhibited by the elements which they respectively contain. The assemblages obtained by packing together the atomic domains mentioned are partitionable into identical units, each of which represents in composition, constitution, and configuration a chemical molecule of the substance concerned. The relation between the crystalline form and chemical constitution of a series of substances is conveniently illustrated by comparing the dimensions of polyhedra, of which the volumes are represented by the sum, W, of the valencies of the atoms composing the molecules, and of which the relative dimensions are the crystallographic axial ratios $a:b:c$. The dimensions referred to are termed the equivalence parameters $x:y:z$, and are calculated from the relations that $a:b:c=x:y:z$ and $xyz=W$.

In the present paper the above considerations are applied to a number of derivatives of picric acid and allied substances; it is shown that in this series one of the three equivalence parameters remains approximately constant, and has about the value of z in the equivalence parameters of crystalline benzene, namely, $x:y:z=3{\cdot}101:3{\cdot}480:2{\cdot}780$. The direction in which the dimension z is measured in benzene is that in which columns formed by superposing triangularly arranged groups of three polyhedra, each occupied by a carbon atom, occur throughout the assemblage representing crystallised benzene. It is concluded that the crystal structures of the picryl derivatives are derived from that of benzene by moving the columns of carbon domains apart and packing the substituting groups in between them in accordance with the method already described by Barlow and Pope.

"On the Hysteresis Loss and other Properties of Iron Alloys under very Small Magnetic Forces." By Prof. Ernest **Wilson**, V. H. **Winson**, and G. F. **O'Dell**. Communicated by Sir William H. Preece, K.C.B., F.R.S.

The experiments were carried out on two alloys of iron, namely, "stalloy," of which the distinguishing feature is that it contains about 3 per cent. of silicon, and "lohys," which is a good sample of transformer plate. The principal object of the research is to find the magnetic properties of these materials under small magnetising forces, especially as regards hysteresis loss. Information is also given on the specific resistance and temperature coefficients of the materials.

For the magnetic tests the specimens are in the form of rings composed of stampings, and the ballistic galvanometer method has been employed.

Lord Rayleigh found by the magnetometer method that in the case of Swedish iron the permeability was nearly constant when the magnetic force (H) varied from 0·00004 to 0·04. In the present experiments the permeability also tends to become constant, the limiting values being 260 for stalloy and 222 for lohys. As regards the maximum value of the permeability, the results obtained have been compared with published figures for a very pure iron and a good sample of plate rolled from Swedish iron. For these materials the maximum permeabilities are respectively 5480 and 4450, and occur for values of the magnetic induction (B) of 9100 and 7000 respectively. For stalloy and lohys the maximum permeabilities are 4520 and 3080, and occur for values of B of 5000 and 5500 respectively.

As regards hysteresis loss, the following figures are

given in full, as they form the most important part of the paper. The loss for stalloy is somewhat lower than that for the pure iron specimen above alluded to, while that for lohys is slightly higher.

Stalloy			Lohys		
Bmax.	Hmax.	Ergs per cycle per cubic centimetre	Bmax.	Hmax.	Ergs per cycle per cubic centimetre
0·1267	0·000474	—	0·70	0·00311	—
0·1918	0·000739	—	1·95	0·0087	—
0·674	0·00267	—	4·25	0·0181	0·000725
0·937	0·00357	0·0000111	8·99	0·0352	0·00645
1·870	0·00695	0·0000672	15·0	0·0528	0·0224
3·60	0·01286	0·000347	37·4	0·1042	0·152
8·25	0·0251	0·00384	84·1	0·1860	0·84
*13·02	0·0358	0·01153	286	0·404	8·80
38·0	0·080	0·0811	568	0·565	32·2
94·1	0·157	0·5680	965	0·697	85·0
171·0	0·245	1·686	1930	0·905	253
*269	0·312	4·810	3780	1·260	725
*629	0·420	21·65	6280	1·960	1620
2245	0·677	203·0	7970	2·740	2375
*6050	1·354	1030·0	11510	6·575	5060
8200	2·130	1688	13440	14·90	7050
9810	3·26	2335			
11500	5·71	3110			
13480	16·20	4530			

The stalloy specimen requires careful attention in order that a truly symmetrical hysteresis loop may be obtained, more especially for values of B between 200 and 8000. In an extreme case, after reducing the force H from about 63 to 0·712 without subjecting the specimen to a series of reversals of the magnetic force as it was reduced, a complete hysteresis loop was obtained. This loop is unsymmetrical in the sense that if the axis of H be so placed that the coercive forces are equal, the positive and negative values of the maximum induction B are not equal, but the positive and negative values of the residual magnetism are equal. The value of the permeability defined as the ratio of half the total change of magnetic induction to the maximum value of H is less than is the case when the loop is truly symmetrical. In the table the figures for loops which are not quite symmetrical are indicated by an asterisk.

The Steinmetz coefficients have also been investigated, the relation being ergs per cycle per cubic centimetre $= \alpha B^{\beta}$. Both coefficients vary considerably. For stalloy the coefficients are very nearly constant between values of B of 600 and 11,000; over this range $\beta = 1{\cdot}71$ and $\alpha = 0{\cdot}000342$. For values of B from 0·937 to 8·25 the coefficient β is as high as 2·69. In the case of lohys, between values of 500 and 8000 for B, the values $\beta = 1{\cdot}62$ and $\alpha = 0{\cdot}00122$ approximately hold. In this case also the coefficient β rises to a high value when B is small.

Another matter investigated is the value of $\int H d B / H_0 B_{max.}$, where H_0 is the coercive force. Dr. Sumpner has pointed out that this quantity is a linear function of $B_{max.}$ over a large range. For stalloy and lohys the relation only holds apparently between values of B of 1000 and 9000.

The specific resistance and temperature coefficients were obtained in the case of each of the materials. The following figures are in each case the mean of the results of three independent experiments :—

	Mean specific resistance at 15° C. in 10^{-6} ohms per c.cm.	Mean temperature coefficients	
		0° to 50° C.	0° to 100° C.
Stalloy	49·63	0·000975	0·00103
Lohys	14·25	0·00424	0·00446

It will be seen that stalloy has a high specific resistance, which is important in connection with eddy current loss, as this is thereby reduced.

May 28.—"Effect of a Cross Wind on Rifled Projectiles." By A. **Mallock**, F.R.S.

The effect of wind on rifled projectiles is important for practical reasons, especially in the case of small arms, but the object of the present note is not so much to determine the actual effect of wind as to show that accurate experiments on the subject would afford valuable information concerning the flight of projectiles in still air.

It is easily shown that if the air resistance acts always in the direction of the resultant of the velocities of the wind and the projectile, the angle made by the resultant velocity with the line of aim remains constant throughout the range.

In order, however, that the resistance may act in the direction of the resultant velocity, the projectile must be symmetrical about that direction. This, in the case of any form except a sphere, means that the principal axis of the projectile must take the direction of the resultant velocity.

If this is assumed and we take v_0 as the initial velocity of the shot, w as the velocity of the wind (w/v_0 being small), and η as the coordinate of the shot perpendicular to the line of aim, we have at the time t

$$\eta = \frac{w}{v_0}(v_0 t - \mathrm{R}) \text{ or } w\left(t - \frac{\mathrm{R}}{v_0}\right) \qquad (1)$$

This result was first given by Captain Younghusband, R.N., and would be correct if the axis of the projectile set tself in the direction of the resultant velocity from the very beginning.

At first, however, the axis makes an angle w/v_0 with the velocity resultant, and the resistance has therefore a horizontal component at right angles to that resultant, for the same reason that a small angle between the axis of the projectile and the tangent to the trajectory produces an upward force on the former.

The question, then, as to how far (1) may be looked on as giving a true value for the effect of the wind turns on the rate at which the projectile can set its axis in the direction of the velocity resultant.

It is shown, however, in a former paper,[1] that to produce a given angular velocity of the axis of a projectile the couple must vary as the fourth power of the linear dimension.

For a given inclination of the axis to the direction of motion the couple applied by action of the air will vary as the cube of the linear dimension; thus the angular velocity of the axis will be inversely as the linear dimension, or, in other words, the time for a given angle will be as the linear dimensions.

For a given inclination the lateral force will be as the square of the linear dimension, and the distance to which the lateral force will carry the projectile while turning through the angle w/v_0 will be proportional to the linear dimension.

Thus instead of the expression in (1) we should write

$$\eta = \mathrm{AL} + w(t - \mathrm{R}/v_0), \qquad (2)$$

where L denotes the linear dimension and A some constant depending on the form, weight, and initial velocity of the projectile.

If careful experiments were made on wind deflection, the velocity of the wind being recorded at several positions along the range at the instant that each shot was fired, the value of A might be determined, and therefrom the angle which the axis of a projectile fired in still air makes with the tangent to the trajectory.

Physical Society, June 12.—Dr. Charles Chree, F.R.S., president, in the chair.—Experiments on a directive system of wireless telegraphy: E. **Bellini** and A. **Tosi**. The authors describe the results obtained in the course of their work upon a further development of their original directive system. In the earlier method previously described (*Electrical Engineering*, ii., p. 771, 1907, and iii., p. 348, 1908) it was not possible to say from which side of the receiving station the transmitted waves arrived, for though the radiation was practically confined to the plane of the aërial system, it was emitted equally in the opposite direction to that desired. In the new unilateral system the waves are sent in a single direction only, and the problem of getting rid of the backwardly extending radiation has thus been solved. The method adopted consists in superposing a bilateral directive system, as previously described, upon an ordinary or vertical antenna system. The system of unilateral directive wireless tele-

[1] "The Behaviour of Rifled Projectiles in Air," Roy. Soc. Proc., vol. lxxix., p. 547.

graphy described in the present paper is of special interest owing to the facility with which it is possible to change over from one system to the other, thus, from the ordinary vertical antenna system to the bilateral directive or the unilateral directive, or *vice versâ*. The aërial arrangements, moreover, remain exceedingly simple. When a message from a station of unknown position is expected, the vertical antenna or ordinary system would be employed; on once effecting reception, one can pass to the bilateral or unilateral directive system, and thus determine the direction and on which side the transmitting station lies, at the same time making oneself independent of other transmissions. In the same way, with the transmission, the vertical antenna would be employed for calling up an unknown station or for simultaneously sending to several stations; on getting a reply the operator can readily determine the position of the receiving station, with the aid of the unilateral system, and thenceforth will transmit solely in that direction.—The lateral vibration and deflection of clamped-directed bars: Dr. J. **Morrow.** This is an investigation of the problems which arise in connection with the lateral vibrations of clamped-directed bars. The term "directed" is used to describe the extremity of a bar which is constrained to maintain its original direction, but is free to take up any position of lateral deflection. These terminal conditions are mentioned in Rayleigh's "Sound," but are dismissed on the ground that the directed end cannot be realised experimentally. In the present paper, however, it is shown that the "directed" end is of great importance and of frequent occurrence in engineering practice, and, further, that by the aid of a simple device it can easily be investigated in the laboratory.—The resistance of a conductor of uniform thickness whose breadth suddenly changes, and on the shape of the stream-lines: Prof. C. H. **Lees.** A knowledge of the resistance of a conductor the section of which suddenly changes is of considerable practical importance, but mathematical difficulties have prevented an exact solution of the problem. The paper shows that the resistance between two transverse sections through points situated at considerable distance from the change of section on opposite sides of it is equal to the sum of the resistances of the portions of conductor between each of the two sections and the change of section, each considered as part of an infinite length, plus the resistance of a length of either conductor equal to its breadth multiplied by an expression given.—The inductance of two parallel wires: Dr. J. W. **Nicholson.** When direct and return currents flow in two wires of great length, and the alternation is not rapid, the effective self-induction per unit length of the system may be calculated readily by simple integration. If the wires have radii a, b, and permeabilities μ, ν, and if C be the distance between their axes,

$$L = 2 \log c^2/ab + \tfrac{1}{2}(\mu + \nu).$$

This formula is often of little practical use when the frequency of alternation is several thousands per second. Such frequencies are of constant use in practical work. For example, in the measurement of small inductances by Mr. Campbell's method, it is necessary to employ long leads in order to keep them at some considerable distance from the bridge and other circuits. The self-induction of these leads must be small, and a calculation of its value is very desirable. The general case presents very great mathematical difficulty, but the solutions given in the paper appear to include most cases of practical utility.—Homogeneous secondary radiation: Dr. **Barkla** and Mr. **Sadler.**—(1) Note on the amount of water in a cloud formed by expansion of moist air; (2) an elementary treatment of the motion of a charged particle in a combined electric and magnetic field: Prof. **Morton.**

DUBLIN.

Royal Irish Academy, May 11.—Dr. F. A. Tarleton, president, in the chair.—A synopsis of Irish algæ, freshwater and marine: J. **Adams.** After an historical account of past investigations on Irish algæ, and the various attempts to divide the country into botanical districts, there follow complete lists of the genera and species, and their geographical distribution in each of the four provinces is briefly indicated. For facility of reference the genera and species belonging to each of the main groups of algæ are arranged in alphabetical order. In all, 2224 species are included, 1379 species being fresh-water and 845 species marine. A summary of the total species recorded for each province is given, followed by a brief description of the local distribution of the rarer or more interesting species. At the end is a bibliography in which all known sources of information on the distribution of Irish algæ are indicated.

May 25.—Dr. F. A. Tarleton, president, in the chair.—Some unpublished work of the late Prof. Charles J. Joly, F.R.S., on geometry, part i.: Rev. W. R. Westropp **Roberts.** The author discusses curves, both plain and twisted, by expressing the coordinates of such curves in terms of a parameter, and deduces from this point of view the nature of their singularities.—Some general principles of the theory of dimensions: E. E. **Fournier d'Albe.** The author discusses the methods of discovering relations between physical quantities by means of their dimensions. He shows that when the quantity investigated is purely mechanical, and expressible in terms of length, mass, and time, it can depend upon not more than three independent variables, which are also purely mechanical quantities. When the number of fundamental units is increased, as by adding angle, temperature, or electric quantity, the number of independent physical variables is increased in proportion. The attempts to account mechanically for forces acting at a distance by means of dimensional formulæ are criticised.

PARIS.

Academy of Sciences, June 22.—M. H. Becquerel in the chair.—Study of the phenomena shown by concave wings in the stationary, floating, and hovering flight of birds: Marcel **Deprez.** A calculation of the horizontal and vertical components of the forces resulting from the action of air in motion on the surfaces of wings, supposed curved. The formula arrived at contains no other experimental condition than the mass of unit volume of air, thus dispensing with the empirical coefficients commonly employed.—M. Gaillot was elected a correspondant in the section of astronomy, in the place of the late M. Trepied.—The analysis of polymorphic curves: Émile **Borel.**—The orientation of an anisotropic ellipsoid in a uniform field: Georges **Meslin.**—The nature of charges of positive electricity and the existence of positive electrons: Jean **Becquerel.** The recent work by the author on the magneto-optic phenomena of the rare earths over a wide scale of temperature leads to the view that positive electrons exist; Lilienfeld has also obtained phenomena which he attributes to positive electrons, but these results have been negatived by Bestelmeyer and Marsh. In the present paper an account is given of experiments with a modified form of Crookes's tube. The results confirm the hypothesis of the existence of positive electrons.—The photographic registration of sound vibrations: Georges and Gustave **Laudet.** These photographs, which were obtained by purely mechanical means and without the aid of a microphone, are distinguished by the clearness of the line produced. Reproductions of the vowels and the sibilants *s* and *z* and of the word Laudet are given. No details are given of the method employed.—The relation between the biochemical effects of radiations and the quantity absorbed: H. **Guilleminot.** In studying the biochemical effects of the X-rays, it is more important to make quantitative measurements on the energy absorbed in the material than to measure the energy of the incident bundle. Fluoroscopic measurements of the incident rays show great divergences between the biochemical effects of the X-rays and the radium rays; these discrepancies disappear when the amount of energy really absorbed in the two cases is studied.—The heat of neutralisation of acetic and benzoic acids by aniline in benzene solution: Léo **Vignon** and M. **Évieux.** Aniline does not react to form salts with acetic and benzoic acids in benzene solutions. Aniline benzoate and acetate are destroyed by solution in benzene.—A new method of separation of silica and tungstic anhydride: Ed. **Defacqz.** At a red heat silica is not reduced by hydrogen, whereas tungstic anhydride is readily reduced to lower oxides under the same conditions. The latter are readily removed by heating in a current of chlorine, forming

volatile chlorides and oxychlorides, the silica remaining unchanged in the boat.—A new automatic principle applied to the carburettor: A. **Lauret.** A description of a new form of carburettor for internal combustion engines possessing the advantages of being free from moving parts, strictly automatic in its action, and freedom from liability to derangement.—The constitution of some derivatives of diphenylmethane and the preparation of some orthodiamines of this series: H. **Duval.**—The αα-dialkyl-β-ketonic alcohols and their transposition by dehydration: E. E. **Blaise** and I. **Herman.** The course of the transposition under the influence of alkalis of the ketone

$$CH_2(OH)—C(CH_3)_2—CO—C_2H_5$$

is shown to consist probably in a dehydration to

$$—CH—C(CH_3)_2—CO—C_2H_5,$$

followed by a migration of a methyl group resulting in the ketone

$$CH_3—CH=C(CH_3)—CO—C_2H_5.$$

—Study of the molecular concentration of the liquids of the organism in the pathological state: Adolphe **Javal.** The cryoscopic constant of liquids extracted from pathological growths is generally greater than the normal figure —0°·56, and it is shown that this cannot be accounted for by the presence of an abnormal excess of sodium chloride. The amount of nitrogenous products in these pathological fluids is above the normal, but is insufficient to account for the observed hypertonicity.—A chemical character differentiating the orthoses and the microclines: Ph. **Barbier.** The orthoses uniformly contain small quantities either of lithium or rubidium, frequently both; these elements are absent from the microclines. The exact method of separating these alkalis is given in detail.—*Synalpheion giardi*, an entoniscian parasite of *Synalpheus longicarpus*: H. **Coutière.**—The comparative anatomy and histology of the Blochmann glands in the Tectibranchs: Rémy **Perrier** and Henri **Fischer.**—Chromatic reactions and classification of the leucocytic granulations of the invertebrates: M. **Kolmann.**—Vascular elasticity and its variations: Gabriel **Arthaud.**—The acetyl derivative of atoxyl in sleeping sickness: Paul **Salmon.** The acetyl derivative of atoxyl has been in the form of sodium salt (sodium acetyl-para-amido-phenylarseniate) in experiments on the treatment of sleeping sickness. It possesses the advantages of being perfectly soluble, sterilisable at 100° C. without decomposition, and less toxic than atoxyl itself. Experiments on rats, guinea-pigs, and apes infected with *Trypanosoma gambiense* demonstrate that acetyl-atoxyl may be administered in doses four times as great as atoxyl, causing the disappearance of the trypanosome from the blood of the animals.—The geological constitution of the *massif* of Beni Snassen, Morocco: Louis **Gentil.**—The eolian origin of the finely divided minerals found on the sea floor: M. **Thoulet.** An account of a quantitative study of atmospheric dust collected on the tower of Nancy Cathedral, 75 metres above the ground.—Two new sheets of the industrial map of zoology of the coasts of France: M. **Joubin.**—The torrential origin of ruin-shaped limestone rocks: E. A. **Martel.**—The radio-activity of the waters of Ax (Ariège), demonstrated by photography: F. **Garrigou.**—Rain and the state of water-courses: Paul **Garrigou-Lagrange.**—The ablation of the glacier at Chamonix during fifteen years and during fifty years: J. **Vallot.**—New magnetic determinations in the western basin of the Mediterranean: Charles **Nordmann.**

NEW SOUTH WALES.

Linnean Society, March 25.—Mr. A. H. Lucas, president, in the chair.—Notes on the native flora of New South Wales, part vi., Deepwater to Torrington and Emmaville: R. H. **Cambage.** Although the locality the flora of which is described lies to the west of the Great Dividing Range, a large percentage of the plants noticed occur also in the Sydney district. The similarity of the two floras is attributable to somewhat similar geological formations, for while the Sydney rocks are sandstone, the acid granites of Torrington contain quite 75 per cent. of silica, and the soil derived therefrom approximates to that of a sandstone area. Reference is made to the occurrence of both inland and coastal plants, an association which is intelligible on the ground that the effect of higher altitude is counterbalanced by that of a more northerly latitude.—Note on the breeding habits of the red-bellied newt (*Molge pyrrhogastra*, Boie): E. R. **Waite.**

CAPE TOWN.

Royal Society of South Africa, April 6.—Mr. S. S. Hough, F.R.S., president, in the chair.—Transvaal sea-level temperatures: R. T. A. **Innes.** The object of the paper was to find what reductions applied to temperature readings in the Transvaal would reduce them to sea-level temperatures. For this purpose, a curve was plotted with the temperature entered horizontally and the altitudes vertically. This was assumed to be a parabola, and the correction was calculated on this assumption. A comparison with Buchan's maps in Bartholomew's Meteorological Atlas showed great differences. These the writer attributed to the fact that Buchan had no South African data on which to base his correction.—The geology and mineralogy of Albany: Prof. **Young.** The author described the evidence he had of volcanic action having occurred in the Albany district along a line of crustal weakness running east and west some miles to the south of Grahamstown. He described some investigations he had carried out on some of the rocks and minerals found in the neighbourhood of this volcanic line. The evidence goes to show that the district is mineralised with gold and other rare metals, and that a mineral grease or oil occurs in association with the rare metals. He also suggested several chemical reasons to account for the failure of most South African assayers to detect these metals, while the European assayers have found them in several hundreds of samples from Albany during the last two years.

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