THURSDAY, JULY 11, 1889.

AFRICAN RIVER LIFE.

A Visit to Stanley's Rear Guard at Major Bartelot's Camp on the Aruhwimi; with an Account of River Life on the Congo. By J. R. Werner. (Edinburgh and London: Blackwood and Sons, 1889.)

THAT, with our present knowledge of its geography and resources, Africa should be considered *the* special field for travellers *en grand*, is not surprising. Nor is it strange that merchants and moneyed men should be attracted to a land so rich in the means and materials of commerce. Immense progress has of late years been made in filling up the blanks for which its maps were notorious up to a very recent generation of school-boys; but the impulse in this direction is not yet expended, and Europe awaits eagerly much-needed enlightenment on the Sahara and Western Soudan, besides those countries of which more is heard, and remains to be heard, in the development of our existing foreign or colonial relations. To the north, Algiers and Egypt; to the south, the Cape of Good Hope and neighbouring territories; and east and west, the coast lines, and outlying islands generally, of the main land, have long since become familiar localities to students of travel and current events. It is only, however, within the last ten or fifteen years that equatorial Africa has been fairly opened out. Across the huge continent Europeans have now placed a broad and continuous girdle, reaching from the mouth of the Congo at Banana to the dominions of the Sultan of Zanzibar. Looked at from west to east, the component parts of this girdle are the French Congo, won to France by M. De Brazza and Belgian concession; the Portuguese Congo, allowed to Portugal in deference to a long-asserted claim, the frequent rejection of which by the English Foreign Office seemed to demand a change of treatment; the Free State of the Congo, founded and acquired by Stanley and a host of explorers and emissaries serving the King of the Belgians, first among promoters of Central African exploration; the wide-spreading German lands obtained from the chiefs of Usagara, Nguru, Useguha, and Ukanio, by three skilful and enterprising negotiators, whose work—like that of the Society of German Colonization—was almost immediately taken under the protection of the Imperial ægis on the signatures being affixed to the Treaty of Berlin; and now the girdle has become deepened by the important addition of the tracts ceded to the chartered Imperial British East African Company. What may be done by the Company dealing with the African Lakes is a problem the solution of which should belong to the combined or separate action of both philanthropists and commercial speculators.

If the progress of mapping out Africa has been marvellously rapid in the second half of the present century, the educational gain to the civilized world from the process is due not only to the labours of practical exploration, but also to the literary skill and ability with which those labours have been recorded. Travellers such as Burton, Speke, Grant, Livingstone, Baker, Johnson, Thomson, and Stanley, have been enabled, by the possession of natural qualifications, to give to the world their personal impressions and experiences with more or less of artistic power, and the advantage to a reading and appreciative public has been consequently great. But a second class of writers must not be ignored, who, without laying claim to the rank of chief explorers or the merit of original discovery, have shown themselves fully capable of strengthening the revelations of the princes of African travel, by chronicling the results of their own lesser, yet always intelligent, nomadism. Of this class Mr. Werner is a good representative. His well-written narrative might well have won attention as a mere description of African river life, without the use of an *ad captandum* title in reference to "Rear Guards."

The author, accepting service as an engineer under the Congo State, embarked from Antwerp in April 1886, arrived at Banána late in May, passed up the river to Boma and Matádi (which has taken the place of Vivi on the left bank), and left the latter station for Stanley Pool, by land, on June 10. After many days of roughing and sickness, he reached the Pool station at Leopoldville, was detained there until the middle of July, and on August 1 came to a halt at Bangala, his prescribed head-quarters. This is one of the more northerly posts of the Free State, and is situated about a third of the way between the Equator and Stanley Falls stations. Here he was seldom allowed to rest for many weeks together; for the little steamer to which he was attached was in constant requisition. In fact, his river expeditions—at one time of a punitive or political, at another of a searching or scientific character—extending, in advance, to Stanley Falls, and, in rear, to Leopoldville, or limited to places within either distance—form the substance of his book.

Mr. Werner's official residence may be described in his own words:—

"Bangala Station stands on the north bank of the Congo, in the town of Iboko, which forms the centre of a ten-mile line of towns and villages inhabited by the Ba-Ngala tribe. This settlement is surrounded on three sides by swamp, and on the fourth the River Congo cuts off all communication except by boat. According to native accounts it is possible in the dry season to go some two days' journey inland; and I should think it quite practicable to penetrate as far as the Oubangi, but as the tribes on the bank of that river are hostile to the Ba-Ngala, I had no means of ascertaining the fact, and I have never been more than six or seven hours' journey in that direction myself. I found the country gently undulating—the rising ground for the most part cleared and cultivated, and the hollows filled with a dense scrub, which, in the wet season, grew out of three or four feet of water, sometimes more. After some three hours' journey inland, all cultivation ceases, and the path runs through one continuous jungle of scrub, there being very few large trees."

Vivid pictures of scenery are not wanting in these pages, and a chapter headed "Exploration of the Ngala," gives an account of a nine days' endeavour to test the navigability and uses of a feeder of the Congo which empties itself into the larger river about forty or fifty miles above Iboko. This expedition was, however, brought abruptly to an end by hostilities on the part of angry and warlike tribesmen. Mention is also made of a large lake supposed to exist in the regions between the Lower Lomami and the head of the Congo, and to be distant only one day's canoe journey from the former. Its appearance in the map accompanying Mr.

Werner's narrative presents a new geographical feature, the warrant for which has probably by this time been confirmed or disallowed. But the chief interest attaching to the book arises from the description of living persons, European or native, who take, or have taken, part in the story of the Congo Free State. The narrative may not always be as gratifying as truthful; nor is the record of that kind of warfare which tells us of the shooting of natives as though they were but large game, quite pleasant reading; but allowance must be made for unrecorded provocations and exigencies, and let us hope that conciliation will have a wider field for exercise when the harder obstacles to peaceful settlement shall have been removed. No civilized being could wish for the renewal of days such as those in which Mr. Werner "saw more than one poor wretch put up his shield, only just in time to receive a ball right through it and himself as well, and come rolling down the clay bank into the river, dead as a door-nail." The author has dwelt, moreover, upon a passage in his own particular career which cannot but leave a painful impression on the mind of his reader. He had been told that Tippoo Tip had threatened mischief to Major Barttelot if certain conditions were unfulfilled, and he had been restrained by circumstances from communicating intelligence of the threat to that gallant and lamented officer. It is easy to understand how this non-revelation of foreshadowed ill haunted his brain, and how mental distress became aggravated by the sad news of Major Barttelot's death; but he may well derive consolation from the conviction that the reported threat was the outcome of a state of things which must have been fairly appreciated by all Europeans in those days encamped in the neighbourhood of Stanley Falls.

Mr. Werner is no doubt right in assuming that "facility of transport to the coast by means of railways and steamers will do more, by making slave-caravans unprofitable, to put down the curse of Africa," than the extinction of elephants—an hypothesis much favoured by recent writers. Were steam once made available for traffic along the main thoroughfares of the Dark Continent, the necessity for the employment of slaves in the conveyance of ivory would naturally cease, and one source of evil would thus be stopped by the mere force of circumstances—means quite as efficacious as, and more satisfactory than, armed intervention. In the final chapter the author considers with much intelligence and practical sagacity the different lines of communication now being opened out between the coast and the interior of Africa. These are notably, on the east, a land and water route from Uganda to the sea-mouth of the Tana River, passing through or skirting the possessions of the British East African Company: to the westward, the proposed railway to facilitate traffic between Banana and Stanley Falls; and, on the south, communications developing under the far from insignificant agency of the African Lakes Company. Truly, European enterprise is astir in the land; and England, the party most interested in the movement, if she remain content to be the most responsible speculator in its risks, should further seek to become the most important participator in its benefits.

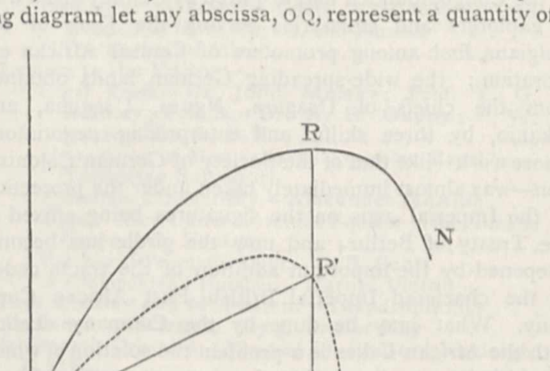
The attraction of this volume is enhanced by photographs and illustrations. Stanley's likeness is excellent, and the sketch of Mata Bwyki highly characteristic.

THE MATHEMATICAL METHOD IN POLITICAL ECONOMY.

Untersuchungen über die Theorie des Preises. Von Rudolf Auspitz und Richard Lieben. (Liepzig: Verlag von Duncker und Humblot, 1889.)

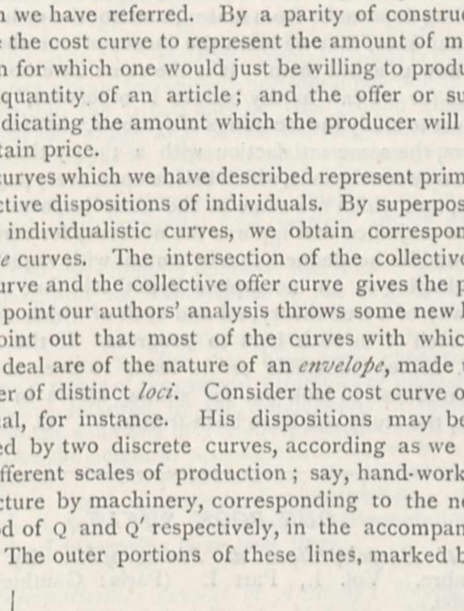
THE usefulness of mathematical reasoning applied to political economy, the value of the methods originated by Cournot and developed by Jevons, may be said to be still *sub judice*. The consideration of Messrs. Auspitz and Lieben's diagrams and symbols tends to confirm the opinion that mathematical analysis is a potent, if not an indispensable, means of obtaining clear general ideas in economics. The metaphysician who twists and turns the terms force and energy without grasping their mathematical signification is not more likely to become entangled in his talk than the practical man who reasons about supply and demand, and cost and value, without having once for all considered the ideas in their clearest and most abstract form. For the purpose of this contemplation Messrs Auspitz and Lieben employ a construction differing from most of their predecessors; namely, a figure in which the abscissa represents the quantity of a certain commodity, the ordinate the amount of some other article—in particular, money—which is exchanged for that which the abscissa represents. We cannot, however, quite admit the statement: "Unsere Kurven unterscheiden sich schon durch die zu Grunde gelegten Koordinaten von Jenen unserer Vorgänger." The same construction is used in the papers of an eminent English Professor, which, though unpublished, have been widely circulated in the learned world. It has also appeared in at least one English publication, Mr. Edgeworth's "Mathematical Psychics," with due acknowledgment to the distinguished originator.

However, our authors have made the construction their own by many important developments. They employ, in addition to demand and supply curves, a less familiar *locus*, which may be thus described. In the accompanying diagram let any abscissa, OQ, represent a quantity of a



certain commodity; and let QR represent the amount of money which a consumer would be just willing to give in exchange for the commodity OQ: in such wise that it would be indifferent to him whether he procured OQ on such terms, or did not consume the article at all. The *locus* of this point ON is called the utility curve. Correlated with this primary curve is the demand curve ON', which indicates the amount which any individual is willing to purchase at the price represented by the tangent of the angle R′OQ. The advantage which the individual derives from that purchase is represented by the length of the line RR′—that is, supposing money to be a uniform measure of value, which would cease to be true when the transaction is on a very large scale: for instance, the payment of so much as QR would so cripple a person's resources as to render money a more important object to him, to alter his *Wertschätzung des Geldes*. Still, even in this general case, ON is regarded as a "curve of constant satisfaction," which we may describe as much the same as the "line of indifference" of the English publication to which we have referred. By a parity of construction we have the cost curve to represent the amount of money in return for which one would just be willing to produce a certain quantity of an article; and the offer or supply curve indicating the amount which the producer will offer at a certain price.

The curves which we have described represent primarily the effective dispositions of individuals. By superposition of such individualistic curves, we obtain corresponding *collective* curves. The intersection of the collective demand curve and the collective offer curve gives the price. On this point our authors' analysis throws some new light. They point out that most of the curves with which we have to deal are of the nature of an *envelope*, made up of a number of distinct *loci*. Consider the cost curve of the individual, for instance. His dispositions may be represented by two discrete curves, according as we consider different scales of production; say, hand-work and manufacture by machinery, corresponding to the neighbourhood of Q and Q′ respectively, in the accompanying figure. The outer portions of these lines, marked black



in our figure, form the genuine cost curve; from which a similarly composite offer curve may be derived. This sort of discontinuity has not been unnoticed by other writers, in the case of production. But we believe that Messrs. Auspitz and Lieben are the first writers who have maintained that the *locus* on the side of consumption is similarly composite; that the demand curve is made up of several bits, corresponding to different styles of life (*Lebensweise*).

It follows from these conceptions that the demand and supply curve, whose intersection determines price, must be of a simple shape, not re-entrant and crumple-horned, as they have sometimes been represented. Whence we may deduce that—theoretically, and on the supposition of enlightened self-interest—the price which tends to prevail in an ideal market is not only determinate, but unique. There cannot be, as it were, several solutions of the equations of exchange. The interest of this conclusion will be apparent when it is remembered that the contrary statement is advanced as important by Mill, with respect to international trade, and by Prof. Sidgwick, with respect to trade in general.

The curves employed by Messrs. Auspitz and Lieben assist us in conceiving a subject on which many misapprehensions exist—the gain of foreign trade. It takes Mill and Prof. Sidgwick a good many words to prove that it is possible for a country, by a judicious import or export tax, to benefit itself at the expense of the foreigner. The truth is seen much more easily, and in a higher degree of generality, by a glance at the appropriate mathematical diagrams.

The method also adapts itself to the dealings of a monopolist. The influence of a single large dealer in competition with several small ones is represented by a construction of peculiar beauty and originality. If it is true that we are drifting towards a *régime* of trusts, combinations, and monster establishments, surely any ray of new light on this somewhat unexplored field ought to be welcomed. It may be difficult, perhaps, to estimate the positive practical value of this use of the mathematical method. We might compare, perhaps, the function of the sovereign science in respect to the theory of monopolies, with the duties of government in respect to their management—to exercise a general supervision without attempting to control details.

Messrs. Auspitz and Lieben have also treated the case of monopoly in which an individual or combination deals with another economic unit. They of course see the point, which is often missed by the *littérateur*, that, without perfect competition, the determination of price is, within certain limits, indeterminate. On the question, what basis of arbitration—in the absence of the mechanical principle of competition—should prevail, we venture to regard their answer as much more profound than that which has been given by the most eminent English Professors. An agreement to the terms which afford the greatest sum total of utility will tend to come to pass. The utilitarian position thus indicated would coincide with the settlement towards which perfect competition tends, upon a certain condition which our authors have introduced. The condition may be described as proper to perfect competition; namely, that every portion of an article should be exchanged at the same rate. We are not satisfied that our authors are justified in predicating this condition of a bargain, such as that between an employer and a combination of workmen. Nor do we accept the implied optimistic conclusion that, in the abstract at least, the play of competition in the labour market tends to the arrangement which is the best possible for all concerned.

But we are sensible that on points so abstruse it is hardly possible to make our own meaning, or that of our authors, clear, without a more copious use of symbols and verbal explanation than would be here admissible. We regret, also, that, while indicating some salient features of the work before us, we have not been able to bring out the beauty and completeness of the whole. Perhaps no other piece of reasoning which has issued from the mathematical school of economics is so perfectly fitted together. No other of equal originality is equally easy to understand. The intellectual pleasure which is compounded of mathematical exertion and the interest in human affairs is here enjoyed must purely. F. Y. E.

PROFESSOR VON "CRANK."

Richtigstellung der in bisheriger Fassung unrichtigen Mechanischen Wärmetheorie und Grundzüge einer allgemeinen Theorie der Aetherbewegungen. Von Albert R. von Miller-Hauenfels, Professor a. D. in Graz. Pp. 256. (Wien: Manz'sche k.k. Hof-Verlags- und Universitäts-Buchhandlung, 1889.)

IT is quite refreshing to come across a real "crank" among the sober Germans. As might be expected, there is a good deal of irregular metaphysics involved in the lucubrations of a German "crank." One would not, however, expect an entire ignorance of the first principles of the mathematics involved. The author of this hardly sufficiently ingenious to be even curious work begins by objecting to the well-known thermodynamic equation for perfect gases—

$$J(C-c) = p\frac{dv}{dt} = R = \frac{pv}{T},$$

because, forsooth, it is not identical with the general differential equation—

$$R = p\frac{dv}{dt} + v\frac{dp}{dt};$$

forgetting that the definition of C, as he himself gives it, assumes that, in the first equation, p is constant. In order to escape this invented difficulty, he loads himself with an equation—

$$JQ = Jcdt + vdp + pdv,$$

which involves the remarkable result that the heat required to warm a gas at constant volume is $JQ = Jcdt + vdp$, while by definition it is $= Jcdt$. It is not necessary to remark that the author carefully neglects to draw this conclusion. His equation is founded on the interesting principle that, when any event produces two different effects on the same organ of sense, each effect must be due to a separate flow of energy. When a mass of gas is warmed at constant volume, and one resists its expansion, one feels two effects with the same organ of sense: (1) the increase of pressure, and (2) the increase of temperature; and it is argued that each must be due to a separate flow of energy. This interesting principle leads to the startling conclusion that the heat required to change a body from one state to another, is independent of the states through which the body passes, and depends only on the initial and final states; and this startling conclusion involves the equally startling inference that the internal energy of a body *is* a function of the states it has passed through. It would be very interesting to study the difference between water that had frequently passed through some cyclic process, and water which had not: no chemist has yet detected the difference.

It would be multiplying words without wisdom to go through the elaborate bolstering of hypothesis by assumption and unreason required to deduce any semblance to fact from these beginnings. It may however, be worth while to notice something in the second part of this work on the nature of the ether. It is assumed that Fresnel has conclusively proved that an ether consisting of molecules which repel one another would transmit transverse vibrations like light; and, in order to turn the difficulty of the existence of longitudinal vibrations to useful account, it is assumed that these latter exist and are heat. It is hardly necessary to investigate a theory of electric and magnetic forces founded upon such an ether, and upon some curious ideas as to forces flowing from place to place.

And what is the use of spending time looking into such a work as this? It is by studying extraordinary and startling departures from reason, and not the ordinary and familiar ones, that we learn the causes of our aberrations and how to avoid them. It is the same unreasoning prejudice for "I can hardly believe it otherwise," the same neglect to study the meanings of symbols, whether words or letters, the same satisfaction with a theory that leads to some true conclusions, which bristle upon every page of this book, and which are some of the most important factors in the prejudice that ignores the necessity for verification, the muddle-headedness that is content with vague notions, the clinging to an incomplete hypothesis that stands in the way of a true theory, all and each of which are in all and each of us such bars to progress. If the study of Prof. Miller-Hauenfels' errors leads to even a state of preparedness to look out for similar errors in our own work, the study will have been fruitful. G. F. F. G.

OUR BOOK SHELF.

Traité Encyclopédique de Photographie. By Charles Fabre. Vol. I., Part I. (Paris: Gauthier-Villars, 1889.)

THIS is the first part of an encyclopædic work on the history and development of photographic methods. Its general object is to set forth, not only full particulars of the methods now in actual use, but also a complete story of the gradual improvements which have led up to them. There is little doubt that the rapid progress which has been made in photography has been largely due to the fact that the whole subject is so new, that every investigator who sets himself to work soon becomes familiar with what has gone before, and is thus in a position to consider what further advances are possible. It is certainly not too much to expect that such a work as is contemplated by M. Fabre will do a great deal towards simplifying the acquirement of this knowledge.

It is proposed to issue the work in twenty monthly parts, of which five parts will constitute a volume. The first volume will treat more particularly of the general history of photography and photographic apparatus, special attention being given to the subject of lenses. The second volume will deal with the production of negatives, and the third with positives of every description. The fourth volume will first treat of the methods of enlargement, and then of photographic chemistry and theories of the formation of photographic images. This comprehensive scheme, if well followed out, as no doubt it will be, if we may judge by the excellence of the first part, will obviously constitute a valuable addition to photographic literature.

In the first part the whole subject of lenses is considered, from the chemical composition of the various kinds of glass employed in their construction to the various combinations now used. Spherical aberration, distortion, astigmatism, and chromatic aberration, and their remedies, are all fully considered. A useful bibliography is also appended to each chapter.

Les Levers Photographiques, et la Photographie en Voyage. By Dr. Gustave Le Bon. Part I. (Paris: Gauthier-Villars et Fils, 1889.)

THIS work treats of methods of obtaining by means of photography elevations and plans of monuments, buildings, &c., the intention being to render unnecessary the laborious tasks and long calculations which up to the present time have been unavoidable.

The modifications a camera has to undergo before operations are begun consist of the addition, first, of an india-rubber support fitted between the camera and the tripod, and, secondly, of a graduated ground glass in the place of a plain one. The india-rubber support is to enable the camera always to assume a horizontal position in whatever position the tripod may be; the ground glass thus being parallel to the face of the building which is about to be photographed. There is also an arrangement by which the camera can be rotated. By means of the ground glass the dimensions of objects can be easily measured, and horizontal and vertical angles can be read off.

The first few chapters relate to methods of graduating this glass, and its employment in the measurement of angular distances, also the mode of determining the focal lengths of the lenses employed, and the measurement of the sizes of objects after they have been photographed. Chapter v. treats of the general principles of photographic perspective, followed by the applications of those principles to the solutions of various problems, such as, "To determine the height of an inaccessible tower by a single photograph;" "To obtain without any measurement on the object itself its various dimensions," &c. Lastly, Chapter vi. deals with photographic triangulation and methods of measuring large base lines.

The International Annual of Anthony's Photographic Bulletin. Edited by W. J. Harrison, F.G.S., and A. H. Elliot, Ph.D., F.C.S. (London: Illiffe and Son, 1889.)

THIS is the second issue of an interesting and useful work. The number of articles has been considerably increased, and there is also an increase in the number of tables at the end, which will be of service both to professional and to amateur photographers. Various methods of printing are displayed in the illustrations. Two pretty views are given, one of which is taken with Dallmeyer's long-focus rapid landscape lens, and the other with his wide-angle landscape lens, showing well the effect of these different focus lenses. No pains seem to have been spared to make this issue surpass the first one, and the editors are to be congratulated on the results of their labours.

Industrial Education. By Sir Philip Magnus. (London: Kegan Paul, Trench, and Co.)

THE articles and addresses brought together in this volume form a valuable contribution to the study of one of the most important and interesting questions of the present day. Sir Philip Magnus has not attempted to exhaust his subject, or to deal with it systematically. He merely presents it from various points of view, offering suggestions as to the urgent need for a proper technical training, and as to the methods which may be most fitly used for the attainment of the ends in view. Every page bears witness not only to the writer's general knowledge and ability, but to his practical familiarity with all the aspects of the problems he discusses. One of the best papers in the book is that in which he gives an account of the school system of Bavaria, whose educational arrangements are not so well understood in this country as those of Prussia. No one who reads this paper, and takes into account all that has been done for education in the other States of Germany, will find much difficulty in explaining the fact that in industry and trade the Germans have become our most formidable competitors. Another excellent paper is on mercantile training, and there is also a good paper on technical instruction in elementary schools.

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.*]

An Index to Science.

I AM glad to see that Mr. Taylor Kay has again brought forward the question of a subject index to scientific periodicals. I say again, because the proposal to make such an index was suggested by me in a short letter in NATURE, vol. xviii. p. 251, and more fully at the first meeting of the Library Association at Oxford, in October 1878 (Transactions of Library Association, 1878, p. 85). Dr. Garnett also read a paper before the same Association on this subject in 1879, which was fully printed in NATURE, vol. xx. p. 554. In my original letter I suggested making the index from the papers themselves, and not from the Royal Society's Catalogue; my reason for this was the difficulty that must be experienced in indexing many papers, should the indexer have nothing but the title in front of him. Reference to the paper is absolutely necessary in many instances, especially when the title does not fully set forth its contents. Dr. Garnett, however, pointed out that much labour might be saved if the Royal Society would give two copies of its Catalogue of Scientific Papers, which might be cut up to form the copy of the subject-index. There can be no doubt that Dr. Garnett is right, because, by his plan, however many papers it might be necessary to refer to, the amount of labour as regards manuscript would be very materially diminished. The greatest difficulty of all is the money. Mr. Taylor Kay takes comfort in a Treasury Minute of November 1864, and hopes, from that, that help might be obtained from the Government. I am afraid, however, it will damp his ardour to be told that the Government have refused to bear the cost of printing the Catalogue for the decade 1874–83, although the matter is all ready for the press. It seems to me that, as suggested in my original paper, the co-operation of the learned Societies is the only way in which the necessary funds can be obtained.

I gather from Mr. Taylor Kay's paper that he rather suggests a "classified" list of papers. If that be so, I would like to protest against such an undertaking, feeling sure that it will, like all its predecessors, be doomed to failure. What is wanted is an index pure and simple, in which information can be turned up without consideration as to what "class" or "classes" the indexer has thought fit to enter the subject under. Anyone who has used the admirable catalogue of Dr. Billings will at once admit its superiority to any "classified" arrangement, whether it be that of Comte or of any other philosopher.

The question of this index has been hanging fire too long, and I should be delighted if Mr. Taylor Kay's paper were the means of some active steps being taken to start the work. Poole's Index is a standing answer to those who say it cannot be done. All that we want are willing hands and a long purse: if the scientific Societies or an enterprising publisher will find the latter, I cannot believe the former will be wanting.

JAMES BLAKE BAILEY.

Royal College of Surgeons, July 5.

A Cordial Recognition.

I HAVE just witnessed a curious case of bird instinct which seems worth recording. A gardener living at Zukaleriá, three miles from here, caught in his garden a young but fully fledged sparrow, which he brought to the house of a friend with whom we are staying in Canea, leaving home early in the morning. He presented the bird to one of the children in the house, and it was put in a cage and hung at the window, where it seemed likely to be contented, losing its fright after a few hours. Late in the afternoon an old bird was noticed fluttering about the cage apparently trying to get at the little one, and the young bird on its appearance became frantic to get out to the old one. It was evidently the mother of the young one, as the recognition was too cordial to have been owing to the interest of a strange bird; and when my daughter opened the cage, as she did after a little, they both flew off rapidly in the direction of Zukaleriá. It is impossible that the old bird should have followed the gardener, as we should have seen it earlier in the day.

Canea, Crete, June 27. W. J. STILLMAN.

Seismology in Italy.

I HAVE only lately seen Dr. Johnston-Lavis's article in NATURE (vol. xxxix. p. 329), on the present state of seismology in Italy. I have read it with much interest, and with the greatest satisfaction, because it deals with the most recent works due to the new and serious impulse given to the study by the Government during the last five years. I thank the author for having noticed one of my writings, "Sulla sistemazione delle osservazioni geodinamiche regolari." There is little—hardly anything—absolutely new in this work, because in writing it I desired only to sum up the deliberations of the Royal Geodynamical Commission, to which I had the honour to belong. I also brought together in it all that was really serious and positive in other works, with the intention of dispelling the confusion which unhappily prevailed when this scientific branch was in the power of dilettantism, which had the prerogative of the long-winded style, the charlatanism, and the seismic magic, of which the author of the article justly complains. In a word, I wished to set forth a proper programme, with the ideas which the Commission conceived, and which continue to form the principle of the deliberations of the directing Council for Meteorology and Geodynamics, in which the Commission has been merged On this serious and well-determined principle the service is continued in the island of Ischia as elsewhere.

In accordance with the just ideas of your correspondent, I must nevertheless make one remark on the subjects which relate more especially to the studies carried on in the island of Ischia; namely, that there is really something of novelty in some of the other writings of mine included in the volume that contains the work commented on.

One of these writings consisted of the theoretical relation I presented in response to the demand of the Royal Geodynamical Commission in the sittings of June 1886. The approval of this work by the Commission contributed to the adoption, for the study of the form of seismic movements, of the mechanical principle of three components adapted to a steady point. This principle was studied, and put into execution, by the mechanicians Brassart of the Central Office of Meteorology and Geodynamics; and while it has tended to simplify completely the methods used in the observation of earthquakes, and to bring to an end the innumerable imperfections of former times, it is not even yet well understood by men of the old school.

Three of my works relate to the variations observed in the temperature of the thermal springs at Porto d'Ischia. A rigorously mathematical analysis has revealed a hydrostatical law in relation to changes in the level of the sea. Later studies which I undertook upon the diagrams of a registering thermometer, and which the Director, Prof. Tacchini, presented to the Accademia dei Lincei on October 7, 1888, proved the influence exerted by the horary state of the tide, while previously some isolated observations had made way for hypotheses of another nature.

Another of my works expounds a new principle for rendering astatic—or nearly so—in a horizontal direction, the steady point in seismographs, and gives a mathematical demonstration of it. Upon this principle, which I conceived in 1886, is apparently based the construction of an instrument by Prof. Ames (see the *American Journal of Science*, February 1888, p. 106); but the fact that he has made the suspension with four threads, instead of three, suffices to prove that he has not formed a precise idea of my original principle, and that he has much less considered it necessary to procure for himself the mathematical proof of it. Some months before the publication of Mr. Ames's work I took care to bring out prominently, on p. 266 of the volume referred to, the error to which one would expose oneself in this way.

Of the ten writings by me in the volume, these are the works to which I attach some importance; and I take the liberty of directing to them the attention of your readers, in the hope of making known the beginnings of the success which is to be achieved through the action of the Italian Government. For the rest, the history of this enterprise is set forth in the abstract of the sittings which forms the introduction of the volume.

GIULIO GRABLOVITZ,
Director of the Osservatorio Geodinamico di Casamicciola.

Saxicava Borings and Valves in a Boulder Clay Erratic.

WHEN examining a few weeks ago the boulders in the workings of the New Ferry Brick and Tile Company, Cheshire, with Mr. Harnett Harrisson, we discovered a boulder having superficially a scoriaceous appearance, which on examination proved to be of limestone, and perforated with Saxicava and other borings. After careful washing several of the burrows were found to be occupied by the shells of the animal that had made them, both valves complete. The washings that came out of the burrows after careful reduction by pouring off the clay water I found to consist of well-rounded grains of quartz intermixed with a few microscopic drift pebbles and small shell fragments. Some of them were very much rounded and waterworn. Several broken spines of Echinus also occurred.

The stone was taken from a heap picked out of the boulder clay previous to passing it through the machine. There is no doubt as to its origin, as one side is strongly planed and striated in the direction of the longer axis. The extreme measurements are $6\frac{1}{2}'' \times 4\frac{1}{2}'' \times 2\frac{3}{4}''$; weight, 3 lbs. 10 oz. The Saxicava burrows are placed so as to give the idea that the stone had lain on the glaciated side when most of them were made, as they get nearly horizontal towards the glaciated bottom. The termination of one burrow, however, occurs on the planed face. There are also other worm-like burrows which occur on the glaciated face, and one of them has been cut longitudinally for a length of an inch by the plane of glaciation.

It is now about eighteen years since I commenced a study of the glacial deposits of the north-west of England, but have never found a similar example with the burrows occupied, although the low-level boulder clay in which it occurs is almost universally more or less full of shell fragments. The bearing of the discovery on the origin of the low-level boulder clay is obvious.

The history of the stone appears to have been this. It had its origin in the Carboniferous limestone of the north; it has then been rounded into a boulder, has lain upon a shore, and become the seat of operations of molluscan and other burrowers. Afterwards it has been frozen into coast-ice, glaciated by attrition on a pebbly or rocky shore through tidal movement, has been again released from the ice grip, spent another time on the shore resting on its glaciated face, during which period it became perforated with the Saxicava burrows now occupied by the remains of the animal. While still on the shore, fragments of shells of other Mollusca got washed into the occupied and unoccupied perforations, and finally it was again frozen into coast-ice, floated off, and dropped into the bed of the low-level boulder clay sea, where it remained undisturbed until the pick of the brickmaker disinterred it. The boulder clay in which it occurs is plastic, and contains comparatively few stones, and there are no sand seams to be seen in the present face, though I believe they occur at a greater depth below the bottom of the pit.

The special interest of this example lies in the proof it affords of the marine origin of the low-level boulder clay of Cheshire and Lancashire. Some geologists contend that this clay is the bottom of the Irish Sea ploughed up by land ice, but the necessities of a theory that requires such an operation to have taken place in the past when there is an obvious and simple explanation at hand does not commend it to my mind. It is not even proved that such a ploughing up is possible; no examples are adduced where such a phenomenon is going on; it does not account for the structure of the beds of low-level boulder clay; and speaking from eighteen years of close investigation, there is no necessity in the nature of the case for resorting to such an extreme hypothesis.

The age of land ice preceded that of the low-level marine boulder clay, and numerous examples of striated rock surfaces and other phenomena occurring below the low-level marine boulder clay can be quoted in support thereof.

T. MELLARD READE.

Park Corner, Blundellsands, June 5.

Test of Divisibility by any Prime.

IN NATURE of May 30 (p. 115), Mr. Tucker has given the formula :—

$$N = 21M + 10^{n-1}(7Q) = 7Q'.$$

In an exactly similar way we may show that—

$N = 11M + 10^{n-1}(11Q) = 11Q'$, giving a multiplier 1,
$N = 91M + 10^{n-1}(13Q) = 13Q'$, ,, ,, 9,
$N = 51M + 10^{n-1}(17Q) = 17Q'$, ,, ,, 5,

&c., &c., for any number ending in digits 1, 3, 7, or 9.[1]

The general principle may be simply shown as follows :—

We have $17 \times 3 = 5{\cdot}1$, say.

This means (1) that, if *any number* ends in unity, and is also of Form 17M, then all the figures to the left of unity will form a number of Form 17M + 5.

It also means (2) that, if we *multiply the units digit* by 5 (casting out the prime 17, if need be), we get the figures to the left ; *e.g.* 2346 ends in 6, and is of Form 17M. Therefore, 234 is of Form 17M + 13 (since $17 \times 8 = 13{\cdot}6$) ; also, $6 \times 5 = 30$, and $30 - 17 = 13$. The process can be repeated to any extent. Thus, since $234 = 17M + 13$, subtract 13 from 234, giving $221 = 17M_1$. Since 221 ends in unity, therefore 22 is of Form 17M + 5, and, subtracting 5 from 22, we have $17 = 17M_2$. Hence the rule.

From similar considerations I have deduced the following formula, giving the periodicity of $\frac{1}{N}$ where N is a prime :—

If $[\{(uN + 1)/10\}^p + N - 1]/N \equiv I$ (an integer), then p will be the periodicity of 1/N.

Here u means the unit's digit of N, or else the integral quotient of 9 divided by the unit's digit.

Thus for all numbers ending in 9 the formula becomes $[\{(N + 1)/10\}^p + N - 1]/N$, *e.g.* $(2^p + 18)/19$ gives the periodicity of 1/19, &c.

The corresponding formulæ for numbers ending in 7, 3, 1, are, respectively,

$$[\{(7N + 1)/10\}^p + N - 1]/N ;\ [\{(3N + 1)/10\}^p + N - 1]/N ;$$
$$[\{(9N + 1)/10\}^p + N - 1]/N.$$

Another useful deduction from the same principle is :—

If p be the periodicity of the recurring fraction 1/N (where N ends in 1, 3, 7, or 9), then the test will give the true remainder of any $p + 2$ figures; *e.g.* What is the remainder of $98765 \div 37$?

Since $37 \times 3 = 11{\cdot}1$, our multiplier is 11.

Therefore $9876 - 11 \times 5 = 9821$, and $982 - 11 \times 1 = 971$.

Also $97 - 11 \times 1 = 86 = 37M + 12$. Thus 12 is the remainder.

I find that by this new process the remainder may be obtained in about one-half of the time taken by the ordinary method of division.

ROBT. W. D. CHRISTIE.

Wavertree Park College, Liverpool.

QUARTZ FIBRES.[2]

IN almost all investigations which the physicist carries out in the laboratory, he has to deal with and to measure with accuracy those subtle and to our senses inappreciable forces to which the so-called laws of Nature give rise. Whether he is observing by an electrometer the behaviour of electricity at rest, or by a galvanometer the action of electricity in motion ; whether in the tube of Crookes he is investigating the power of radiant matter, or with the famous experiment of Cavendish he is finding the mass of the earth—in these and in a host of other cases he is bound to measure with certainty and accuracy forces so small that in no ordinary way could their existence be detected ; while disturbing causes which might seem to be of no particular consequence must be eliminated if his experiments are to have any value. It is not too much to say that the very existence of the physicist depends upon the power which he possesses of producing at will and by artificial means forces against which he balances those that he wishes to measure.

I had better perhaps at once indicate in a general way the magnitude of the forces with which we have to deal.

The weight of a single grain is not to our senses appreciable, while the weight of a ton is sufficient to crush the life out of anyone in a moment. A ton is about 15,000,000 grains. It is quite possible to measure with unfailing accuracy forces which bear the same relation to the weight of a grain that a grain bears to a ton.

To show how the torsion of wires or threads is made use of in measuring forces, I have arranged what I can hardly dignify by the name of an experiment. It is simply a straw hung horizontally by a piece of wire. Resting on the straw is a fragment of sheet-iron weighing ten grains. A magnet so weak that it cannot lift the iron yet is able to pull the straw round through an angle so great that the existence of the feeble attraction is evident to every one in the room.

Now it is clear that if, instead of a straw moving over the table simply, we had here an arm in a glass case and a mirror to read the motion of the arm, it would be easy to observe a movement a hundred or a thousand times less than that just produced, and therefore to measure a force a hundred or a thousand times less than that exerted by this feeble magnet.

Again, if instead of wire as thick as an ordinary pin I had used the finest wire that can be obtained, it would have opposed the movement of the straw with a far less force. It is possible to obtain wire ten times finer than this stubborn material, but wire ten times finer is much more than ten times more easily twisted. It is ten thousand times more easily twisted. This is because the torsion varies as the fourth power of the diameter, so we say $10 \times 10 = 100$; $100 \times 100 = 10{,}000$. Therefore with the finest wire, forces 10,000 times feebler still could be observed.

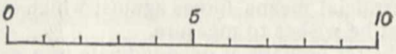
It is therefore evident how great is the advantage of reducing the size of a torsion wire. Even if it is only halved the torsion is reduced sixteen-fold. To give a better idea of the actual sizes of such wires and fibres as are in use I shall show upon the screen a series of photographs taken by Mr. Chapman, on each of which a scale of thousandths of an inch has been printed.

The first photograph (Fig. 1) is an ordinary hair—a sufficiently familiar object, and one that is generally spoken of as if it were rather fine. Much finer than this is the specimen of copper wire now on the screen (Fig. 2), which I recently obtained from Messrs. Nalder Brothers. It is only a little over one-thousandth of an inch in diameter. Ordinary spun glass, a most beautiful material, is about one-thousandth of an inch in diameter, and this would appear to be an ideal torsion thread (Fig. 3). Owing to its fineness its torsion would be extremely small, and the more so because glass is more easily deformed than metals. Owing to its very great strength, it can carry heavier loads than would be expected of it. I imagine many physicists must have turned to this material in their endeavour to find a really delicate torsion thread. I have so turned only to be disappointed. It has every good quality but one, and that is its imperfect elasticity. For instance, a mirror hung by a piece of spun glass is casting an image of a spot of light on the scale. If I turn the mirror, by means of a fork, twice to the right, and then turn it back again, the light does not come back to its old point of rest, but oscillates about a point on one side, which, however, is slowly changing, so that it is impossible to say what the point of rest really is. Further, if the glass is twisted one way first, and then the other way, the point of rest

[1] These numbers only can give, when multiplied, all the digits in the units place.

[2] Lecture delivered at the Royal Institution, on Friday, June 14, by Mr. C. V. Boys, F.R.S.

moves in a manner which shows that it is not influenced by the last deflection alone: the glass remembers what was done to it previously. For this reason spun glass is quite unsuitable as a torsion thread; it is impossible to



Scale of 1000ths of an inch for Figs. 1 to 7. The scale of Figs. 8 and 9 is much finer.

FIG. 1.

FIG. 2.

say what the twist is at any time, and therefore what is the force developed.

So great has the difficulty been in finding a fine torsion thread that the attempt has been given up, and in all the most exact instruments silk has been used. The natural

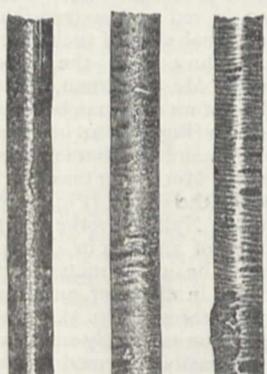


FIG. 3.

cocoon fibres, as shown on the screen (Fig. 4), consist of two irregular lines gummed together, each about one two-thousandth of an inch in diameter. These fibres must be separated from one another and washed. Then each component will, according to the experiment of Gray, carry nearly 60 grains before breaking, and can be safely loaded with 15 grains. Silk is therefore very strong, carrying at the rate of from 10 to 20 tons to the square inch. It is further valuable in that its torsion is far less than that of a fibre of the same size of metal or even of glass, if such could be produced. The torsion of silk, though exceedingly small, is quite sufficient to upset the working of any delicate instrument, because it is never constant. At one time the fibre twists one way, and another time in another, and the evil effect can only be mitigated by using large apparatus in which strong forces are developed. Any attempt that may be made to increase the delicacy of apparatus by reducing their dimensions is at once prevented by the relatively great importance of the vagaries of the silk suspension.

The result, then, is this. The smallness, the length of period, and therefore delicacy, of the instruments at the physicist's disposal have until lately been simply limited by the behaviour of silk. A more perfect suspension means still more perfect instruments, and therefore advance in knowledge.

It was in this way that some improvements that I was making in an instrument for measuring radiant heat came

FIG. 4.

to a deadlock about two years ago. I would not use silk, and I could not find anything else that would do. Spun glass, even, was far too coarse for my purpose; it was a thousand times too stiff.

There is a material invented by Wollaston long ago, which, however, I did not try because it is so easily broken. It is platinum wire which has been drawn in silver, and finally separated by the action of nitric acid. A specimen about the size of a single line of silk is now on the screen, showing the silver coating at one end (Fig. 5).

As nothing that I knew of could be obtained that would be of use to me, I was driven to the necessity of trying by experiment to find some new material. The result of these experiments was the development of a process of almost ridiculous simplicity which it may be of interest for me to show.

The apparatus consists of a small cross-bow, and an arrow made of straw with a needle point. To the tail of the arrow is attached a fine rod of quartz which has been melted and drawn out in the oxyhydrogen jet. I have a piece of the same material in my hand, and now after melting their ends and joining them together, an operation which produces a beautiful and dazzling light, all I have to do is to liberate the string of the bow by pulling the trigger with one foot, and then if all is well a fibre will have been drawn by the arrow, the existence of which can be made evident by fastening to it a piece of stamp-paper.

In this way threads can be produced of great length, of almost any degree of fineness, of extraordinary uniformity, and of enormous strength. I do not believe, if any experimentalist had been promised by a good fairy that he might have anything he desired, that he would have ventured to ask for any one thing with so many valuable properties as these fibres possess. I hope in the course of this evening to show that I am not exaggerating their merits.

In the first place, let me say something about the degree of fineness to which they can be drawn. There is now projected upon the screen a quartz fibre one five-thousandth of an inch in diameter (Fig. 6). This is one which I had in constant use in an instrument loaded with about 30 grains. It has a section only one-sixth of that of a single line of

Fig. 5.

silk, and it is just as strong. Not being organic, it is in no way affected by changes of moisture and temperature, and so it is free from the vagaries of silk which give so much trouble. The piece used in the instrument was about 16 inches long. Had it been necessary to employ spun glass, which hitherto was the finest torsion material, then, instead of 16 inches, I should have required a piece 1000 feet long, and an instrument as high as the Eiffel tower to put it in.

There is no difficulty in obtaining pieces as fine as this yards long if required, or in spinning it very much finer. There is upon the screen a single line made by the small garden spider, and the size of this is perfectly evident (Fig. 7). You now see a quartz fibre far finer than this, or, rather, you see a diffraction phenomenon, for no true image is formed at all; but even this is a conspicuous object in comparison with the tapering ends, which it is absolutely impossible to trace in a microscope. The next two photographs, taken by Mr. Nelson, whose skill and resources are so famous, represent the extreme end of a tail of quartz, and though the scale is a great deal larger than that used in the other photographs, the end will be visible only to a few. Mr. Nelson has photographed here what it is absolutely impossible to see. What the size of these ends may be, I have no means of telling. Dr. Royston Piggott has estimated some of them at less than one-millionth of an inch, but whatever they are they supply for the first time objects of extreme smallness the form of which is certainly known, and therefore I cannot help looking upon them as more satisfactory tests for the microscope than diatoms and other things of the real shape of which we know nothing whatever.

Since figures as large as a million cannot be realized properly, it may be worth while to give an illustration of what is meant by a fibre one-millionth of an inch in diameter.

A piece of quartz an inch long and an inch in diameter would, if drawn out to this degree of fineness, be sufficient to go all the way round the world 658 times; or a grain of sand just visible—that is, one-hundredth of an inch long and one-hundredth of an inch in diameter—would make 1000 miles of such thread. Further, the pressure inside

Fig. 6.

Fig. 7.

such a thread due to a surface tension equal to that of water would be 60 atmospheres.

Going back to such threads as can be used in instruments, I have made use of fibres one ten-thousandth of an inch in diameter, and in these the torsion is 10,000 times less than that of spun glass.

As these fibres are made finer their strength increases in proportion to their size, and surpasses that of ordinary bar steel, reaching, to use the language of engineers, as high a figure as 80 tons to the inch. Fibres of ordinary size have a strength of 50 tons to the inch.

While it is evident that these fibres give us the means of producing an exceedingly small torsion, and one that is not affected by weather, it is not yet evident that they may not show the same fatigue that makes spun glass useless. I have therefore a duplicate apparatus with a quartz fibre, and you will see that the spot of light comes back to its true place on the screen after the mirror has been twisted round twice.

I shall now for a moment draw your attention to that peculiar property of melted quartz that makes threads such as I have been describing a possibility. A liquid cylinder, as Plateau has so beautifully shown, is an un-stable form. It can no more exist than can a pencil stand on its point. It immediately breaks up into a series of spheres. This is well illustrated in that very ancient experiment of shooting threads of resin electrically. When the resin is hot, the liquid cylinders which are projected in all directions break up into spheres, as you see now upon the screen. As the resin cools, they begin to develop tails; and when it is cool enough, *i.e.* sufficiently viscous, the tails thicken and the beads become less, and at last uniform threads are the result. The series of photographs show this well.

There is a far more perfect illustration which we have only to go into the garden to find. There we may see in abundance what is now upon the screen—the webs of those beautiful geometrical spiders. The radial threads are smooth like the one you saw a few minutes ago, but the threads that go round and round are beaded. The spider draws these webs slowly, and at the same time pours upon them a liquid, and still further to obtain the effect of launching a liquid cylinder in space he, or rather she, pulls it out like the string of a bow, and lets it go with a jerk. The liquid cylinder cannot exist, and the result is what you now see upon the screen (Fig. 8). A more perfect

FIG. 8.

FIG. 9.

illustration of the regular breaking up of a liquid cylinder it would be impossible to find. The beads are, as Plateau showed they ought to be, alternately large and small, and their regularity is marvellous. Sometimes two still smaller beads are developed, as may be seen in the second photograph, thus completely agreeing with the results of Plateau's investigations.

I have heard it maintained that the spider goes round her web and places these beads there afterwards. But since a web with about 360,000 beads is completed in an hour—that is, at the rate of about 100 a second—this does not seem likely. That what I have said is true, is made more probable by the photograph of a beaded web that I have made myself by simply stroking a quartz fibre with a straw wetted with castor oil (Fig. 9). It is rather larger than a spider line; but I have made beaded threads, using a fine fibre, quite indistinguishable from a real spider web, and they have the further similarity that they are just as good for catching flies.

Now, going back to the melted quartz, it is evident that if it ever became perfectly liquid it could not exist as a fibre for an instant. It is the extreme viscosity of quartz, at the heat even of an electric arc, that makes these fibres possible. The only difference between quartz in the oxyhydrogen jet and quartz in the arc is that in the first you make threads and in the second are blown bubbles. I have in my hand some microscopic bubbles of quartz showing all the perfection of form and colour that we are familiar with in the soap bubble.

An invaluable property of quartz is its power of insulating perfectly, even in an atmosphere saturated with water. The gold leaves now diverging were charged some time before the lecture, and hardly show any change, yet the insulator is a rod of quartz only three-quarters of an inch long, and the air is kept moist by a dish of water. The quartz may even be dipped in the water and replaced with the water upon it without any difference in the insulation being observed.

Not only can fibres be made of extreme fineness, but they are wonderfully uniform in diameter. So uniform are they that they perfectly stand an optical test so severe that irregularities invisible in any microscope would immediately be made apparent. Everyone must have noticed when the sun is shining upon a border of flowers and shrubs how the lines which spiders use as railways to travel from place to place glisten with brilliant colours. These colours are only produced when the fibres are sufficiently fine. If you take one of these webs and examine it in the sunlight, you will find that the colours are variegated, and the effect consequently is one of great beauty.

A quartz fibre of about the same size shows colours in the same way, but the tint is perfectly uniform on the fibre. If the colour of the fibre is examined with a prism, the spectrum is found to consist of alternate bright and dark bands. Upon the screen are photographs taken by Mr. Briscoe, a student in the laboratory at South Kensington, of the spectra of some of these fibres at different angles of incidence. It will be seen that coarse fibres have more bands than fine, and that the number increases with the angle of incidence of the light. There are peculiarities in the march of the bands as the angle increases which I cannot describe now. I may only say that they appear to move not uniformly but in waves, presenting very much the appearance of a caterpillar walking.

So uniform are the quartz fibres that the spectrum from end to end consists of parallel bands. Occasionally a fibre is found which presents a slight irregularity here and there. A spider line is so irregular that these bands are hardly observable; but as the photograph on the screen shows, it is possible to trace them running up and down the spectrum when you know what to look for.

To show that these longitudinal bands are due to the irregularities, I have drawn a taper piece of quartz by hand, in which the two edges make with one another an almost imperceptible angle, and the spectrum of this shows the gradual change of diameter by the very steep angle at which the bands run up the spectrum.

Into the theory of the development of these bands I am unable to enter: that is a subject on which your Professor of Natural Philosophy is best able to speak. Perhaps I may venture to express the hope, as the experimental investigation of this subject is now rendered possible, that he may be induced to carry out a research for which he is so eminently fitted.

Though this is a subject which is altogether beyond me, I have been able to use the results in a practical way. When it is required to place into an instrument a fibre of any particular size, all that has to be done is to hold the frame of fibres towards a bright and distant light, and look at them through a low-angled prism. The banded spectra are then visible, and it is the work of a moment to pick out one with the number of bands that has been found to be given by a fibre of the desired size. A coarse fibre may have a dozen or more, while such fibres as I find most useful have only two dark bands. Much finer ones exist, showing the colours of the first order with one dark band; and fibres so fine as to correspond to the white or even the gray of Newton's scale are easily produced.

Passing now from the most scientific test of the uniformity of these fibres, I shall next refer to one more homely. It is simply this: the common garden spider, except when very young, cannot climb up one of the same size as the web on which she displays such activity. She is perfectly helpless, and slips down with a run. After vainly trying to make any headway, she finally puts her hands (or feet) into her mouth, and then tries again, with no better success. I may mention that a male of the same species is able to run up one of these with the greatest ease, a feat which may perhaps save the lives of a few of these unprotected creatures when quartz fibres are more common.

It is possible to make any quantity of very fine quartz fibre without a bow and arrow at all, by simply drawing out a rod of quartz over and over again in a strong oxyhydrogen jet. Then, if a stand of any sort has been placed a few feet in front of the jet, it will be found covered with a maze of thread, of which the photograph on the screen represents a sample. This is hardly distinguishable from the web spun by this magnificent spider in corners of greenhouses and such places. By regulating the jet and the manipulation, anything from one of these stranded cables to a single ultra-microscope line may be developed.

And now that I have explained that these fibres have such valuable properties, it will no doubt be expected that I should perform some feat with their aid which, up to the present time, has been considered impossible, and this I intend to do.

Of all experiments the one which has most excited my admiration is the famous experiment of Cavendish, of which I have a full-size model before you. The object of this experiment is to weigh the earth by comparing directly the force with which it attracts things with that due to large masses of lead. As is shown by the model, any attraction which these large balls exert on the small ones will tend to deflect this 6-foot beam in one direction, and then if the balls are reversed in position the deflection will be in the other direction. Now, when it is considered how enormously greater the earth is than these balls, it will be evident that the attraction due to them must be in comparison excessively small. To make this evident the enormous apparatus you see had to be constructed, and then, using a fine torsion wire, a perfectly certain but small effect was produced. The experiment, however, could only be successfully carried out in cellars and underground places, because changes of temperature produced effects greater than those due to gravity.[1]

Now I have in a hole in the wall an instrument no bigger than a galvanometer, of which a model is on the table. The balls of the Cavendish apparatus, weighing several hundredweight each, are replaced by balls weighing 1¾ pound only. The smaller balls of 1¾ pound are replaced by little weights of 15 grains each. The 6-foot beam is replaced by one that will swing round freely in a tube three-quarters of an inch in diameter. The beam is, of course, suspended by a quartz fibre. With this microscopic apparatus, not only is the very feeble attraction observable, but I can actually obtain an effect eighteen times as great as that given by the apparatus of Cavendish, and, what is more important, the accuracy of observation is enormously increased.

The light from a lamp passes through a telescope lens, and falls on the mirror of the instrument. It is reflected back to the table, and thence by a fixed mirror to the scale on the wall, where it comes to a focus. If the mirror on the table were plane, the whole movement of the light would be only about 8 inches, but the mirror is convex, and this magnifies the motion nearly eight times. At the present moment the attracting weights are in one extreme position, and the line of light is quiet. I will now move them to the other position, and you will see the result—the light slowly begins to move, and slowly increases in movement. In forty seconds it will have acquired its highest velocity, and in forty more it will have stopped at 5 feet 8½ inches from the starting-point, after which it will slowly move back again, oscillating about its new position of rest.

It is not possible at this hour to enter into any calculations; I will only say that the motion you have seen is the effect of a force of less than one ten-millionth of the weight of a grain, and that with this apparatus I can detect a force two thousand times smaller still. There would be no difficulty even in showing the attraction between two No. 5 shot.

And now, in conclusion, I would only say that if there is anything that is good in the experiments to which I have this evening directed your attention, experiments conducted largely with sticks, and string, and straw and sealing-wax, I may perhaps be pardoned if I express my conviction that in these days we are too apt to depart from the simple ways of our fathers, and, instead of following them, to fall down and worship the brazen image which the instrument-maker hath set up.

[1] Dr. Lodge has been able, by an elaborate arrangement of screens, to make this attraction just evident to an audience.—C. V. B.

A NEW SCHOOL OF ORIENTAL STUDIES.

THE Imperial Institute has taken a most important step towards the organization of higher commercial education in London, by effecting an arrangement between University and King's Colleges for the establishment of a new School for Oriental Studies. The close connection between the mercantile interests of this country and of India, Turkey, China, South Africa, and other lands, renders it very desirable that travellers and traders should have full facilities for acquiring, not only a knowledge of the languages of those countries, but also some acquaintance with the habits and customs of the inhabitants. In France and Germany, we find that the wants of this class of students have been fully recognized by the State. The French School of Oriental Languages has been in existence over 100 years, and has recently been reconstructed at an annual expense, for maintenance alone, of £6000; and in 1887 a new school was opened in Berlin, as a special department of the University, which receives a subvention from the Government of over £3000 a year. In England, the economy to the nation of adequately supporting institutions for higher education is not yet understood, and consequently private effort has to step in and relieve the State of a duty which in other countries is discharged in no niggard spirit. The new School of Oriental Studies promises to supply a distinct want. Instruction will be given in the principal Indian languages, in Persian, Burmese, Malay, Arabic, Turkish, Russian, Modern Greek, Chinese, Japanese, and Swaheli. The students will be taught not only to read and write, but also, as far as is possible, to speak those languages; and to this end the Committee contemplate the appointment of native readers and teachers of conversation. It has already been arranged that some of the Professors will preface their courses of linguistic teaching by lectures on the history, the physical and commercial geography, and the economic condition of the countries in which the various languages are spoken. It is hoped that by such means our mercantile and official classes may have the opportunity of acquainting themselves with the life and thought of the different Eastern peoples with whom they may be brought into communication.

The Imperial Institute is to be congratulated on having succeeded in bringing into harmonious working the two London Colleges, to each of which has for many years been attached a staff of eminent Professors of Oriental languages. The Indian School of University College, and the Oriental Section of King's College, have both done useful work; but, mainly from want of proper organization, the classes of many of the Professors have been but poorly attended, and several important modern languages a knowledge of which is now needed have not been included in the prospectus of either school. The Institute has effected an arrangement with the Colleges whereby the Indian and some allied tongues will continue to be taught in Gower Street, whilst the other languages will be taught at King's College, Strand. This is perhaps the first instance of such an arrangement between the two Colleges having been brought about, and suggests the practical advantage of an extension of the system to other branches of learning. It is only by a proper organization of the higher instruction that London can secure the full advantages of University education, and it may be hoped that as soon as a teaching University can be established in London, the two Colleges and the Medical and Science Schools will be found to co-operate with one another, so as to supplement, without unduly interfering with, each other's field of work.

We should add that the new School of Oriental Studies, which will be opened in October next, is under the general management of a special Committee, which comprises among its members Sir Francis Bell, Sir Charles Wilson, Sir Thomas Wade, Sir Frederic Goldsmid, and representatives of the governing bodies and teaching staffs of the two Colleges.

NOTES.

THIS year the French Association for the Advancement of Science will hold its annual meeting in Paris. The session will last from August 8 to 14. A great number of members are expected to attend the meeting, and it is hoped that many foreign men of science may also be present.

THE International Congress which met in Paris in 1887 to make arrangements for the preparation of a photographic chart of the heavens expressed a wish that a similar Congress might meet for the discussion of questions relating to celestial photography in general. M. Janssen and Mr. Common were asked to take such steps as might be necessary for the attainment of this object; and afterwards, by a Ministerial decision at Paris, an organizing Committee, with M. Janssen as President, was appointed. The arrangements have now been completed, and the Congress will be held in Paris from August 22 to September 3. The aim of the Congress will be to determine the methods which are most suitable for each branch of celestial photography, and the means by which the results obtained by these methods can be most effectually published and preserved.

THE Botanical Society of France announces the following programme of the forthcoming Botanical Congress to be held in Paris:—Tuesday, August 20: opening sitting of the Congress at 2 p.m., at the hotel of the Horticultural Society, 84 Rue de Grenelle; reception of foreign members at 8.30 p.m. Wednesday, August 21: sitting at 9 a.m., devoted to the consideration of the first question, on the utility of an agreement between the different Botanical Societies and Museums, for the purpose of drawing up charts of the distribution of species and genera of plants on the globe; and other communications, if time allows. Thursday, August 22: excursion in the neighbourhood of Paris. Friday, August 23: sitting at 9 a.m., devoted to the consideration of the second question, on the characters furnished by anatomy for classification; and other communications, if time allows. In the afternoon a visit to the botanical collections and laboratories of the Museum of Natural History, and of the other large scientific establishments in Paris. Saturday, August 24: sitting at 9 a.m., miscellaneous contributions. In the afternoon a visit to the Exhibition. Sunday, August 25: banquet to the foreign botanists. During the following week several botanical excursions will also be arranged. Special arrangements with regard to railway fares will be made in favour of botanists announcing their intention to be present to M. P. Maury, the Secretary to the Committee of Organization, 84 Rue de Grenelle, before July 25.

THE following are subjects proposed for discussion at the International Zoological Congress, to be held in Paris (August 5–10):—Adoption of rules on the nomenclature of organisms, and of an international scientific language; determination of regions the fauna of which calls for investigation; methods of investigation and procedure in preparation and preservation of animals; the use of embryology in classification; relations between living and fossil fauna. The Secretary's address is 32 Rue de Luxembourg.

AT the International Congress on Hygiene and Demography, also to be held during the Paris Exhibition, there will be discussed:—The administrative and medical regulations framed in different countries in the interests of health and of infantile life; removal and utilization of solid detritus in cities and the country; regulation and distribution of temperature in the dwelling; action of the soil on germs of disease; protection of watercourses and of ground water from pollution by factory refuse; sanitation of ports; accidents through food-stuffs of animal origin containing poisonous alkaloids; statistics of the causes of death in cities.

SOME valuable reports were distributed among the members of the International Agricultural Congress, which finished its labours at Paris the other day. One of them relates to agricultural education. This report is signed by a dozen authors, among whom are MM. Tisserand, Prilleux, and Jamieson, the latter an Englishman.

THE sixty-second meeting of German Naturalists and Physicians will be held at Heidelberg from September 17 to 23. One whole day will be devoted to excursions in the neighbourhood, and on the evening of September 23 the Castle of Heidelberg will be brilliantly illuminated.

AT a meeting of the Council of Dundee University College, held on the 3rd instant, Mr. J. Martin White announced that he had been authorized by Mr. John Bett, merchant, Rohallion, to offer a third of the amount required to found and establish a Chair of Physiology in connection with the Medical School of the College, provided the remaining two-thirds of the amount required be raised. It was mentioned that, to provide a fund adequate for the endowment of the Chair and the furnishing of suitable buildings and equipment, a sum of about £15,000 would be necessary. The foundation of this Chair would enable the College to complete the first two years of a medical curriculum.

A CIRCULAR from Harvard College Observatory, dated June 26, states that the sum of fifty thousand dollars has been received by that Observatory from Miss C. W. Bruce, of New York, to be applied "to the construction of a photographic telescope having an objective of about 24 inches aperture with a focal length of about 11 feet; . . . also to secure its use under favourable climatic conditions in such a way as will best advance astronomical science."

A STATUE of Paul Bert was unveiled at Auxerre on Sunday last. The ceremony was attended by the Annamite Envoys, and M. Spuller represented the French Government.

DR. E. HEINRICHER has been appointed Professor of Botany and Director of the Botanical Garden at Innsbrück; and Dr. H. Ambronn, Professor of Botany at Leipzig.

THE number of working botanists in Portugal is so small that it is with great satisfaction we are able to announce the appointment of Dr. G. von Lagerheim of Stockholm, recently of Freiburg-i-B., as assistant in the botanical laboratory of the Polytechnic School at Lisbon.

IT is stated that the Imperial Museum of Vienna has accepted the eccentric conditions of the bequest of the late Prof. H. G. Reichenbach, of Hamburg, according to which his extensive collection of dried orchids and drawings of orchids shall be placed in sealed packets in the Museum, and shall not be exhibited or in any way used within twenty-five years of his death.

THE *Kew Bulletin* for July consists of an excellent guide to the botanical literature of the British Empire. The primary object of the compilation is to supply useful information on the literature of the systematic, economic, and geographical botany of British Possessions, Dependencies, and Protectorates. The compiler explains that Kew is often called upon to answer questions, on the shortest notice, concerning the vegetation of some remote part of the world, and the best books to consult on the subject. Such questions are not always easily answered, and they frequently entail a considerable expenditure of time. The intention is that the present guide shall supply what is wanted, and everyone who may have occasion to use it will find that it is admirably adapted to its purpose.

MR. THOMAS SCOTT, of the Scientific Department of the Scottish Fishery Board, on June 27, in the Moray Firth, successfully fertilized the ova of the lemon sole (*Pleuronectes microcephalus*) with the milt of the turbot (*Rhombus maximus*). Development proceeded rapidly for three days and a half, when the ova were killed by dust getting into the water, and they sank. At this period the embryo was well formed, development was going on quickly, and hatching would probably have occurred on the seventh or eighth day.

LAST week, the Rev. W. S. Green, Mr. W. de Vismes Kane, and other zoologists, had a successful trawling expedition in the Atlantic, off the Irish coast. They started from Queenstown, in the *Flying Fox*, on Monday, July 1, and returned on Sunday. All the captures were divided and subdivided into different classes, carefully preserved in spirits, and packed in the cases which were used in the *Challenger* Expedition; and they have been forwarded to the Natural History Department of the British Museum, for whose benefit the expedition was organized.

MISS MARIA MITCHELL, well known as a writer on astronomy, died recently in New York. She was the daughter of William Mitchell, astronomer, and was born in Nantucket, Massachusetts, on August 1, 1818. In 1847 she made the discovery of a comet, for which she received a gold medal from the King of Denmark, and other distinctions. During a visit to Europe, in 1858, she was the guest of Sir John Herschel and Sir George B. Airy, and afterwards she visited Leverrier in Paris and Humboldt in Berlin. In 1865 she was called to the Professorship of Astronomy at Vassar College, which, with the post of Director of the Observatory, she retained until January 1888, when she secured a long leave of absence. The degree of LL.D. was conferred upon Miss Mitchell by Hanover College in 1852, and by Columbia College in 1887. She was a member of various scientific Societies, and was the first woman elected to the American Academy of Arts and Sciences. She contributed numerous articles to scientific journals.

THE heat in Russia and other parts of Northern Europe has been intense of late. The Central Observatory at St. Petersburg has not recorded such a high temperature at the same time of the year since 1774.

A SHOCK of earthquake occurred at Guernsey on Monday afternoon, about 2.30. It was not quite so violent as that experienced on May 30. The weather during the whole of the morning was extremely sultry.

ON the evening of January 31 last, about 9 o'clock, the self-recording barometer at the Deutsche Seewarte showed a sudden dip of about 0·04 inch, with a corresponding jump upwards a few minutes afterwards; and in the course of a day or two it was found that the barographs at other stations exhibited a similar phenomenon. Although the disturbance cannot be compared in any way to the air-wave caused by the Krakatão eruption, yet the rapidity of its translation proved it to be a noteworthy meteorological phenomenon, and its behaviour over Central Europe is discussed in an article contributed to the *Annalen der Hydrographie und maritimen Meteorologie* for June, by Dr. E. Herrmann, of the Deutsche Seewarte. The disturbance is traced from Keitum (lat. 54° 54′), where it occurred at 7h. 50m. p.m., Berlin time, on January 31, to Pola (lat. 49° 42′), which it reached at 4h. 38m. a.m. on February 1, having travelled at the rate of about 71 miles per hour. In an easterly and westerly direction the disturbance seems to have been confined to narrow limits. The barometer was high over Southern Europe (30·5 in.), with minima (28·7 in.) over Northern Finland, and between Iceland and Norway. There was no earthquake in Europe at the time, and the cause of the phenomenon remains at present unexplained.

PÈRE CHEVALIER, S.J., Director of the Sikawei Meteorological Observatory, near Shanghai, has issued his monthly Bulletin for August last. It is an unusually interesting number, as it contains a full study, with diagrams, of the two typhoons which were felt at Shanghai and in the south of China. These elaborate studies of the typhoons of the China seas are invaluable, especially when supplemented by the labours of Dr. Doberck, of Hong Kong; of the Japan Observatory; and of that of Manilla, in the Philippine Islands. Père Chevalier has a number of charts showing the tracks of the storms.

THE Committee of the General Board of Studies of the Victoria University of Manchester have issued their report on local lectures during the past three sessions 1886-87 to 1888-89. Twenty courses of local lectures have been delivered, and the Committee state that they have every reason to be satisfied with the results obtained so far. The subjects selected have been very varied, ranging over many branches of literature and science. The local Committees have been of very different constitution, including Committees specially formed for the purpose of the lectures, Literary and Philosophical Societies, mechanics' institutes, and educational institutions of various grades; and the audiences, while mainly drawn from the middle classes, have in some cases consisted entirely of working men. The attendance at the lectures has been well maintained, averaging for all courses about 130.

IN the forty third Annual Report of the Commissioners in Lunacy, just issued, it is stated that there were, on New Year's Day, 84,340 insane persons under restraint. Of these, 7970 were of the private class, 75,632 were paupers, and 738 were criminals. The Commissioners believe that during recent years medical men have become increasingly unwilling to certify to the insanity of persons requiring treatment, in consequence of the results of recent litigation connected with this part of their duties. The causes of insanity are set forth in a table covering 136,478 cases. These are very diverse. Thus 9569 persons lost their reason from domestic trouble, 8060 from adverse cicumstances, 8278 from over-work and worry, 3769 from religious excitement, and 18,290 from intemperance. The influence of heredity was ascertained in 28,063 cases, and congenital defect in 5881.

A Bill has been introduced into the House of Commons which would, if it became law, prove a great boon to young people in the rural districts. The object is to provide instruction in agricultural and horticultural subjects in public elementary schools, and to afford practical illustration in such teaching. The Industrial Agricultural Education Bill, as it is called, would not only secure for children in rural districts practical instruction on such subjects as fruit, flowers, and vegetable growing, the proper method of keeping cattle, rotation of crops, packing fruit for market, and other matters of equal importance: it proposes, further, that the instruction in these branches shall be carried on after the children leave school. To effect this it is proposed to establish schools at which lessons would be given in the evenings, and on Saturday afternoons. To induce parents to keep their children at school for a longer period, or to send them to the new schools, the promoters of the measure advocate the provision of a small number of scholarships of the value of thirty shillings per annum, and tenable for two years, for children who have passed the fourth standard. They foresee, also, that the ordinary appliances of elementary schools will not be sufficient to secure comprehensive instruction in practical agriculture, and they are bold enough to hope that a special grant will be made by the Education Office or the Science and Art Department for the expenses of such allotments, school gardens, and buildings as may be necessary to make the teaching thoroughly practical. The Bill is backed by Mr. George Dixon, Mr. Henry Fowler, Sir John Lubbock, Mr. Jesse Collings, Sir Bernhard Samuelson, Mr. Howell, Sir John Kennaway, Mr. Robert Reid, and Major Rasch.

Messrs. Trübner and Co. will publish, probably in October, "An Account of the Aborigines of Tasmania, their Manners, Customs, Wars, Hunting, Food, Morals, Language, Origin, and General Characteristics," by Henry Ling Roth, assisted by E. Marion Butler. The work will contain a chapter on the osteology, by Dr. J. G. Garson, and a preface will be contributed by Dr. E. B. Tylor. Numerous autotype plates, from original drawings made by Edith May Roth, will illustrate the text. The edition will be strictly limited to subscribers.

The Delegates of the Clarendon Press will shortly issue Mr. Oliver Aplin's "Birds of Oxfordshire"; the second volume (treating of electro-dynamics) of Messrs. Watson and Burbury's "Mathematical Theory of Electricity and Magnetism"; and a new edition of the fourth volume (on the dynamics of material systems) of Prof. Bartholomew Price's "Treatise on Infinitesimal Calculus."

In the new number of the *Internationales Archiv für Ethnographie* (Band ii., Heft 3) Mr. Felix Driessen gives an interesting account, in English, of tie and dye work, manufactured at Semarang, Java. The article is accompanied by a plate representing the manufacture in all its different stages. Mr. R. Parkinson continues his excellent notes, in German, on the ethnology of the Gilbert Islanders. The valuable German paper, by Dr. F. von Luschan, on a Turkish "Schattenspiel," is also continued. The number, like its predecessors, has many notes on ethnographical museums, collections, and books.

The Department of Mines, Sydney, has issued the first number of what promises to be a valuable publication—*Records of the Geological Survey of New South Wales.* It opens with "Notes on the Geology of the Barrier Ranges District and Mount Browne and Tibooburra Gold Fields," by Mr. C. S. Wilkinson. Messrs. T. W. E. David and R. Etheridge, Jun., contribute an interesting report on the discovery of human remains in the sand and pumice bed at Long Bay, near Botany. There are other papers by the same writers, and by Mr. W. Anderson, Mr. J. C. H. Mingaye, and Mr. H. W. Powell.

Messrs. George Philip and Son have issued the third volume of the well-known series, "Rustic Walking Tours in the London Vicinity." It deals with the west-to-south district, and contains a field-path map, a geographical description, forty-five charts, with ample and plain directions, and an index.

A little book called "Walks in Holland," edited by Mr. Percy Lindley, has just been issued. It presents concisely much information that may be of service to tourists.

The other day the plough of a peasant in the island of Gothland unearthed a valuable treasure, consisting of two large spiral armlets, a buckle, and a long bar used in payment, all of solid silver, together with nearly 400 silver coins. Some of the coins were Anglo-Saxon, and bore the effigy of King Ethelred. The others were German and Cufic coins. The "find" has been purchased by the State.

The richness of the cod fisheries this spring on the coast of Finmarken has clearly shown that these fisheries are not in the least affected by whales. The Government has voted a sum of £850 towards the cost of a Commission for dealing with the much-needed protection of the whale.

The preservation of the eider in Sweden is to be extended from April 24 to May 31. Through strict protection these valuable birds have increased greatly in recent years along the Baltic and the Cattegat.

Dr. Schweinfurth has presented a valuable collection of plants from Yemen to the Christiania Museum.

The late Mr. Wilson, of Gothenburg, has left a legacy of £5500 to that city for the promotion of science, art, and education. He has also left his valuable collections to the Gothenburg Museum. A few years ago Mr. Wilson endowed this institution with a similar sum.

The Finnish naturalist, Dr. J. Kinunen, has set out on a voyage of scientific research to Nova Zembla and adjacent parts.

A new series of double oxalates of the rare metal rhodium and the metals of the alkalies or alkaline earths are described by M. Leidié in the July number of the *Annales de Chimie et de Physique.* The hydrate of rhodium sesquioxide, $Rh_2(OH)_6$, a substance having the peculiar appearance of a black jelly, and which is but slightly attacked by most acids, dissolves readily, when recently precipitated, in a concentrated solution of oxalic acid. On evaporation of this solution, containing presumably rhodium oxalate, no crystalline oxalate is obtained, but only a non-crystallizable transparent mass. If, however, this solution is evaporated along with a solution of neutral oxalate of potassium, sodium, or ammonium, on cooling beautiful garnet-red crystals of a double oxalate are deposited, containing one molecule of the oxalate of rhodium sesquioxide and three molecules of the alkaline oxalate. The potassium salt, $Rh_2(C_2O_4)_3 . 3C_2K_2O_4 . 9H_2O$, separates from solution in red triclinic prisms, very soluble in water. The largest crystals are obtained from a perfectly neutral solution, and may be most readily prepared by saturating a boiling solution of acid potassium oxalate with recently precipitated hydrate of rhodium sesquioxide. It is an evidence of the strength of the combination that the solution gives none of the characteristic tests for rhodium, not being precipitated either by potash or soda, and only partially by sulphuretted hydrogen. The ammonium compound $Rh_2(C_2O_4)_3 . 3C_2(NH_4)_2O_4 . 9H_2O$ is isomorphous with the potassium salt, and crystallizes in smaller red prisms. It is soluble in its own weight of warm water. On the other hand, the sodium salt crystallizes with $12H_2O$, in red prisms which are very efflorescent. The salts containing the alkaline earthy metals are much less soluble, and are generally obtained as crystalline precipitates by decomposition of the potassium salt by the chloride of the metal which it is desired to introduce. It is interesting that these salts are perfectly analogous to the double oxalates of ferric iron and chromium, $Fe_2(C_2O_4)_3 . 3C_2(NH_4)_2O_4$, for instance; but the two series are not isomorphous owing to the difference in water of crystallization. Evidence of similarity between iron and rhodium is of course shown by the fact that their most stable chlorides are those derived from the sesquioxides—namely, Fe_2Cl_6 and Rh_2Cl_6; but the formation of these double oxalates shows that the connection is perhaps closer than has hitherto been supposed. And the interest in this connection is by no means lessened by the fact that iron and rhodium occupy corresponding positions in the eighth vertical group of Prof. Mendeleeff's periodic classification.

THE additions to the Zoological Society's Gardens during the past week include two Indian Jerboas (*Alactaya indica*) from India, presented by Mr. Cuthbert Johnson; a Bonnet Monkey (*Macacus sinicus* ♀, white variety) from India, presented by the Waterbury Watch (Sales) Company, Limited; a Lesser White-nosed Monkey (*Cercopithecus petaurista* ♀) from West Africa, presented by Captain Stewart Stephens; a Brown Bear (*Ursus arctos* ♀), European, presented by Mr. John Foster Spence; a Polar Bear (*Ursus maritimus* ♀) from Spitzbergen, presented by Mr. Arnold Pike; a Python (sp. inc.), presented by Mrs. Bertha M. L. Bonser; a Hybrid Wild Swine (between *Sus scrofa* and *Sus domesticus* ♀) from Spain, presented by Mr. Ralph Banks, F.Z.S.; a Brush-tailed Kangaroo (*Petrogale penicillata* ♂) from New South Wales, presented by Sir Edmund A. H. Lechmere; five Violaceous Night Herons (*Nycticorax violaceus*) from St. Kitt's, W.I., presented by Dr. A. P. Boon, C.M.Z.S.; twelve Aldrovandi's Skinks (*Plestiodon auratus*) from North Africa, two Barnard's Parrakeets (*Platycercus barnardi*) from South Australia, purchased; a Laughing Kingfisher (*Dacelo gigantea*) from Australia, deposited; two Wonga Wonga Pigeons (*Leucosarcia picata*) from New South Wales, and a Red-winged Parrakeet (*Aprosmictus erythropterus*) from Australia, received in exchange; an African Wild Ass (*Equus tæniopus* ♀), and a Collared Fruit Bat (*Cynonycteris collaris*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE LATE PROF. CACCIATORE.—Prof. G. Cacciatore, whose death we have briefly recorded (p. 208), had been associated with the Royal Observatory of Palermo, during nearly the whole of his life. He was born at Palermo on March 17, 1814, his father being the well-known Prof. Nicolo Cacciatore, assistant at one time to Piazzi, and later his successor in the directorship of the Observatory. Gaetano Cacciatore, on the death of his father in 1841, was appointed Director of the Observatory and Professor of Astronomy in the University of Palermo, and he held these positions until 1849, when, having taken a very prominent part in the revolution of the previous year, he was compelled to leave Palermo by the return to power of the Bourbons. In 1860, however, Garibaldi recalled him to his former position. He spared no pains to increase the power and usefulness of the Observatory, and greatly increased its equipment. It was under his direction that the scope of the institution was enlarged, so that in 1880 it was reorganized in three sections—one of Geometrical Astronomy; one of Physical Astronomy, in the modern sense of the word; and the third of Meteorology.

COMET 1889 *d* (SWIFT).—A new comet was discovered on July 5·833 G.M.T., by Prof. Lewis Swift, of the Warner Observatory, Rochester, New York. The comet's place was as follows:—

R.A. = 22h. 52m. 30s. Daily Motion, − 2m.
Decl. = 89° 11′. + 10′.

COMET 1889 *b* (BARNARD, MARCH 31).—This object may soon again be observed in the early morning. The following elements and ephemeris are by Prof. Millosevich, from observations made at the Lick Observatory on March 31, April 15 and 29 (*Astr. Nach.* No. 2907):—

T = 1889 June 10·63608 Berlin M.T.

$$\left.\begin{aligned}\pi &= 186^\circ\ 38'\ 20''\cdot 8\\ \Omega &= 310\ \ 40\ \ 19\cdot 3\\ \iota &= 163\ \ 49\ \ 47\cdot 8\end{aligned}\right\}\ \text{Mean Eq. } 1889\cdot 0.$$

$$\log q = 0\cdot 353613$$

Error of middle place O − C).

$\Delta\lambda = -1''\cdot 3.\quad \Delta\beta = +5''\cdot 4.$

Ephemeris for Berlin Midnight.

1889.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Brightness.
July 19	5 7 52	10 59·0 N.	0·3618	0·4706	0·83
23	5 7 1	10 34·4	0·3635	0·4624	0·85
27	5 5 53	10 7·7	0·3654	0·4534	0·88
31	5 4 26	9 38·7 N.	0·3675	0·4436	0·91

The brightness at discovery is taken as unity.

COMET 1889 *c* (BARNARD, JUNE 23).—The following elements for this comet are by Dr. H. Kreutz, from observations at Lick on June 23, at Strasburg June 25, and at Munich June 26; the ephemeris is by Prof. A. Krueger:—

T = 1889 July 2·8884 Berlin M.T.

$$\left.\begin{aligned}\omega &= 75^\circ\ 19'\cdot 5\\ \Omega &= 278\ \ \ 6\cdot 7\\ \iota &= 32\ \ 50\cdot 2\end{aligned}\right\}\ \text{Mean Eq. } 1889\cdot 0.$$

$$\log q = 0\cdot 09248$$

Ephemeris for Berlin Midnight.

1889.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Brightness.
July 14	3 1 51	47 38·9 N.	0·0970	0·1432	0·9
18	3 21 50	48 35·5	0·1006	0·1489	0·9
22	3 41 23	49 17·9	0·1051	0·1548	0·8
26	4 0 56	49 47·7 N.	0·1105	0·1603	0·8

The brightness at discovery is taken as unity.

COMET 1888 *e* (BARNARD, SEPTEMBER 2).—The following ephemeris is in continuation of that given in NATURE for May 30, p. 109:—

1889.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Brightness.
July 11	21 7 34	0 1·4 N.	0·4287	0·2491	2·5
15	20 52 59	0 36·3 S.	0·4342	0·2487	2·4
19	20 38 17	1 16·7	0·4396	0·2509	2·4
23	20 23 44	1 58·9	0·4450	0·2559	2·3
27	20 9 33	2 42·0	0·4503	0·2634	2·2
31	19 55 58	3 25·0 S.	0·4556	0·2733	2·0

The brightness at discovery is taken as unity.

Mr. Barnard, observing this comet on June 3, at 3 a.m., noticed that it showed only one tail and that this *followed* the comet, and therefore pointed almost directly towards the sun. The tail was about a degree in length, and some 2′ or 3′ in breadth; position-angle, 90°. The head of the comet was roundish, with an almost stellar nucleus in an extended condensation, this latter having a position-angle of about 135°.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 *JULY* 14–20.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on July 14

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. and declination on meridian. h. m.	° ′
Mercury..	2 36	10 37	18 38	6 7·1	21 14 N.
Venus	1 10	8 51	16 32	4 20·8	18 8 N.
Mars	3 16	11 33	19 50	7 3·6	23 32 N.
Jupiter	18 38	22 32	2 26*	18 4·0	23 20 S.
Saturn	6 32	14 0	21 28	9 30·0	15 59 N.
Uranus	12 6	17 36	23 6	13 7·4	6 31 S.
Neptune..	0 50	8 39	16 28	4 8·4	19 20 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Sun rises, 4h. 2m.; souths, 12h. 5m. 36·0s.; daily increase of southing, 6·4s.; sets, 20h. 10m.: right asc. on meridian, 7h. 35·8m.; decl. 21° 38′ N. Sidereal Time at Sunset, 15h. 42m.

Moon (at Last Quarter on July 19, 20h.) rises, 21h. 4m.*; souths, 1h. 17m.; sets, 5h. 36m.: right asc. on meridian, 20h. 45·2m.; decl. 20° 28′ S.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·5	81 17 N.	July 14,	21 5	*m*
			,, 19,	20 44	*m*
Y Virginis	12 28·2	3 49 S.	,, 18,		*M*
U Ophiuchi	17 10·9	1 20 N.	,, 18,	1 37	*m*
			,, 18,	21 45	*m*
X Sagittarii	17 40·6	27 47 S.	,, 14,	23 0	*M*
			,, 19,	2 0	*m*
Y Sagittarii	18 14·9	18 55 S.	,, 16,	22 0	*m*
U Aquilæ	19 23·4	7 16 S.	,, 17,	20 10	*m*
S Vulpeculæ ...	19 43·8	27 1 N.	,, 15,		*m*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
Near Algol	48°	42° N.	Very swift; streaks.
,, γ Draconis	270	50 N.	Swift.

GEOGRAPHICAL NOTES.

THE paper read at the meeting of the Royal Geographical Society on Monday night, by Mr. Basil H. Thomson, was one of unusual scientific interest. It described a visit made by Mr. Thomson last autumn, along with the New Guinea Commissioner, to the Louisiade and D'Entrecasteaux Islands, both within the British sphere. Mr. Thomson's observations on the natives, on the geology and natural history of these islands, are of special value. The first island described is that of Sudest, the largest of the Louisiades. It is forty-five miles long and four to ten wide. It is of a slaty formation, with veins of crystalline quartz running through it in all directions. The eastern portion is mountainous, the highest point, Mount Rattlesnake, being about 3000 feet high. The highest parts are densely timbered, but the low hills near the sea are covered with grass, whose bright green offers a welcome contrast to the sombre tropical forest. Rossel Island is surrounded by a distant barrier reef of irregular form. The natives are dangerous head-hunters, who, however, kept out of the way of the visitors. With some difficulty the densely-timbered island was crossed, and proved a rich field for the botanist. Even at an elevation of 3000 feet a network of native paths was found. At the village, the inhabitants of which had fled, the party stayed the night. The village was scrupulously clean and the paths well kept. The houses were shaped like an inverted boat, built on a platform some 5 feet from the ground; the interior was reached through two trap-doors in the floor. The natives of Rossel suggest a hybrid between the Papuans and the natives of the Solomon Islands. The stone axe has fallen into disuse, its place being taken by blades of iron procured from wrecks. The language bears no resemblance to any known New Guinea dialect nor to the languages of Eastern Polynesia. St. Aignan Island, called by the natives Misima, is more than 100 square miles in area, being about twenty-eight miles long, and varying in breadth from about eight or nine miles on the east end. The west end consists of a great mountain range named Lakia, about 3500 feet above the sea, composed of schistose slate. The eastern part of the island consists of very rugged hills, through which the streams have cut very deep and narrow gorges. They are composed of coral upheaved by volcanic action, and mixed with conglomerate formed from shingle, and with broken layers of schistose slate. Round the eastern coast there is a fringe of coral, upheaved more recently, rising to a height of more than 100 feet, through which the mountain torrents have cut their way right down to sea-level. The natives are of two types, the one evidently Papuan, and the other betraying strong Malay characteristics, such as the straight hair and not prominent features. The limestone hills which compose the centre of the island were honeycombed with caves and densely timbered. From one great wall of limestone sprang a stream which, after 200 yards of daylight, plunged into a great cave in the opposite cliff. The mouth was a perfect arch, 150 feet from floor to roof. At the far end the river thundered down into a black tunnel, through which it passed under the range, emerging into daylight after some three miles of darkness. Normanby Island, the most easterly of the D'Entrecasteaux Group, is a narrow L-shaped mountain range, with deeply furrowed sides and wide valleys excavated by water-wear. It is probably nowhere of greater breadth than ten or twelve miles, and the area about 350 square miles. The highest parts of the island are perhaps 3500 feet above the sea-level. The south-eastern portion is composed of schistose slate varying much in hardness, interlaid with veins of white crystalline quartz, which is free from any compound of iron or other metal. Traces of gold were found in the creeks. Toward the north end of the island the formation is igneous, consisting mainly of limestone, but in some of the river-beds are large beds of basalt and boulders of siliceous stone. The mountains of Dawson Straits, however, differ much in formation from the rest of the island. The rock appeared to be a sort of porphyry, and furnished indications of tin. The natives have strong Papuan characteristics. They wear the usual dress. Mr. Thomson penetrated some miles inland, passing through no less than thirty-one villages, and seeing many others perched on every available spur or ridge, and surrounded by its plantations. These villages were remarkable for their cleanliness. The cultivation is wonderful, and bears witness of their activity and industry. Normanby Island is the eastern limit of the wallaby, of which were found two varieties. It is also the eastern limit of a bird peculiar to the D'Entrecasteaux Group—the largest of the five species of Manucodia, which are still classed with the birds of Paradise. It feeds on insects, and though the strait which divides Normanby Island from the mainland is only ten miles wide, this bird, which is the commonest of all large birds in the D'Entrecasteaux Group, has never crossed to New Guinea. War and the difference of dialect have so completely isolated the various tribes as to make them different peoples as regards everything but their physical characteristics. At a spot not ten miles from a tribe that would barter all they possessed for tobacco and pipes, were people so ignorant of their use that they put the tobacco into a bottle given them, poured water upon it, and drank off the compound. Ferguson Island, the largest of the D'Entrecasteaux Group, is thirty miles long by seventeen broad, with an area of about 500 square miles. There are three great mountain masses on the island: Mount Kilkerran, on the north-east corner, 6000 feet high; the Maybole Range, on the north-west, which is probably 5000 feet above sea-level; and a lower range in the south-west corner, which is apparently unnamed, and which Mr. Thomson was unable to examine. The formation of the Kilkerran and Maybole Ranges is the same, consisting principally of micaceous schist with veins of white quartz intersecting it. In the beds of the rivers were boulders of quartz, and of a slaty rock very rich in silica, and there were boulders of what seemed to be a kind of porphyry. The south-eastern part of Ferguson and the small outlying islands, Goulvain and Welle Islands, are of igneous formation, and Mr. Thomson noticed two extinct volcanoes and some hot springs. This part is densely populated, owing probably to the fertility of the extensive flats of volcanic deposit. The people were in most respects similar to those in Normanby Island. The inland or bush natives have evidently no communication with those on the coast, except as enemies: they knew nothing of firearms. They are true Papuans. At Mount Kilkerran, near Hughes Bay, it was noticed that the sides of the mountain, consisting of great precipices and steep inclines, were dotted with villages up to a height of 10,000 feet, half concealed in clumps of cocoa-nut palms. Six specimens of a variety of *Paradisea raggeana* were obtained in this island. Near Seymour Bay there was a large extent of flat land and sago swamp, in which were found some saline lakes, and some hills giving off sulphur fumes strong enough to discolour the white paint on the vessel, which was lying nearly two miles distant. Some of the hills appeared to be composed of alum and sublimed sulphur. There were also springs of boiling water and boiling mud, and in one instance boiling mud was spouted up from a chimney-like cavity in the hill-side. Goodenough Island, the most westerly of the group, was visited. A great range of mountains running north and south, and culminating in two peaks not less than 7000 feet high, forms the centre of the island. On the east side is a plain some seven or eight miles wide, nearly clear of forest. The formation is slaty schist containing much mica and quartz. On the east side are projections of igneous formation, and on the point nearest to the sulphur springs in Seymour Bay is a small crater, probably not long extinct.

OPTICAL TORQUE.[1]

II.

IT will be convenient here for me to refer to some researches, not yet published, which I have made, as to the various orders of transition tints, with the view of ascertaining which of them is the most sensitive—which of them, in fact, shows the greatest change of tint for the smallest amount of rotation. Reference to the diagram on the wall displaying Newton's tints will make clear what I mean by the transition tints of the several orders. The tints obtained from quartzes of varying thicknesses may be considered as approximately identical with the tints of Newton's rings, provided we remember that the air-film which gives any particular tint in Newton's rings is about 1/300,000 part as thick as the quartz which yields the corresponding tint in the polariscope. Better far than any painted diagram, because richer and purer, are the tints now thrown upon the screen by introducing into the field a thin wedge of selenite, displaying the whole of the colours of the first three orders of Newton's scale. You will notice the successive recurrence of purple tints, both in the colours seen in the bright field, and in those seen in the dark field.

First I will show you the transition tints of the first and second orders in the bright field. That of the second order is much less intense than that of the first ; and yet it is very sensitive, turning to a green tint whilst the first order purple has only turned to a blue. On the other hand, with reversed rotation of the analyzer it turns to red less rapidly than does the tint of the first order.

Next I take the transition tints of orders I., II., and III. in the dark field. These, though arranged, by means of superposed half-disks of "quarter-wave" plates, to be optically equivalent to biquartzes of two rotations, are really built up of selenite and mica. You will notice how the tint of order I. surpasses in sensitiveness both the others. I cannot here show you on the screen the means by which I have compared the tint of order I. in the dark field with that of order I. in the other set. Suffice it to say that I find the tint of order I. in the dark field—corresponding to 7·5 millimetres thickness—more sensitive than that of order I. in the bright field, which corresponds to 3·75 millimetres thickness.

A method which was at one time supposed to be more precise, was that of placing a spectroscope (or its prism) in front of the analyzer, and watching the motion along the spectrum of the interference bands which are then seen. My three pieces of crystal remain. I introduce a slit in front of them, also a single film of quarter-wave mica, and then a prism to give the spectrum. This prism (Fig. 9), by the way, is a new sort of direct-vision prism, having a single very wide-angled prism of Jena glass inclosed in a cell with parallel ends containing cinnamic ether (first recommended by Wernicke), a liquid which has the same mean refractive power, but widely different dispersion. It is preferable to bi-ulphide of carbon in several respects : first, its odour is a delicate reminiscence of cinnamon ; it is barely volatile ; and it is whiter than bisulphide. This prism, which is shown also in plan in Fig. 10, was constructed for me by Messrs. R. and J. Beck. It will be seen that the dark bands in the spectrum are nebulous and ill-defined. It is idle to hope to secure accuracy by turning the analyzer until they shift along to a definite point. And there is no advantage in using the higher orders of tints which give more bands ; for, though the bands are certainly better defined, their progression across the spectrum for a given amount of rotation is proportionally smaller.

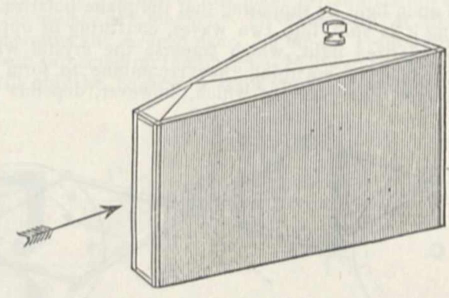


FIG. 9.—Direct-vision prism for projection of spectrum.

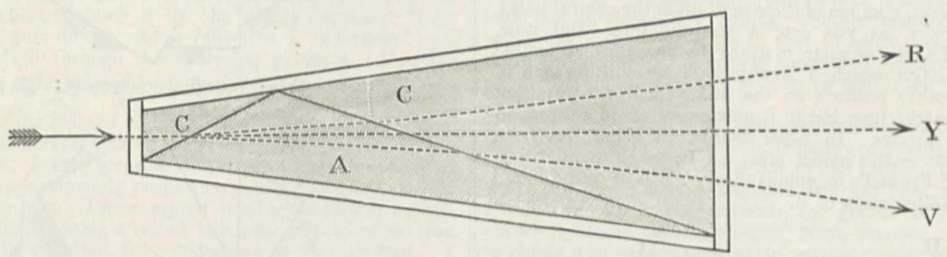


FIG. 10.—Direct-vision prism. A, wide-angled prism of Jena glass ; C, cinnamic ether.

Another suggestion, due to Sénarmont, is to use two sets of superposed wedges of right- and left-handed quartz. Such you now see before you. Instead of starting with extinction you start with coincidence between the upper and lower set of bands. Any rotation of the light shifts the bands, one set moving to left, the other to right. By turning the analyzer through an equal angle coincidence is again obtained.

Another method, used by Wild in his polaristrobometer, is to produce the phenomenon known as Savart's bands (due to the introduction of two crossed slices of quartz cut at a particular angle). The bands disappear when the analyzer is set in a particular direction. Anything that twists the plane of polarization causes them to reappear ; but they again fade out when the analyzer is turned through an equal angle.

There is yet another method in polarimetry, due to Soleil, in which the optical torsion due to the sugar is counterbalanced or compensated by introducing a pair of sliding wedges of quartz of the opposite rotation. This device is known as a "compensator." By sliding the quartzes over one another a greater or less thickness of quartz is introduced at will. But I must not stop to illustrate this elegant device.

Yet one other method must be mentioned, and this is certainly the most preferable. It consists in aiding the eye to recognize with precision a particular degree of extinction, by the device, first suggested in 1856 by Pohl, of covering a portion of the visible field with something which slightly alters the initial plane of polarization, so that complete blackness is not obtained at once over both parts of the field. A common device is to cover half the field with a slice of some thin crystal—mica or quartz—so that only one half can be perfectly black at any instant. As an example, here is the field covered half over with a plate of mica of the thickness known as half-wave. The result is that when one half of the field is black the other is light. Adjust the analyzer now to equality. Now introduce something that rotates the light—say a tube with sugar solution in it. At once the balance is upset, and I must, in order to get equality, turn my analyzer.

Of the same class are the polarimeters with special prisms made in two parts slightly inclined to one another. The earliest of these was devised by the late Prof. Jellett, of Dublin, and has been followed by imitations of the same plan by Cornu, by Lippich, and by Schmidt and Haensch. The beautiful "shadow polarimeter," by the latter firm, which I here exhibit, has the divided prism, and a quartz compensator.

I have suggested two simpler methods of accomplishing the same end. In the first place, I have proposed to use *twin-prisms.* These are made on a plan suggested to me by finding that Mr. Ahrens's method of cutting calc-spar for prisms was admirably

[1] A Discourse delivered at the Royal Institution, May 17, 1889, by Prof. Silvanus P. Thompson. Continued from p. 235.

adapted for making such prisms, either with wide or narrow angles between the respective planes of polarization in the two parts of the visible field. Two such twin-prisms, one with 90°, the other with 2½°, between the prisms, are here on the table. In the second place, I have essayed a polarimeter, an example of which is before you, in which an arrangement of twin-mirrors (each set at the polarizing angle, but slightly inclined to one another) is made to yield a half-shadow effect.

Before I leave the subject of quartz I must refer to the famous mathematical theory of Fresnel, who endeavoured to explain its action upon light by supposing that the plane-polarized wave on entering it is split into two waves, consisting of oppositely circularly-polarized light, which traverse the crystal with different speeds. On emerging they recombine to form plane-polarized light, the plane of which, however, depends on the

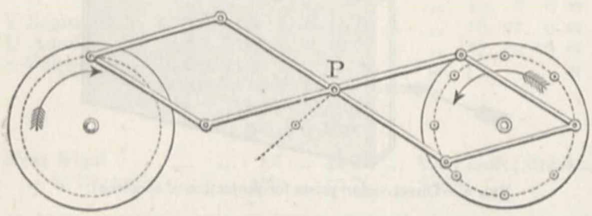


FIG. 11.—Model illustrating recomposition of rectilinear motion from two opposite circular motions.

retardation of phase between the two components. I here introduce a mechanical model to illustrate one of the points in this theory—namely, the recombination of two circular motions to form a straight-line motion. These two disks (Fig. 11), which turn in opposite senses, but at equal rates, represent two circularly-polarized beams of light. The linkages, which connect two pins on these disks, compound their motions at the central point, P, which executes, as you see, a straight line. But now, suppose one of these circular motions to be retarded behind the other, an effect which I can imitate by shifting one of the pins to another position on the disk. Still the resultant motion is a straight line, but it is now executed in a direction oblique to the former. In other words, its plane has been rotated. Of course this model must not be taken as establishing the truth of Fresnel's ingenious theory: it is at best a rough kinematical representation of it.

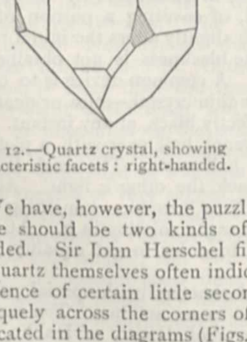


FIG. 12.—Quartz crystal, showing characteristic facets: right-handed.

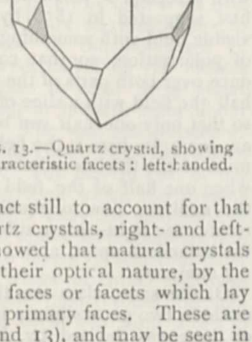


FIG. 13.—Quartz crystal, showing characteristic facets: left-handed.

We have, however, the puzzling fact still to account for that there should be two kinds of quartz crystals, right- and left-handed. Sir John Herschel first showed that natural crystals of quartz themselves often indicated their optical nature, by the presence of certain little secondary faces or facets which lay obliquely across the corners of the primary faces. These are indicated in the diagrams (Figs. 12 and 13), and may be seen in two of the specimens of quartz crystals which lie upon the table. The largest of these is right-handed. The wider generalizations of Pasteur, respecting the crystalline form of optically active substances, show that those substances which exercise an optical torque, whether as crystals or in solution, belong to the class of forms which the crystallographer distinguishes as possessing non-superposable hemihedry. In other words, they all show *skew symmetry*, as if in the growth of them they had been built up in some screw-fashion around an axis, and must therefore be either right-handed or left-handed screws. By piling up a number of wooden slabs in skew-symmetric fashion, I am able roughly to illustrate (Figs. 14 and 15) the difference between the right-handed and the left-handed structure. It is a curious fact, if I am rightly informed, that down to the present date the only substances possessing this skew symmetry are natural substances; that those which the chemist can produce by artificial synthesis are all optically inactive. It is perhaps equally significant that as yet no inorganic substances have been found which will in the liquid state rotate the light. This appears to be a property possessed solely by certain compounds of carbon. Quartz fused in the blowpipe or dissolved in potash shows no trace of rotatory power.

Yet we can have little doubt that this property is bound up in the yet unravelled facts of atomic and molecular structure. In the case of the liquids, such as turpentine and sugar solution, there must be some skew symmetry in the grouping of atoms in the molecule to produce the result. In the case of quartz, there must be a skew in the building of the molecules—there must, to borrow a phrase from the architect, be

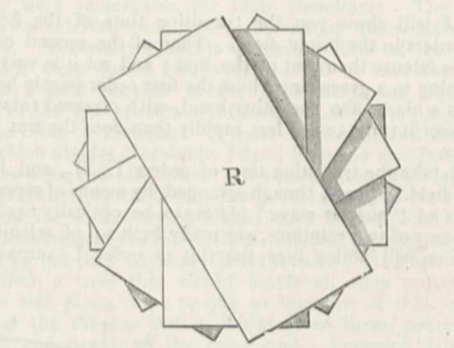


FIG. 14.—Skew-symmetrical arrangement: right-handed.

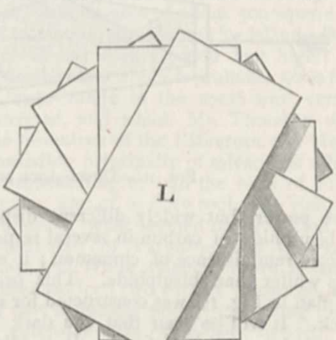


FIG. 15.—Skew-symmetrical arrangement: left-handed.

an oblique *bonding* of the minute bricks of which its transparent mass is builded. Though we cannot even rebuild it from its solution, we know this must be so, for we can reproduce all the optical phenomena which it exhibits by an actual skew building of thin slices of another non-rotatory crystal. Here is an artificial object (I built it myself) constructed on Reusch's plan, from sixteen thin slips of mica built up in staircase fashion—right-handedly—one above the other, and set symmetrically at equal angles of 45° to one another, the whole set making a cork-screw of two complete turns. In the lantern it behaves just as a quartz of about 9 millimetres thickness would do. It even gives tolerably perfect rings, as quartz does, when viewed by convergent light.

I must now pass hastily onwards to the great discovery of Faraday. Here (Fig. 16) is a magnetizing coil of wire, M, having about 8300 turns, and enclosed in an iron jacket. When it is traversed by a powerful electric current from the dynamo machine, it produces an intense magnetic field along its axis. In this axial position lies a bar of heavy glass, not quite so dense as that which Faraday himself used, but nearly so. The bar lies along the line of light from our lantern, but the polarizer, P (the Ahrens reflector, Fig. 7), and analyzer, A (the Ahrens triple spar prism, Fig. 6), are crossed, so that here is the dark field. On turning on the current, light is at once restored, being twisted to the right when the current circulates right-handedly. To measure the rotation, I must turn the analyzer; and now I find that, owing to the greater rotation of blue waves than of red, complete extinction does not occur. Introducing a half-shadow plate, and using coloured glasses, it is very easy to verify the greater amount of rotation for blue light, and to show that reversing the current reverses the rotation. You will perhaps better understand it if I use (as in Fig. 16) the 24-ray star, S, which I have previously employed. It is now obvious to you that there is a large rotation—over 50° in fact—which is reversed when I reverse the magnetizing current. We have thus repeated the fundamental experiment of magneto-optics. But now we meet with another consideration. Reflect that the circulation of current, if it be taken as right-handed when regarded from one end of the coil, will be left-handed when regarded from the other end of the coil. This is, therefore, no case of skew symmetry: it clearly indicates that something is going on in the glass which tends to twist the light quite irrespective of which way the light enters.

The next magneto-optic phenomenon is that discovered by Dr. Kerr, of the rotation of the plane of polarization by reflection at the surface of a magnet. To observe this at all requires good apparatus and a keen eye. So far as I am aware, it has never been projected on the screen. If I can succeed in doing so, it will only be because I have special means of the most

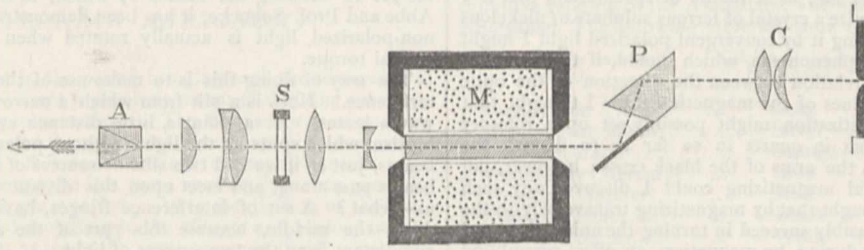


FIG. 16.—Projection of magnetic rotation of plane of polarization. C, condensing lenses; P, reflecting polarizer; M, magnetizing coil surrounding bar of heavy-glass; S, mica disk of twenty-four rays; A, analyzer (Ahrens's triple prism).

favourable character for so doing. We withdraw the bar of heavy glass from the coil, and replace it (Fig. 17) by an iron core polished at its coned end. This will be intensely magnetized when the current is turned on.

Now we must throw the beam of light obliquely down the hollow of the coil, polarizing it by one of my improved Nicol prisms, P, as it goes down. After reflection it is focussed by a lens which sends it through the analyzing prism, A. You see the dim spot of reflected light upon the screen. Now for the current: "on," "off," "on," "off." Reversing its direction ought to double the amount of torsion.

Whilst Mr. Thomas is making the needful arrangements for the next experiment, I may mention that it was found by Kerr that the effect was approximately proportional to the magnetic induction through the iron. I have myself tried some further experiments: for example, using a bar of lodestone instead of an iron core. The light reflected from lodestone is also twisted. I

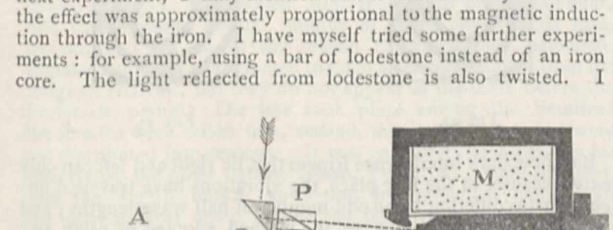


FIG. 17.—Apparatus for projecting rotation of plane of polarization by reflection at pole of magnet. P, polarizer; M, magnetizing coil with coned iron core; A, analyzer.

should expect the ferro aluminium alloy which Sir H. Roscoe showed us a fortnight ago to do the same thing, because that alloy is, as I have found, susceptible of magnetization. But I should not expect manganese steel to rotate the light, because of its singularly non-magnetizable nature.

The experiment of Kundt, transmitting polarized light through a thin transparent film of iron, magnetized normally whilst the light is passing through it, is another difficult of repetition before an audience. The small disks here are covered with films of iron, kindly prepared for me by Mr. Crookes, by squirting them electrically in a high vacuum. But the thin ones barely transmit enough light to make the observation of the effect possible even to the solitary observer. I have observed the effect projected on the screen, using this very coil and these transparent mirrors. It requires, however, an absolutely dark room, and is at best so faint that it would be hopeless to attempt to show it to a large audience. Prof. Kundt has not only observed similar rotations in other magnetic films of nickel and cobalt, but has even shown that the degree of rotation of the light is proportional not to the magnetizing force, but to the resulting magnetic induction. This is a result of utmost importance in considering the theory of the phenomenon. He has further shown that, whereas the magnetic rotations in elementary bodies, whether magnetic or diamagnetic, are in the same sense as that in which the current circulates, the magnetic rotations in compound magnetic bodies, such as a solution of sulphate of iron in water, are in the opposite sense.

These experiments with transparent mirrors of iron raise interesting speculations as to the probable nature of a transparent magnet, if such there could be. It is one of the cardinal points of Maxwell's celebrated electro-magnetic theory of light, that the better a body conducts electric currents, the greater is its tendency to absorb light and become opaque. Now, suppose it were possible to obtain a substance such as to possess greater electric conductivity in one direction than in another, such a substance ought to absorb those vibrations of light which are executed in the direction of the greater electric conductivity more than those in the direction at right angles. In other words, such a substance ought, like the tourmaline, to polarize light by absorption. Now, since the researches of Sir W. Thomson in 1856, we have known that the electric conductivity of iron is altered in the direction of the magnetic lines of force, when it is powerfully magnetized. More recently it has been discovered—I myself observed it in tinfoil, and announced the discovery to the Physical Society a few days before the announcement of the same fact by Righi—that non-magnetic metals alter their resistance in the magnetic field. Notably so do bismuth and tellurium. I had therefore conceived it possible that a film of iron or possibly of tellurium, if strongly magnetized in its own plane, might exhibit polar absorption and act like a tourmaline. Unfortunately, if the effect exists it is so faint as to be yet undiscovered, though I have made many efforts to find such. I have further tried to obtain a similar result by making a transparent magnet out of a film of magnetic oxide of iron, precipitated chemically. In this too I have not succeeded. I have tried to precipitate a transparent film of magnetic oxide in the midst of a transparent jelly. And I have mixed particles of precipitated oxide with melted gelatine so as to get a film. In this way I hoped to get, by placing the preparation in a strong magnetic field, a sort of magnetic structure which would operate upon waves of light. That such a task was not hopeless was shown by two facts: first, that many mere vegetable and animal structures can act as polarizers; and second, that a mere film of paint, such as indigo, can, if a proper mechanical drug is given to it so as to produce structure, also act as a polarizer.

The film of indigo-carmine which I have here, acts nearly as strongly, though not quite as evenly, as a tourmaline slice, and costs but a fraction of a penny.

Well, my films of jelly enclosing particles of magnetic oxide of iron do faintly act on polarized light; but their action is not as marked as that of films of jelly inclosing actual small scraps of iron. This film, when placed across the poles of this electro-magnet, between two Nicol prisms at 45°, shows an action when the magnet is turned on, as you see by the way in which it flashes into light in the dark field. When the jelly is fresh, and of the proper consistency, the action is very strong, but with the rather dry sample before you I fear we can only call the effect a *succès d'estime*.

Incidentally, in the course of these experiments on magnetic films, I came across a new magnetic body unknown hitherto, I believe, to the chemist—namely, a magnetic double oxide of cobalt and iron—a ferroso-cobaltic oxide, I think—a black powder, a sample of which I have here.

It also occurred to me, as a matter of speculation, that if I could strongly magnetize a crystal of ferrous sulphate or nickelous sulphate, whilst viewing it by convergent polarized light I might find some interesting phenomena, which should, if they existed, show some sort of a relation between the direction of the optic axis and that of the lines of the magnetic field. I thought that a longitudinal magnetization might possibly set up a rotatory phenomenon like that in quartz in so far as to disturb the central field between the arms of the black cross; however, not by the most powerful magnetizing could I discover any such effect. Again, I thought that by magnetizing transversely to the optic axis I might possibly succeed in turning the uniaxial crystal into a biaxial, or producing by magnetism an effect resembling the action of heat on crystals of selenite. Owing probably to the small depth of any crystals that can be obtained, I have failed so far to obtain any such effect, though I am convinced that it must exist.

An effect precisely analogous to the magnetic effect which I vainly sought has, however, been lately discovered by Prof.

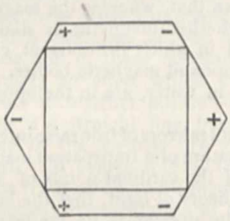


Fig. 18.

Fig. 19.

Röntgen. I sought a distortion of the optic axis by transversely magnetizing, and I sought it in crystals of sulphate of nickel: he has found a distortion of the optic axis by transversely electrifying, and he has found it in crystals of quartz.

Suppose a piece of a quartz crystal is cut as a square prism, its long faces being principal planes of section respectively parallel to and at right angles to two of the natural faces of the hexagonal prism. Fig. 18 shows the form of the portion cut. The + and − signs in this figure refer to the pyro-electric poles of the crystal. Such a piece viewed by convergent light shows the usual rings and black cross with a coloured centre (Fig. 19). If now two opposite faces be covered with tinfoil, and the crystal be electrified transversely, the rings are distorted into lemniscates, the direction of the distortion changing with the sign of the electrification. It is necessary to use a red glass, or still better sodium light, to observe the changes in form on reversing the sign of the charges. Figs. 20 and 21, 22 and 23, show the changes of form, but these sketches grossly exaggerate the effects. As you see upon the screen, when the charges imparted by this fine Wimshurst machine are rapidly reversed, there is a decided distortion of the rings, but it is small in amount.

Returning to the phenomena of the rotation impressed by magnetism on polarized light, I may point out that the torque which a magnetic field exerts on the light-waves appears to be really an action upon the matter through which the light-waves are passing. It is as though the magnetic field were really a portion of space rotating rapidly on itself, or perhaps as though the ether were there rotating, and that this rotation in some way dragged the particles of matter along with it. It has long been supposed necessary, in order to account for the refractive and dispersive properties of transparent bodies, to consider that their particles are in some way concerned in and partake of the vibrations going on in the ether within them or between their molecules. It is impossible to explain the phenomena of magneto-optic rotation by the supposition that any skew structure is imparted to the medium; for these phenomena, unlike those of quartz, do not exhibit skew symmetry. There seems to be no other way of explaining the magneto-optic torsion of light than by supposing that the molecules of matter in the magnetic field are actually subjected to rotatory actions; as indeed was suggested long ago by Sir William Thomson.

However, there is room here not only for speculation but for experiment. Some day, when facts enough have been collected, we shall be ready to build thereon the wider generalization which at present seems to escape us.

So far we have been applying an optical torque to previously polarized light, and producing a torsion of it. It remains for me yet to describe the means by which, in the hands of Prof. Abbe and Prof. Sohncke, it has been demonstrated that natural, non-polarized light is actually rotated when subjected to an optical torque.

The way of doing this is to make use of the principle of interference. Here is a slit from which a narrow beam of light-waves issues. At a point a little distance away is a Fresnel's biprism which splits up the light (without polarizing it) into two beams, just as if we had two slits or sources of light. These two beams pass along, and meet upon this distant screen, and give us—what? A set of interference fringes, having a bright line down the middle, because this part of the screen is exactly equidistant from the two sources of light.

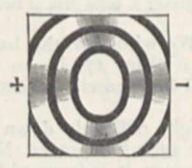


Fig. 20.

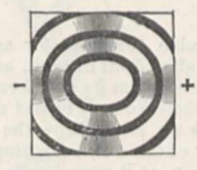


Fig. 21.

Fig. 22.

Fig. 23.

But these dark interference fringes that lie right and left can only exist because, in the first place, the vibrations have travelled unequal paths differing by an odd number of half wave-lengths; and secondly, because (owing to the method adopted of using two images of one slit) the phases of the emitted waves from the two sources are identical.

This being so, let us now introduce across the two interfering beams of light a special biquartz, made of right- and left-handed quartz of only 1·88 mm. thick. This will rotate—*if it rotates natural light at all*—the yellow light in one beam 45° to the right and that of the other beam 45° to the left. The angles will be a little more for green and blue, a little less for red and orange. Consequently we shall not get quite a perfect result for all kinds of colours. But for the main body of the light the result is this: that because the two beams have had their respective vibrations turned so that, whatever their primitive positions, they are now at right angles to one another, they cannot interfere. In other words, if it be true that the quartz rotates natural light, the interference bands will die out. [Experiment shown.]

Here I have the light passing through the biprism only, and giving us this narrow series of interference bands. You must notice carefully—with opera-glasses if you have them—the narrow bright and dark stripes. Now I shift this little diaphragm so that the light passes through the biquartz as well. Instead of sharp interference bands we have merely a dull line of nebulous light. The disappearance of the fringes proves that quartz does twist the not-previously-polarized waves of light.

That the magnetic field can also exert a magnetic torque on non-polarized light is readily proved, at least when one already has the biquartz. Two strips of heavy-glass of exactly equal length and similar quality, such as those I hold in my hand, must be introduced in the respective paths of the two beams: and one at least of them must be surrounded by a magnetizing coil. The biquartz has wiped out the interference fringes; but on magnetizing one of the two pieces of heavy-glass, or on magnetizing the two in opposite senses, the interference bands can be made to reappear. It is in this way that Prof. Sohncke's experiment—hardly suitable for a lecture theatre—was performed. It is in this way that we establish upon an experimental basis the fact that light itself, and not merely the plane of its polarization, experiences an optical torsion when subjected to those forces which, whether crystalline, molecular, or magnetic, exert upon it an optical torque.

BABYLONIAN ASTRONOMY.[1]

II.

THE year—that is, the period bringing back the recurrence of the seasons—is not a primitive means of dividing time, but the result of many observations. The simplest way of marking time is by seasons, and the system is still employed by some savage nations in Africa. A season does not correspond to one year, and more than one may be in a year; seasons, however, generally correspond to the year period. As to the division of the year, it must have varied according to the climate and region, but the simplest is by ten, as ten is the most common dividing number, and such was the one originally adopted by the Semites and Egyptians. This year of ten months, or rather ten parts, has left traces among the Semites and in classical authors. The Babylonians assimilated their first ten kings to the ten parts of the year. At Rome, we are told that the year before Numa Pompilius was composed of ten months only.

A year of ten lunar months is impossible, for after two or three of such periods it would no longer correspond with the seasons. We find, therefore, that the ten parts of the year were composed of thirty-six days distributed in four periods or weeks of nine days. This last division was not, however, official: the days of each of the ten divisions of the year were merely numbered from one to thirty-six; it was at a later date that the days received names from the protecting gods attributed to them.

It is to be noticed that in Egypt the months had no special names; the year was divided, after the reform of the calendar, into three seasons of four months of thirty days, called first, second, and so on, of the season to which they belonged. Popular names were attributed to them afterwards, taken from the religious festivals, but they do not appear in the texts before the Ptolemaic period. The like took place among the Semites: the months were called first, second, third, and so on, but were not distributed into seasons. It was only after the Akkadian invasion that the other names, Nisan, Tyyar, &c., were adopted, and the eighth month never lost its numerical name. In the astronomical omen tablets the primitive nomenclature by numerical order was often preserved.

It is still uncertain at what time the old calendar of ten divisions of thirty-six days was reformed into one of twelve months of thirty days. The change was due to the desire to measure the time by the appearance of the moon. This reform may be due to the influence of the Akkadians, who made the conquest of Babylon about 7000 B.C. These people had a lunar calendar composed of thirteen months of twenty-eight days, giving, therefore, a year of 364 days. It was no doubt more accurate than the Semitic calendar, but the Akkadians adopted their subjects' calendar. The deficiency with the normal solar year of 365 days was made up by means of a supplementary month placed irregularly by the priests when they thought it necessary. That is why we find various intercalary months, and why, in some cases, as late even as Nebuchadnezzar the Great, they occur in three successive years. To make up the deficiency the Babylonians had also a supplementary day called the "heavy 21st," which could be inserted in any month before the normal 21st. We find the mention of such supplementary days in several consecutive months.

The Akkadians, before invading Babylonia, divided their month into four parts or weeks of seven days each. This division had, however, nothing to do at first with the planets, to which the days were assimilated only at a later date. The Akkadians looked on the planets as evil spirits disturbing by their irregular motion the harmony of heaven; and, as evil spirits were the chief objects of their worship, they naturally attributed to each day of the week the name of a planet. When the Akkadians adopted the Semitic month of thirty days, the week of seven days was naturally abandoned in common use, but it was retained for religious purposes with some modification, a new series of four weeks commencing with each month. The Semites rejected the Akkadian names of the days of the week, though they preserved the symbolism attached to them, as is shown by the seven tablets buried under the foundation-stone of Khorsabad.

Our names of the days of the week are derived from the Akkadian assimilation of these days to the planets. There is no doubt as to the order in which the planets were assimilated to the names of the days, if we compare them with the colours of the walls of Ekbatana built by a Medic tribe, which preserved the primitive religion of the Akkadians, and also with the tablets of Khorsabad. The following table will show the correspondence:—

Names of the days and planets.	Colours of the walls of Ekbatana.	Materials of the tablets of Khorsabad.
1 Sunday (the Sun) ...	... Gold ...	Gold
2 Monday (the Moon)	... Silver ...	Silver
3 Tuesday (Mars) ...	... Orange ...	Copper
4 Wednesday (Mercury)	... Blue ...	Tin
5 Thursday (Jupiter)	... Red ...	Iron
6 Friday (Venus) ...	... Black ...	Basalt
7 Saturday (Saturn)...	... White ...	Limestone

Iron, corresponding to Thursday, or Jupiter, is represented by a red colour, no doubt on account of the rust, which is red. And we must not be surprised to see Venus represented symbolically by black, for Vesper or the Evening Star is really the *dusky*.

This proves that the week of seven days, which is found all over Asia and Europe, spread, not from Babylonia, but from the country whence came the Akkadians.

[1] Abstract of the second lecture delivered by Mr. G. Bertin at the British Museum. Continued from p. 237.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE summer meeting of this Institution was held in Paris last week under the presidency of Mr. Charles Cochrane.

The papers offered for reading and discussion were a description of the lifts in the Eiffel Tower, by Mr. A. Ansaloni, of Paris, supplemented by the results of working to date, communicated verbally by Mr. Gustave Eiffel, President of the Société des Ingénieurs Civils; the rationalization of Regnault's experiments on steam, by Mr. J. Macfarlane Gray; on warp-weaving and knitting without weft, by Mr. Arthur Paget; on gas-engines, with description of the Simplex engine, by Mr. E. Delamare-Deboutteville; on the compounding of locomotives burning petroleum refuse in Russia, by Mr. T. Urquhart; and description of a machine for making paper bags, by Mr. Job Duerden.

In the discussion of the first paper, which, as its title shows, was mainly technical in character, the interesting meteorological circumstance of the Eiffel Tower acting as a thunder-cloud discharger was referred to; clouds laden with electricity having passed quietly over the region of the tower, which previously and afterwards flashed with lightning. It was also pointed out that the perpendicularity of the building is not affected by temperature variations, nor by any wind pressure hitherto recorded.

We have not received a copy of the paper by Mr. Gray, who reserves the right of reproducing it, but from the syllabus of papers published by the Institution of Mechanical Engineers, it may be stated that Mr. Gray proposes a new unit of heat, which he compares with the ordinary water-unit, and a new diagram of energy, which he calls the Theta-phi (θ ϕ) or temperature-entropy diagram, a graphic representation of the Carnot-Clausius fundamental principle, of which the area shows heat-units, the co-ordinates being the temperature, θ, and entropy, ϕ. He compares Regnault's experimental steam-pressures with the pressures calculated by means of his formulæ, showing closer agreement than is obtained by Regnault's most accurate formulæ.

In Mr. Paget's paper the three chief methods of making fabric or cloth or tissue from yarns or threads, viz. ordinary weaving, knitting, and what the author calls warp-weaving, are referred to. The paper describes the method by which shaped goods can be made by warp-weaving, and the machine by which this is effected. The machine, which is of a very ingenious character, comprising several interesting points of construction and detail, is at work at the Paris Exhibition.

Mr. Deboutteville, in his paper, first reviews the gas-engines hitherto proposed or employed. He carries back his researches nearly a century, when the first gas-engine was proposed by Barber, and completes them with a description of the Simplex engine, which he brought out with Mr. Malandin in 1884. This engine is founded on principles laid down by Mr. Beau de Rochas—that, to realize the best results from the elastic force of gas, the cylinders should have the greatest capacity with the smallest circumferential surface, the speed should be as high as possible, the cut-off should be as early and the initial pressure as high as possible. In the author's engine the ignition is effected by a practically continuous electrical spark; the air and gas are mixed in an external receptacle fixed on the cover of the slide, and are drawn in through channels of varied forms so as intimately to mix them. The governors described act on the principle of totally cutting off the supply of gas for one or more strokes whenever an increase of speed occurs. From the tests made with this engine the consumption of gas is low, and it appears to compare favourably with good steam-engines as regards economy of application.

Besides the reading and discussion of papers, the members of the Institution visited the Exhibition, and various works which were opened for this purpose.

SCIENTIFIC SERIALS.

THE numbers of the *Journal of Botany* for June and July are chiefly devoted to articles interesting to students of systematic or geographical botany, especially that of our own islands; the latter number contains a biographical sketch of the late Prof. Reichenbach, by the editor.

THE most interesting article in the *Botanical Gazette* for May is the commencement of a detailed paper by Mr. C. Robertson, on the relations between insects and flowers in regard to American plants. The number for June contains original articles by Mr. H. L. Bolley, on sub-epidermal rusts, and by Mr. J. N. Rose, on the Achenia of *Coreopsis*.

THE *American Meteorological Journal* for May contains abstracts of the papers read at the meeting of the New England Meteorological Society on April 16:—In a paper on lightning and the electricity of the atmosphere, Mr. McAdie gave an account of some kite experiments at the Blue Hill Observatory, near Boston, in which the potential was determined at various heights. He also referred to the observations on the character of lightning at the top of Mount Washington during thunderstorms, and to the effect of the electrification of the air upon water, dust, and other particles in it, and to the possibility of foretelling the moment of a flash of lightning.—Prof. W. M. Davis made a report upon the investigation of the sea-breeze, undertaken in 1887, from observations at 100 stations. One fact shown was that the diurnal range of temperature, which is diminished on the coast by the action of the sea-breeze, is not lessened at the inland stations.—Mr. E. B. Weston read a paper on the practical value of self-recording rain-gauges, referring to the importance of knowing the hourly falls when constructing drainage systems.—Prof. H. A. Hazen continues the discussion upon anemometer comparisons, and upon the question of the probable effect of the momentum of heavy cups, when placed on a whirling machine. He considers that the Robinson anemometer is by far the best instrument ever devised for variable winds.—Lieut. Finley discusses the frequency of tornadoes in Illinois for fifty-four years, ending with 1888. The total number of storms was 141. The month of greatest frequency was May, no month being free from storms. The prevailing direction of movement was north-east.—Prof. Harrington communicates the instructions issued by the Chief Signal Officer for the preparation of forecasts and for their verification. The instructions contain nearly 200 regulations, and are very interesting to those who study weather predictions.

THE *Meteorologische Zeitschrift* (Vienna) for June contains the first part of an epitome of Dr. von Bezold's papers on the thermodynamics of the atmosphere, which have already been summarized in our notices of Societies.—Dr. J. Hann contributes a valuable article on the results of the meteorological observations of the late Prof. A. Ackermann at Port-au-Prince, Hayti, 1854-68, being a part of the world where they are of special value. The observations were rescued from entire loss by the exertions of Dr. Hann and Prof. J. Scherer, the originals having been wilfully destroyed. The distribution of rainfall is much affected by the mountain features of the island; in the north the rainy season is from December to April, while in the south it is from May to July. The average yearly rainfall at Port-au-Prince, from the above observations, was 61 inches, on 153 days. The greatest daily fall was 5·6 inches in May 1865, the rain lasting four hours. The climate is very equable; the mean of the absolute maximum temperatures was 98°·2, and of the minimum 56°·8.—Dr. von Lepel describes his experiments in passing electric sparks through glass tubes lined with a thin coating of paraffin, and containing a small amount of moisture, and points out that during thunderstorms many similar discharges may be observed, and may find their explanation in these experiments. The sparks differ in character and in colour, and the author argues that the humidity in the tube may be compared to the particles of vapour in the thunder-clouds, and that the coating of paraffin may have the same optical effect as the translucent clouds themselves. He gives the results of his thunderstorm observations on these lines during the summer of the year 1888.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, June 22.—Prof. Reinold, F.R.S., President, in the chair.—The following communications were made:—Note on some photographs of lightning, and of "black" electric sparks, by Mr. A. W. Clayden. The lightning photographs, three in number, were obtained during the storm on June 6. Two flashes, seen on one plate, show complicated and beautiful structure: one of them is a multiple flash, and flame-like appendages point upwards from every angle; the other is a broad ribbon, and, although the plate shows signs of movement, the displacement is not in a direction such as would produce a ribbon-like effect from a linear flash. The second plate shows four flashes, none of which are ribbon-like, though the camera had moved considerably. The third plate was exposed to six flashes, one of which was believed to pass down the middle of the plate; but, on development, only a triple flash in one corner of the plate was seen. Careful search, however, revealed the central flash as a dark one with a white core, and other dark flashes were subsequently found. The plate was very much over-exposed, and this suggested that black flashes might be due to a sort of cumulative action caused by the superposition of the glare from a white cloud upon the normal image of the flash. To test this, sparks from a Wimshurst machine were photographed, and, before development, the plates were exposed to diffused gas-light for a short time. The bright sparks yielded normal images with reversed margins, and the faint ones were completely reversed. Other experiments showed the reversal to spread inwards as the time of exposure to gas-light increased. Finally, reversal was effected by placing a white screen behind the spark, to represent a white cloud, the only illumination being that of the spark itself. In the discussion which followed, Mr. W. N. Shaw exhibited a photograph taken during the same storm, which is particularly rich in dark flashes branching outwards from an intensely bright one. In some places the bright line has dark edges, and in one part a thin bright line runs along the middle of an otherwise dark portion of the flash. In answer to Mr. Inwards, Mr. Shaw said the plate was exposed about half a minute, and the former thought that, under those conditions, the appearance of the plate did not contradict Mr. Clayden's hypothesis. Speaking of the same photograph, Prof. Perry considered that Mr. Clayden's observations would explain the result, for a bright flash required more exposure to diffused light to reverse it than a faint one did. Prof. Ramsay reminded the meeting that Prof. Stokes's "oxides of nitrogen" explanation was still a possible one; and Mr. C. V. Burton asked whether they may be due to faint sparks cutting off light from brightly illuminated clouds, just as a gas-flame absorbs light from a brighter source. In reply, Mr. Clayden thought the "oxides of nitrogen" hypothesis improbable, and said his experiments did not enable him to answer Mr. Burton's question. As regards Mr. Shaw's plate, he believed the diffused light from the clouds would be sufficient to reverse the fainter tributary flashes, although it was insufficient to reverse the primary one. From data obtained when the ribbon-flash was taken, he had made some calculations which gave the height of the clouds about 1000 yards, and the ribbon-flash 1300 yards long and 100 yards wide.—Researches on the electrical resistance of bismuth, by Dr. Ed. von Aubel. The paper, which is in French, was taken as read. A translation will appear in the Proceedings of the Society.—Expansion with rise of temperature of wires under pulling stress, by J. T. Bottomley, F.R.S. The investigation was to determine whether the coefficient of expansion of wires depends on the stress to which they are subjected, and was undertaken in connection with the secular experiments on the elasticity and ductility of wires, now being conducted at Glasgow University. Two wires, about 17 feet long, of the same material, were suspended side by side within a tube, through which steam could be passed to change the temperature. One wire was loaded to half, and the other to one-tenth its breaking weight, and, in the preliminary experiments the elongations were read by a Quincke's microscope cathetometer. About 150 heatings and coolings, extending over three months, were necessary to bring the heavily loaded wire to its permanent state, so that consecutive expansions and contractions were equal. When this stage was reached, hooks of peculiar shape were attached to the lower ends of the wire. These hooks form a relative geometrical guide, and their horizontal parts mutually support a small table which carries a plane mirror. If the wires expand or contract unequally, the mirror becomes tilted, and the relative displacement is observed by means of a telescope and scale fixed nearly vertically over the mirror. From experiments on copper wires, the coefficient of relative expansion was found to be $0·32 \times 10^{-6}$ per degree Centigrade, or about 1/55 of the ordinary linear expansion of the material. The heavily loaded wire expanded most. The results for platinoid give $0·27 \times 10^{-6}$ as the relative coefficient under the conditions named above; this is about 1/57 of the ordinary linear expansion, which, from separate experiments, was found to be $15·4 \times 10^{-6}$. Mr. H. Tomlinson thought the probationary period for copper might be considerably shortened by repeatedly putting on and taking off the load, and by subjecting the wire to torsional oscillation. With iron wires this would not be the case, for they behave in a most peculiar manner, and require long periods of rest after each oscillation. From experiments he had conducted during the last two years, he found that the permeability of iron could be enormously reduced by repeated heatings and coolings whilst undergoing magnetic cycles of small range. Mr. Gregory said the paper threw considerable light on some experiments on the sag of stretched wires upon which he was engaged. He also suggested heating the wires by electric currents. In reply, Mr. Bottomley said he had considered it important to leave the wires untouched after being suspended, and as regards heating by electricity he thought that convection-currents would make the temperature non-uniform.—Owing to the absence of Prof. S. P. Thompson, his "Notes on Geometrical Optics" were postponed.

Linnean Society, June 20.—Mr. Carruthers, F.R.S., President, in the chair.—Dr. H. Trimen exhibited specimens and drawings of the tuberculated lime of Ceylon, and made some interesting remarks thereon.—Governor Moloney, of the Colony of Lagos, West Africa, exhibited an extensive collection of butterflies and moths, the result of twelve months' collecting during the rainy season. The former, comprising representatives of 65 genera and 158 species; the latter, 78 genera and 112 species, had been named and arranged by Mr. Herbert Druce. A few Chelonians, belonging to the genera *Trinonyx*, *Sternothærus*, and *Cinixys*, were also exhibited, and a remarkably large block of resinous gum, which, in the opinion of Prof. Oliver, was referable to some species of *Daniellia*, and which had been found in Ijo country. As an article of commerce, it possessed the advantage of requiring a heat of 600° F. to "run" it, so as to unite with linseed oil in the manufacture of varnish. In addition to these specimens, Governor Moloney exhibited some long-bows and cross-bows obtained from chiefs of Ibadan from some battle-field in that neighbourhood, and used by natives 300 miles from the coast-line. A discussion followed, in which Dr. Anderson, Mr. D. Morris, and Mr. Harting took part.—Prof. Stewart next exhibited some skulls, adult and immature, of *Ornithorhynchus paradoxus*, and explained the very curious dentition of this animal; upon which Dr. Mivart and Prof. Howes made some critical remarks.—A paper was then read by Dr. John Anderson, F.R.S., on the mammals, reptiles, and Batrachians which he had collected in the Mergui Archipelago, and concerning which he had been enabled to make some interesting field-notes. Attention was particularly directed to a new bat (*Emballonura*), and to the occurrence, on some of the islands, of *Pteropus edulis*, besides a wild pig, musk deer, gray squirrel, and a crab-eating monkey (*Semnopithecus*), which hunts along the shore in search of Crustacea and Mollusca. Some remarks were made on rhinoceros going out to sea, and on a crocodile being found twenty miles off the coast.—A communication was read from Mr. Charles Packe, on a remarkable case of prolonged vitality in a fritillary bulb.—The meeting (the last of the session) was brought to a close by a most interesting demonstration on animal locomotion, by Mr. E. Muybridge, who illustrated his remarks with projections on the screen, by oxy-hydrogen light, of instantaneous photographs taken by him, to which motion was imparted by means of the zoopraxiscope.

SYDNEY.

Royal Society of New South Wales, May 1.—Annual Meeting.—Sir Alfred Roberts in the chair.—The report stated that twenty new members had been elected during the year, and the total number on the roll, April 30, was 474. During the year the Society held seven meetings, at which the following papers were read:—Presidential address, by C. S. Wilkinson.—Forest destruction in New South Wales, and its effects on the flow of water in water-courses and on the rainfall, by W. E. Abbott.—On the increasing magnitude of η Argûs; on an improvement in anemometers; on the storm of September 21, 1888; on a new self-recording thermometer; and on the thunderstorm of October 26, 1888, by H. C. Russell, F.R.S.—Notes on some minerals and mineral localities in the northern districts of New South Wales, by D. A. Porter.—On a simple plan of easing railway curves, by W. Shellshear.—On the anatomy and life-history of Mollusca peculiar to Australia; and on the desert sandstone, by the Rev. J. E. Tenison-Woods.—Description of an autographic stress-strain apparatus, by Prof. Warren.—Considerations of phytographic expressions and arrangements, by Baron Ferd. von Mueller, K.C.M.G., F.R.S.—Indigenous Australian forage plants (non-grasses), including plants injurious to stock; some New South Wales tan substances, Part 5, by J. N. Maiden.—Census of the fauna of the older Tertiary of Australia, by Prof. Ralph Tate.—Results of observations of comets I. and II., 1888, at Windsor, New South Wales, by John Tebbutt.—The Latin verb *jubere*, a linguistic study, by Dr. John Fraser.—Notes on some New South Wales minerals (Note No. 5), by Prof. Liversidge, F.R.S.—The Medical Section held seven meetings, at which the attendance was far above the average; the papers read and specimens exhibited were interesting and valuable. The Microscopical Section held seven meetings. The Clarke Medal for the year 1889 had been awarded to R. L. J. Ellery, F.R.S., Government Astronomer for Victoria. The Society's bronze medal and money prize of £25 had been awarded to the Rev. J. E. Tenison-Woods for his paper on the anatomy and life-history of Mollusca peculiar to Australia, and the Council has since issued the following list of subjects with the offer of the medal and a prize of £25 for each of the best researches if of sufficient merit:—(To be sent in not later than May 1, 1890): The influence of the Australian climate (general and local) in the development and modification of disease; On the silver ore deposits of New South Wales; On the occurrence of precious stones in New South Wales, with a description of the deposits in which they are found. (To be sent in not later than May 1, 1891): The meteorology of Australia, New Zealand, and Tasmania; Anatomy and life-history of the Echidna and Platypus; The microscopic structure of Australian rocks.—The Chairman read the Presidential address, and the officers and Council were elected for the ensuing year. Prof. Liversidge, F.R.S., was elected President.

PARIS.

Academy of Sciences, July 1.—M. Des Cloizeaux, President, in the chair.—On a flow of molten glass occasioned by the accidental piercing of a glass furnace, by M. F. Fouqué. An account is given of the sudden escape of about 400,000 kilogrammes of molten glass from the Clichy-la-Garenne Works, and a comparison is drawn between the action of the discharge and that of volcanic lavas. The absence of bubbles near the surface of the former, and the other differences noticed between the two streams, are attributed mainly to the different chemical composition of the initial magma of each substance. The wollastonite peculiar to the vitreous flow solidifies under very different conditions from those of the feldspars and ferro-magnesian bisilicates occurring in the molten lavas.—The thermo-chemical compared with the surgical method in the study of the animal organism, by M. Sappey. In continuation of his recent communication on this subject, the author here contrasts the advantages and defects of the old and new processes, showing how they are complementary one of the other, and should consequently be associated in all important anatomical researches.—On the duration of lightning, by M. Daniel Colladon. In connection with M. Trouvelot's recent note, the author claims priority of discovery, having shown nine years ago that in thunderstorms the flash cannot always be instantaneous, and must last perceptibly longer than the thousandth part of a second assigned to it by Wheatstone.—Presentation of a volume of the "Annales de l'Observatoire de Paris: Observations de 1883," by M. Mouchez. The delay in issuing this volume is mainly due to the greatly increased number of meridian observations which were required to complete the revision of Lalande's Catalogue. The volume for 1884 is already half printed. —Note accompanying the presentation of M. Ch. Ed. Guillaume's work entitled "Traité Pratique de la Thermométrie de Précision," by M. Cornu. In this work is embodied a summary account of the researches that have been undertaken by the International Bureau of Weights and Measures for the purpose of removing the defects in the mercury thermometer, and giving the required degree of accuracy to that instrument. —On a new apparatus for zoological and biological research at determined marine depths, by Prince Albert of Monaco. With a view to remedying the defects of the instruments used in the expeditions of the *Challenger*, the *Blake*, and the *Vettor Pisani*, the author has prepared the instrument here described and illustrated. It is constructed on entirely new principles, and may be let down closed to any desired depth, then opened for purposes of observation, and re-closed before being brought to the surface. With this appliance Prince Albert has operated with satisfactory results to a depth of 500 metres in the Madeira waters.—Influence of temperature on the mechanical properties of metals, by M. André Le Chatelier. The mechanical properties of the metals at the different temperatures to which they are exposed in the various industrial processes have hitherto been little studied. The author here describes a series of researches that he has undertaken chiefly for iron and steel, but also for copper, zinc, aluminium, silver, nickel, and sundry alloys of copper, iron, and nickel. The results of these researches show generally that the mechanical properties of these metals are gradually modified with increased temperature. The detailed results obtained for iron and steel are reserved for a future communication.—On the malonates of barium, by M. Massol. The neutral malonates $CH_2(COO)_2Ba . 2H_2O$ and H_2O, with their respective heats of solution and heats of formation, are described.—On the sardine fisheries on the coast of Brittany in 1888, by M. Georges Pouchet. The shoals were fully as abundant as in 1887; but for some unexplained reason there was a total suspension of the fisheries from about June 28 to July 20, during which period the sardines everywhere disappeared from the seaboard.—On the scales and calcareous epidermic glands of Globularia and Selago, by M. Edouard Heckel. During his general anatomical researches undertaken to establish a histotaxic classification of the Globularieæ, the author has detected in some species certain prominent anatomical characters, which appear to have escaped the notice of the numerous botanists who have occupied themselves with this family. They are described as calcareous epidermic glands of a scaly type, and are regarded by M. Heckel as condensed hairs clothing the outer surface with granular and crystalline calcareous concretions, instead of secreting an internal cystolith and localizing it in their unicellular chamber, as is the case with the Urticeæ, Verbenaceæ, and some other families.—On the occurrence of a granulite with riebeckite characters in Corsica, by M. Urbain Le Verrier. A microscopic study of this rock, which occurs in large masses about the middle of the west coast, shows that it is a hornblende of a special type, presenting the characters of the riebeckite recently described by M. Sauer.—On the leaves of Lepidodendron, by M. B. Renault. Since his last communication on this subject (*Comptes rendus*, November 28, 1887), the author has found a considerable number of leaves of Lepidodendron in the fossiliferous quartzes of Combres, de Lay, and Esnost near Autun. Some were still attached to the branches of *L. rhodumnense* and *L. esnostense*, and the present paper is restricted to a description of the former species.—The Quaternary stations in the neighbourhood of Lorrez-le-Bocage, Seine-et-Marne, by M. Armand Viré. In these stations, numbering about ten, and distant 25 leagues from Paris, M. Viré has collected several thousand flint instruments and weapons of different types, besides a few fragments of a blackish unornamented pottery.

STOCKHOLM.

Royal Academy of Sciences, June 5.—On the heredity of exterior lesions and of acquired characters, by Prof. G. Retzius. —Prof. A. F. Smitt reported upon a paper, by Dr. Fr. Heincke, of Oldenburg, entitled "Researches on the Stickleback."—Baron Nordenskiöld exhibited some fine specimens of minerals from Norway, sent as a gift by Dr. Jellef Dahl.—Prof. Nilson reported upon an investigation by himself and Prof. O. Petterson on the molecular weight of chlor-aluminium. They have found that it is expressed by the formula $AlCl_3$ and not by Al_2Cl_6, as given by Friedel and Craft.—On some definite integrals, by Dr. Lindman.—Observations on the tidal waters at Polhun in Spitzbergen, by Prof. Wijkander.—On the ammoniacal combinations of iridium, by Herr W. Palmar.—On amidoximes and azoximes within the triazol and tetrazol series, by Dr. Bladin.—On the action of cyanium on *a*- and *b*-naphthylamin, by Herr O. Nordenskiöld.—On *a*- and *b*-monofluornaphthalin, by Messrs. A. Ekbom and R. Mauselius.—Observations on the radiation of the sun, by Dr. K. Ångström.—Ornithological observations made during the year 1887 at Sandhamn and its neighbourhood, by Herr O. Ekbohm.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Proceedings of the Society for Psychical Research, June (Trübner).—Proceedings of the Geologists' Association, November 1888 (Stanford).—Journal of the Royal Microscopical Society, June (Williams and Norgate).—Bulletin of the U.S. Geological Survey, No. 43 (Washington).—The Geological and Natural History Survey of Minnesota, Report for the Year 1887 (St. Paul).—Aus dem Archiv der Deutschen Seewarte, ix. Jahrg., 1886; x. Jahrg., 1887 (Hamburg).—Musical Instruments and their Homes; M. E. Brown and W. A. Brown (New York, Dodd).—The Second Report upon the Fauna of Liverpool Bay and the Neighbouring Seas: edited by Prof. Herdman (Liverpool).—The Chemistry of the Coal-tar Colours, 2nd edition: Dr. R. Benedikt; translated and edited by Dr. E. Knecht (Bell).—Contributions to the Tertiary Flora of Australia: Dr. Constantin (Sydney, Potter).—Hydraulic Motors: G. R. Bodmer (Whittaker).—Contributions to the Knowledge of Rhabdopleura and Amphioxus: E. Ray Lankester (Churchill).—Der Einfluss einer Schneedecke auf Boden. Klima und Wetter: A. Woeikof (Wien).—The Invertebrate Fauna of the Hawkesbury-Wianamatta Series of New South Wales: R. Etheridge, Jun. (Sydney, Potter).—Proceedings of the Geologists' Association, May (Stanford).—Mind, July (Williams and Norgate).

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