THURSDAY, MAY 14, 1885

SIR WILLIAM THOMSON'S "MATHEMATICAL AND PHYSICAL PAPERS"

Mathematical and Physical Papers. By Sir William Thomson. Vols. I. and II. (Cambridge University Press. 1882, 1884.)

EVERY one interested in the study of physics of the more profound kind will welcome this collection of essays by the celebrated natural philosopher, so many of which, hitherto scattered throughout various periodicals, difficult to gather together, or even wholly inaccessible to readers out of the reach of large public libraries, are yet of decisive importance for those chapters of the science to which they refer. With the two volumes now before us, in conjunction with the late publication, "Reprint of Papers on Electrostatics and Magnetism," the collection is now completed down to the date of February, 1856. Vol. II. contains, besides, all that the author has written on the Transatlantic Telegraphs, which, according to the strict order of time, might have been looked for in later volumes. The first volume begins with a series of essays, for the most part of a mathematical nature, ranging from the year 1841 to 1850. So far as these essays relate to physical problems, their chief interest turns on the difficulties connected with the analytic method. These difficulties were, however, even at that early period, treated by the youthful author with great skill, and under comprehensive points of view. The problems are, in part, geometrical and mechanical, referring to lines of curvature, systems of orthogonal surfaces, principal axes of a rigid body, &c. Most of them, however, deal with the integration of the differential equations, on which is based the doctrine of thermal conductivity and potential functions. The latter, as is well known, form the mathematical foundation of a large number of chapters in physics—the doctrine of gravitation, of electrostatical distribution, of magnetic induction, of stationary currents of heat, of electricity and of ponderable fluids. By treating all these problems collaterally and rendering concretely in some what in others appears in the highest degree abstract, the author has succeeded in overcoming the greatest difficulties, and we can only recommend every student of mathematical physics to follow his example. A field particularly favourable for the exercise of his powers was opened up to Sir W. Thomson by the phenomena, newly discovered by Faraday, in diamagnetic and weakly magnetic bodies, crystalline as well as uncrystalline. These our author rapidly and easily succeeded in arranging under comprehensive points of view. One great merit in the scientific method of Sir William Thomson consists in the fact that, following the example set by Faraday, he avoids as far as possible hypotheses on unknown subjects, and by his mathematical treatment of problems endeavours to express the law simply of observable processes. By this circumscription of his field the analogy between the different processes of nature is brought out much more distinctly than would be the case were it complicated by widely-diverging ideas respecting the unknown interior mechanism of the phenomena.

From the year 1848 and onwards there follows a long series of important investigations into the fundamental problems of thermo-dynamics. These start first with Saadi Carnot's conclusions respecting the mechanical functions of heat arrived at before J. P. Joule had experimentally demonstrated the equivalence of heat and mechanical energy. At the time when Carnot published his investigations heat was, by the majority of physical scientists, deemed an imponderable substance capable of flowing from one body to another, of entering occasionally into a more intimate kind of union with ponderable matter, and becoming, so to say, chemically united with it, under changes in the state of aggregation and under chemical processes. According to this older view temperature signified as much as the pressure under which the imponderable fluid stood in the warm bodies. In the case of a great number of thermal processes heat, in point of fact, acts entirely like a substance, showing the constancy of quantity, which is the most characteristic criterion of substances. In this way large sections of the doctrine of heat, embracing great bodies of facts, could very well be treated under the substantial conception of this agent—such, for example, as the exchange of heat between different bodies, the confinement and liberation of latent heat, the chemical production of heat. All that was necessary to render the substantial conception of heat apparently satisfactory was but to leave out of account all cases in which other forms of work are produced by heat or in which heat is produced by such. Cases of this kind then known were indeed very few, whereas the sections of the doctrine of heat already referred to were exactly those which till towards the middle of this century engaged the attention of natural philosophers. Carnot's highly acute investigation was an attempt to bring the phenomena likewise of the performance of work by means of heat into harmony with the assumption of the substantial theory of heat. The result of this endeavour was remarkable enough. He showed, namely, that heat was capable of performing mechanical work only when a quantity of it passed from a body of higher temperature into another body of lower temperature. A complete analogy thus seemed to be established between heat and those gases which through their pressure are capable of performing work, expanding, as they do, and abating their pressure in a measure corresponding with their expansion. The heat of a warm body corresponds n a manner with a compressed gas; it diffuses itself in space, passing into neighbouring bodies, to the lowering of the temperature of the body in which it was originally compacted.

Carnot's deductions, although based essentially on the erroneous assumption that the quantity of heat was constant like that of a substance, proved in reality correct so far as they respected transitions of heat within very narrow limits of temperatu... They cease, however, to be strictly accurate when they are extended to wider intervals of temperature, for in that case finite parts o the transferred heat become transformed into work and no longer continue as heat. We now know through the experiments of Joule that heat does not possess the absolute constancy of a substance, but only the relative constancy of an equivalent of work which, to be sure, can neither be produced from nothing nor come to nothing but is yet capable of being transferred into other forms of equivalents of work which may be presented in a very diverse and hardly recognisable manner.

In his first Essays, Art. XXXIX., "On an Absolute Thermometric Scale," and Art. XLI., "An Account of Carnot's Theory of the Motive Power of Heat," dating from the years 1848 and 1849, our author still occupies essentially Carnot's standpoint, but he nevertheless calls attention to the fact that the argument adduced by Carnot in support of his theorem, apparently valid though it was in all points, was yet defective if the experiments by Joule, which were just then made known, should be confirmed, according to which heat might be generated anew by work (vol. i. p. 116). That which more immediately directed Sir William Thomson's studies to this subject was the possibility of attaining, in accordance with Carnot's theorem, to an absolute scale of temperature, and he endeavoured to utilise the observations which Regnault had shortly before carried out with special care in reference to the pressure and latent heat of steam for he purpose of calculating such a scale. But in doing so, he was obliged to apply the hypothesis, not perfectly exact in this case, that the density of steam was to be calculated from pressure and temperature according to the laws of gases.

The theory of Carnot next obtained highly surprising confirmation from the theoretical deductions drawn by Prof. James Thomson, the elder brother of Sir William, touching the alteration of the freezing-point of water in consequence of differences of pressure. The accuracy in point of fact of this deduction was experimentally demonstrated by Sir W. Thomson. This was a discovery which perhaps more than any other served to draw the attention of physical scientists to the accuracy and the importance of Carnot's theorem.

Meanwhile our author, no longer able to doubt the correctness of Robert Mayer and Joule's thesis respecting the equivalence of heat and work, devoted himself to the problem of how Joule's and Carnot's laws might be combined. This question he answered in his treatise of March, 1851, "On the Dynamical Theory of Heat," Art. XLVIII. Prof. Clausius, in Germany, had, however, been busied with the same problem, and had published the results at which he arrived before Sir W. Thomson, in May, 1850. The essential results of the two investigations coincided exactly; only in their numerical values for the absolute scale of temperature, the two authors had started with two different hypotheses, and had therefore reached different conclusions. Sir William Thomson had, as above mentioned, calculated the density of steam from pressure and temperature, as if for complete gases, whereas Prof. Clausius had accepted the hypothesis set up by Robert Mayer, according to which the work of a gas expanding itself was exactly equivalent to its loss of heat. Later on, when his opponents set forth the unsatisfactory basis of this hypothesis, Robert Mayer pointed to an old and very little-known experiment of Gay-Lussac, according to which a gas diffusing itself in empty space without encountering any resistance suffered no diminution of heat. The same experiment was afterwards carried out by Joule without his having any knowledge of the earlier observation of a similar nature. This form of the experiment was, however, as a whole, not fitted to yield very precise results, seeing that the mass of air available for it, whose consumption of heat was to be measured, was necessarily very small in comparison with the mass of water of the calorimeter. It was not till the investigations into the changes of temperature undergone by a mass of gas made to pass through a very dense porous substance—an investigation carried out in common by J. P. Joule and Sir W. Thomson, in 1852, and described in Art. XLIX., "On the Thermal Effects of Fluids in Motion"—that it was demonstrated how, in point of fact, R. Mayer's hypothesis was accurate to within a very close degree of approximation, although not with absolute precision, in respect of hydrogen and atmospheric air, whereas carbonic acid showed greater deviations.

To this have to be added extended investigations into thermo-electric currents, and the equivalent of their operations (Appendix to Art. XLVIII. and Art. LI. "Experimental Researches in Thermo-electricity," Vol. I., Art. XCI. Bakerian lecture, pp. i., ii., and iii., Vol. II.). In a thermo-electric chain which, from its conducting wire, sets magnets in motion, or generates heat in them, the heat conducted to the soldering seams is manifestly the source of the operations. We know that in such a case, according to the important observations of Peltier, heat disappears from the warmer soldering seam, and becomes developed in the colder. That is, in fact, the condition, according to Carnot's law, under which heat becomes transferable into other forms of work. This particular process was, however, of special interest for the universal validity of the theory, seeing that the work of heat is here produced under conditions altogether different from those of the steam-engine and hot-air engine. Our author was by this investigation led to the conclusion that, contrary to the opinion hitherto entertained, it was not in the soldering-seams of the metals, at all events not in those alone, but in the whole length of the wires, by a process which he calls "electric convection of heat," that the essential cause of the thermo-electric force was to be sought; and, in point of fact, he succeeded by a series of very laborious and subtle experiments in demonstrating that the conduction of heat in iron proceeded more rapidly in the direction of the current of negative electricity, and in copper in the direction of the positive current.

In the first volume of the book which is the subject of notice, the consecutive stages may thus be followed in the development of one of the most remarkable chapters in the history of discoveries, a chapter specially remarkable also as an example of how discoveries are arrived at in a manner not always rational. The course of this discovery reminds one in some measure of the invention of achromatic telescopes. Starting with the erroneous supposition that the eye of man was achromatic, Euler inferred that Newton's assumption of the proportionality between refraction and dispersion of light was false, and that his conclusion as to the impossibility of achromatic telescopes was without foundation. Thereupon Euler gave the receipt for the making of achromatic telescopes—a correct conclusion from a false premiss; similar to the case of Carnot with the doctrine of heat. After all the confirmations which have been obtained in the different branches of physics for the validity of the deductions of the corrected Carnot law there can hardly longer remain any doubt that we have here found one of the most comprehensive and important laws of nature of unlimited applicability. Down to the present moment we are, however, not yet in a position to derive a complete argument for its truth from the general principles of kinetics. Our analytic methods are inadequate even to the problem of completely determining the movement of three bodies reciprocally attracting one another. In the case, however, of motion which we perceive as heat, there are myriads of atoms engaged, all in the most irregular movement, and influenced by forces the nature of which is still almost wholly unknown to us. It is highly probable that the peculiar difficulty of reducing thermal motion into other forms of mechanical energy, which is expressed in Carnot's thesis, is due to the circumstance that thermal motion is a completely "unregulated" movement, that is, that there is no kind of similarity between the movements of atoms immediately neighbouring one another. Even in the case of the most rapid vibrations of light and sound, on the other hand, the movements and conditions of neighbouring atoms are so much the more similar to one another the nearer they are to one another. These, therefore, I am in the habit of calling "regulated" in antithesis to thermal motion. Sir W. Thomson has introduced for this conception the name of "dissipation of energy." Prof. Clausius denotes the quantitatively determined measure of the same magnitude by a more abstract name, "entropie." The dissipation of energy is capable, according to Carnot's law, by every known process of nature in the inorganic world, only of constant increase, never of decrease, and this leads to the much-talked-of conclusion that the universe is tending towards a final state of absolute unchangeableness with stable equipoise of all its forces under the establishment of complete equipoise of temperature, as our author expressed it in the year 1852 (Art. LIX., "On a Universal Tendency in Nature to the Dissipation of Mechanical Energy").

On the other hand the ascertained laws of dynamics yield the deduction that if we were able suddenly to reverse the total movements of the total atoms of an isolated mechanical system the whole system would of necessity retraverse all the states which up to that point of time it had passed through. Therewith also would all the heat generated by friction, collision, conduction of electrical currents, &c., return into other forms of energy, and the energy which had been dissipated, would be all recovered. Such a reversion, however, is a postulate beyond the power of human means to fulfil. We have no agency at our disposal by which to regulate the movement of atoms. Whether, however, in the extraordinarily fine structure of organic tissues a mechanism capable of doing it exists or not is a question not yet to be answered, and I deem it very wise on the part of Sir W. Thomson that he has limited all his theses respecting the necessity of increasing dissipation by restricting their validity to "inanimate matter."

The recognition of this scientific law of so universal applicability and so rich in consequences is, be it repeated, due in the first place, through Carnot, to an erroneous assumption regarding the nature of heat. The universal demonstration given by him of the principle, a demonstration which in his day appeared completely satisfactory, is based purely on this assumption. And, what is still more noteworthy, it is hardly to be supposed that the principle in question could have been deduced from the more correct view—namely, that heat is motion, seeing that we are not yet in a position to establish that view on a completely scientific basis. The two natural philosophers, moreover, who brought Carnot's and Joule's principles into harmony with each other, and whom we have to thank for our present knowledge on this subject, are able to refer their conclusions only to an axiom generalising the experience that heat tends ever to expand, never to concentrate. Sir W. Thomson expresses this axiom in the following terms:—"It is impossible by means of inanimate material agency to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of the surrounding objects."

The reviewer has, further, succeeded in demonstrating that the peculiar limitation affecting the transformation of heat into other forms of work likewise applies to other classes of motions revolving on themselves, so long as no external forces are brought into play directly opposing or accelerating the internal motion.[1]

When by J. P. Joule's experiment it was demonstrated that the basis of Carnot's proof was defective, it might have been apprehended that along with the element of error the element of truth in it would also be rejected. It must therefore be regarded as a special merit on the part of Prof. Clausius and Sir W. Thomson that, while removing the mistakes, they brought the truth into precise expression and into universal recognition, and that the recent theory of heat has become so fruitful in discoveries respecting the most secret connections between the different physical qualities of bodies in nature.

The second volume of these Reprints contains chiefly the researches having relation to the laying of the first submarine telegraph cable. The motion of electricity in these cables undergoes a peculiar retardation in consequence of the fact that the conducting-wire separated from the sea-water, which is likewise a tolerably good conductor, only by a thin isolating layer of gutta-percha, forms an enormous Leyden jar, which must first be charged with the electricity entering it before the current will pass with full force along the whole length of the wire to the other end. The physical laws of the processes which here come into play were generally known, but a far-searching mathematical investigation was still needed to determine the whole procedure of these currents and to ascertain the amount of influence exercised on them by the dimensions and conductivity of the wire, by the neighbourhood of other wires, and by the particular quality of the gutta-percha, as also to arrive at a knowledge of the conditions under which the most rapid series of signals might be transmitted and received at the opposite end.

All these questions our author disposed of thoroughly and exhaustively, having also to contend with opposition to his views based on observations made under restricted conditions on other cables. He was then a comparatively little-known young man, and did not enjoy that recognition and authority now everywhere freely accorded him.

To this were joined mechanical problems connected with the sinking or eventual raising and repairing of

[1] H. von Helmholtz, "Studien zur Statik monocyklischer Systeme." Sitzungsberichte der Berliner Akademie, 1884, März 6, 27, und Juli 10.

the cable; further, the construction of telegraphic signal apparatuses able to utilise the first weak beginnings of the current arriving at the other end of the cable. These ultimately led to the invention of the siphon-recorder—a writing apparatus in which the tube containing the ink does not come into immediate contact with the strips of paper on which it has to write, and is therefore not hindered by friction from moving even under the least electro-magnetic impulse. By electric charges it is brought about that the ink spurts over the paper in a series of fine points.

The conclusion of the second volume is formed by the Bakerian Lecture for 1856, which gathers up the results of the author's investigations into the qualities of metals as displayed under the conduction of electric currents, and under magnetisation, and the changes they undergo in consequence of mechanical, thermal, and magnetic influences.

Let us hope for an early continuation of this interesting collection. There are still nearly thirty years of scientific activity on the part of the author to be accounted for. When we think of that we cannot fail to be astonished at the fruitfulness and unweariedness of his intellect.

HERMANN L. F. HELMHOLTZ

OUR BOOK SHELF

Paradise Found. The Cradle of the Human Race at the North Pole. A Study of the Prehistoric World. By William F. Warren, S.T.D., LL.D., President of Boston University, &c. (London: Sampson Low and Co.)

IT has come to be an understood thing that when geologists or biologists propound theories as to past stages of life on the earth, and these theories attain to a certain popularity, some theologian shall twist the words of the Book of Genesis into a new interpretation, to show that this was what the inspired author meant all the time. A fresh musician has set Moses to dance to a new scientific tune. Since the publication of well-known modern views as to the diffusion of plants and animals from the Polar Region, it was to be expected that we should have a book proving that man was created in an Arctic Paradise with the Tree of Life at the North Pole; and here the book is. Other ancient cosmologies, such as the Greek and Indian, are made to bear their not always willing testimony. Those who take up the book should notice that the commendatory letters published from Professors Sayce, Tiele, and Whitney do not at all imply that these eminent scholars countenance the Polar Paradise doctrine. The President of Boston University seems to have sent them a paper some years ago on "Ancient Cosmology and Mythical Geography," their acknowledgments of which they are now perhaps hardly delighted to find figuring as certificates in a "Paradise Found."

Epping Forest. By Edward North Buxton, Verderer. (London: Stanford, 1885.)

THE public generally, and especially the people of London, and those who take some interest in natural history, are to be congratulated on the acquisition of so charmingly complete a little itinerary of Epping Forest as that now issued in a cheaper form by one of the Committee of Conservators, who is a resident on the borders, and an enthusiast as to the attractions of the Forest. It is, as the author observes in his preface, "hardly a desirable state of things" that so small a percentage of the summer visitors to the Forest "ever venture far from the point at which they are set down by train or vehicle;" and, with the choice of a score of beautiful walks, described in Mr. Buxton's book, and the guidance of his six carefully prepared maps, five of which are on the scale of three inches to the mile, there is no longer any reason for their not venturing into those depths of the Forest in which its chief beauties are to be seen. The chapter on the history of the Forest which the author has wisely prefixed to the itinerary, that visitors may be reminded of the events which secured this magnificent playground for their enjoyment, is most complete, though it is to be regretted that the late City Solicitor, Sir Thomas Nelson, is not mentioned *by name* on p. 22. The practical character of the book may be gauged from the inclusion of railway time-tables, the fact that the distinctive letters of each route have been cut on trees at some points, and from such suggestions as that an east wind is, in Epping Forest, the best for views, because not smoke-laden. Personal experience has convinced the present writer of the skill with which the routes have been selected; the "objects of interest within and around the Forest," and their historical associations, are fully described and illustrated by some excellent drawings, the latter by Mr. Heywood Sumner; but what must render the work peculiarly gratifying to all lovers of nature, is the ample space—more than half the volume—devoted to the fauna and flora of the Forest. The mammals, reptiles, birds; the chief moths and butterflies; the trees, flowering plants, ferns, fungi, and mosses, are all enumerated, with general, *i.e.* not too specific, localities; and the notes on the mammals and birds will be of interest to naturalists in other districts. Such lists can, fortunately, never be complete; insects marked as "rare" are notoriously liable at any time to prove common: even since the publication of this work evidence has been produced suggesting the addition of *Sparganium neglectum* to the list of flowers, and each year's cryptogamic meeting of the Essex Field Club has as yet added several species to the catalogues of the lower plants. There may yet be room for a more pretentious monograph of Epping Forest, and, of course, from the naturalist's stand-point, so rich a collecting-ground affords material for a library of expository literature—the freshwater algæ, for example, call for recognition;—but, for its purpose, the present work could hardly have been executed in a manner more creditable both to author and publisher.

G. S. BOULGER

Traité de Minéralogie appliquée aux Arts, à l'Industrie, au Commerce et à l'Agriculture, &c. Par Raoul Jagnaux. Avec 468 figures dans le texte. (Paris: Octave Doin, Éditeur, 1885.)

THIS work of 883 pages, as is stated in a title-page of corresponding length, is intended for the use of French students in their preparation for a degree in the subjects of engineering, chemistry, metallurgy, &c. We do not think that in its purely scientific contents it is likely to be of advantage to English students. The first part, devoted to the subject of crystallography, is rather incomplete and unsatisfactory, even if regard be had to the main purpose of the work. As usual, in the figure of Wollaston's goniometer the crystal is represented as adjusted in a way that every practical student is immediately taught to avoid. Nor will the chemical formulæ meet with the favour of English students: though the atomic weights of oxygen and silicon are given as 16 and 28 respectively, silica appears throughout as SiO_3, water is still HO, while to nitre is assigned the formula $KO . AzO_6$. Further, the ordinary symbols for the atoms are occasionally, as in the forty-nine formulæ of pp. 423-5, used to signify equivalent proportions of the oxides; olivine, for instance, being given as (Mg . fe)Si. The classification is likewise ancient; in the description of the species alum stone immediately follows the oriental chrysolite, a precious stone, merely because both substances contain alumina. In its explanation of the uses which have been discovered for the various subjects of the mineral kingdom, the work, however, supplies a want which has been long felt, and it will prove convenient for purpose of reference. The amount of detail will be better appreciated if we mention that in the description of the uses of carbonate of lime even the hammers used by stonemasons are specially figured.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Photographing the Aurora Borealis

I SHOULD be obliged if I might be permitted to state, with reference to the negative of the aurora borealis obtained by Mr. Tromholt in Christiania on March 15 (NATURE, vol. xxxi. p. 479)—the first ever obtained—that he now informs me that, although the plate was exposed for eight and a half minutes, the said impression is so faint and imperfect *that it cannot be reproduced as a positive.* My object in asking to be allowed to mention this important fact is to show that the opinion expressed by Mr. Tromholt in his work just published, "Under the Rays of the Aurora Borealis," that it is almost impossible to photograph the aurora borealis on account of the small strength of light and its limited chemical action, may be said still to hold good in the main. CARL SIEWERS

Speed and Velocity

YOUR reviewer of Williamson and Tarleton's "Dynamics" (NATURE, February 26, p. 385) speaks of the confusion therein of *speed* and *velocity*. Does he mean that these words should now be used in distinct senses? If so, would he kindly specify the distinction, which is unknown to me and my friends.

B.

[Certainly. Velocity is a directed quantity, or Vector. Speed is its Tensor.—YOUR REVIEWER.]

Time.—Thunderbolts.—Vision.—Sunglows

ON my return from a magnetic tour along the Red Sea, I ask leave to refer to some back numbers of NATURE. In vol. xxxi. p. 125, Latimer Clark is quite right when he says that mean and sidereal time ought to be distinguished by names. I should prefer a step farther, and use for the latter the decimal angle, thus abolishing our frequent and tiresome conversion of time into space, and *vice versâ*. The resulting advantages would be obvious.

Answering Herr Von Danckelman's remarks in vol. xxxi. p. 127, I beg leave to quote my memoir, "Sur le Tonnerre en Ethiopie," published in 1858 by the French Institute, among its *Mémoires des Savants étrangers*. Facts mentioned there do not support the opinion that fatal thunderbolts are all but unheard of in Tropical Africa.

In your published remarks on vision, is it not Lord Rayleigh who says that the supposed superiority of eyesight among savages may be explained otherwise? Years ago, when reading Bergmann's travels among the Kalmouks, I noticed his remark that when examining camels *returning* to the fold, those natives distinguished sexes with their naked eyes just as well as he could through his excellent field-glass. In conclusion, Bergmann says that savage eyes are superior to civilised ones, or something to that effect. I must confess that I then accepted his opinion as being admirably warranted by the quoted facts. However, some time afterwards I was travelling on foot in the Pyrenees with a Basque illiterate peasant, and a splendid refractor by Cauchoix, which I proudly carried myself. My companion having tauntingly asked me why I had not left that lumber at home, I gave him, foolishly, a lecture on optics, and wound up by saying that the glass enabled me to distinguish a cow from an ox, even from that distant hill. He said he could do as much without my lumber. I then selected a cow grazing, and asked him what that was. "Wait till the brute walks," said the peasant; and at its first step he exclaimed: "it is a cow." I tried him, then, several times, and never found him in fault. He affirmed that cows and oxen do not lift their legs in the same way. May I request your rural readers to tell us whether that remark applies to English cattle? When on the Atlantic a sail was announced for the first time. I could perceive nothing, because I had not yet learnt what kind of a hazy thing I should distinguish. Having then sharp eyesight, I succeeded after a short practice, in discerning distant sails before any of my companions, and could turn tables on them by repeating their own saying, "*Ça crève les yeux.*"

To your lore on far-sightedness in vol. xxxi. p. 506, allow me to add two instances. Zach saw from Marseilles, Mount Canigou (2700 m.), at a distance of 158 English miles; he had calculated the true azimuth beforehand, and says that the peak bursts into view at sunset. Sir W. Jones informs us that the Himalayas have been seen at the great distance of 244 miles. I quote this from Carr's "Synopsis," a useful volume, which I regret to see behindhand in many cases since the death of its clever author.

May I intrude here a comment on our mysterious sunglows? My companion having a nice eye for discriminating colours, has confirmed my notion that on rising from the horizon the successive *nuances* of fiery red, faint red, rose, mallow, prussian blue, and green, are *not* the same on consecutive days, although thermometer, barometer, and wind have not changed. This suggests the hypothesis either that the lower strata of our atmosphere undergoes changes otherwise unperceived, or that there are maxima, minima, and perhaps regular epochs in the phenomenon. To those who, unlike myself, remain stationary under a rainless sky like that of Egypt, I would recommend a careful record of these changes, at least during a few months.

Cairo, April 22 ANTOINE D'ABBADIE

Plutarch on Petroleum

THERE is in "Plutarch's Lives," in the life of Alexander, an interesting notice of the petroleum of Media; I have not found any mention of this passage in "Plutarch" either in encyclopædia or chemical dictionary; I trust, therefore, that you will give me the opportunity of reproducing it in NATURE. I transcribe the passage from the translation of John and William Langhorne (9th edition, London, 1805):—

". . . and in the district of Ecbatana he (Alexander) was particularly struck with a gulph of fire, which streamed continually as from an inexhaustible source. He admired also a flood of naptha, not far from the gulf, which flowed in such abundance that it formed a lake. The naptha in many respects resembles the bitumen, but it is much more inflammable. Before any fire touches it, it catches light from a flame at some distance, and often kindles all the intermediate air. The barbarians, to show the king its force and the subtlety of its nature, scattered some drops of it in the street which led to his lodgings; and, standing at one end, they applied their torches to some of the first drops, for it was night. The flame communicated itself swifter than thought, and the street was instantaneously all on fire."

W. H. DEERING

Chemical Department, Royal Arsenal, Woolwich, May 6

Hut Circles

THE remains of the ancient British habitations on the downs on both sides of Dunstable are fairly well known to archæologists. I have often wished to expose the floor of one or more of these circles, as the task could be accomplished with a spade in an hour or two. It is, however, far better that the remains should be left alone, as it is not likely that anything would be found beyond a few flakes and the other simple forms, such as are abundant in the cultivated fields close to the huts.

On passing some of the circles on the east side of Dunstable, in the railway, about ten days ago, I noticed that the remains were covered with whitish soil instead of the normal green of the short pasture belonging to the downs. Thinking that some persons had been digging at these antiquities, I took an early opportunity of going to the spot. On reaching the circles I found they had been undermined in every direction by a large number of moles. A great deal of the material from the actual floors had been brought to the surface, and on examining this chalk rubble—for such it was—I had no difficulty in securing two or three handfuls of flint flakes. Mingled with them were a very few stones, which had been reddened and crackled by fire. No trace of burnt wood, ashes, or bone could be seen. It was remarkable that nearly all the stones found were flakes, as very few unworked pieces of flint could be lighted on. The flakes from the huts differ in condition materially from the flakes in the fields below, as all the flakes in the fields are marked with dark ferruginous strains, whilst those from the hut-floors are perfectly unstained, no iron having ever reached them.

In the immediate neighbourhood I have at different times found a large number of scapers, a lance-head, a few arrow-heads, and a few rudely-chipped celts, some broken. One small chipped celt has incurved sides, indicating, as Mr. John Evans has pointed out in his work on stone implements, that this particular form was possibly an imitation in flint of an early, flat bronze celt.

It is always well to examine the earth brought out of holes by rabbits, moles, foxes, rats, and other animals, in places where prehistoric relics exist on pasture-land. I have secured a considerable number of my antiquities from such places.

Last year I told a young niece of mine to keep a watch on such places at the spot where the five large tumuli are placed on Dunstable Downs, and where I had on previous occasions found flint flakes in the heaps made by moles, &c. It was not long before my niece lighted on two pieces belonging to the back part of a human skull. They had been scratched out of the base of the northernmost tumulus by some animal. Fortunately the two pieces fitted together; they are evidently of great antiquity, and probably represent part of the person who was buried in the tumulus, quite possibly one of the old chippers of Neolithic implements. WORTHINGTON G. SMITH

A Lady Curator

IN NATURE for November 27, 1884 (p. 90) you acknowledge the receipt of the "Catalogue of the Natural History Collections of the Albany Museum, Grahamstown, Cape of Good Hope," and allude to the "zealous curator." Are you aware that that individual is a young and accomplished lady? Here is another path opened for our daughters and "sweet girl graduates" to fame and fortune. Those who, like myself, have the pleasure and privilege of knowing and corresponding with Miss Glanville can appreciate the ardour and zeal with which she is following up her chosen vocation. May every success attend her. E. L. LAYARD

British Consulate, Noumea, February 25

Hoar Frost

A COMMUNICATION in NATURE of January 8 (p. 216), in regard to frost-formations, leads me to send a word from Maine. I have seen frost-work so like the description there given, that it would answer very well for an account of frosts in this climate. These frost-formations occur when the wind is chilly and blowing steadily, without the compass veering, for hours. I have compared these deposits to the most delicate designs of Oriental lace-work. At one time I witnessed an accretion on a wall, where the feathery forms were from two to four inches in length, with the points towards the wind. I think this is because each added particle adhered to the very tip of the previous one. Certainly no pen-description can do justice to the delicate beauty when the sun suddenly broke through the clouds and shone upon this forest of frost-ferns. CAROLINE W. D. RICH

Auburn, Me., April

Rainbow Phenomenon

ON Saturday night, about six o'clock, I observed, at Old Trafford, on the west side of Manchester, a rainbow with accompanying phenomena, which I had never observed before. Several very heavy showers had occurred during the day. The wind was within a point or two of west. At the hour above named a cloud was passing over, very dense and uniform in colour, and with that dark leaden hue so general in thunderstorms. There was, however, no thunder or lightning. Rain fell in torrents. As the cloud, which was of large area, passed off, the sun shone brightly in the north-west, and a magnificent rainbow painted itself on the dense black screen afforded by the cloud. The rainbow was double, the prismatic colours, of course, occurring in reverse order in the outer bow. The most remarkable feature of the display was the sharp contrast in the shadow of the cloud, evidently caused by the rainbow. Between the two bows it was of the densest leaden hue. Inside the inner bow it was exceedingly light coloured, with the faintest suggestion of luminosity. Outside the outer bow it was of an intermediate grey. The uniform mass of cloud was marked off by the two bows with geometrical accuracy into three regions, each perfectly homogeneous in itself, but distinctly contrasted with the two other tints. The effect was weird and startling, and was observed and commented upon by several spectators in whose company I was. There was another feature connected with the inner bow which I have never observed before. The green and violet colours were repeated inside the bow. Probably the whole tract from green to violet inclusive was repeated, but I could only make out those two colours distinctly.

Have these peculiarities, either or both, been observed before, and, if so, how are they accounted for? CHARLES CROFT

Prestwich, near Manchester, May 11

FIVE MATHEMATICAL RARITIES

A BRIEF reference to some recent reprints, &c., by Dr. Bierens de Haan, of Leyden, may not be unacceptable, though, unfortunately, ignorance of the language in which four of them are written prevents our giving more than the barest description of them.

The "Stelkonstige Reeckening van den Regenboog," or Algebraical Calculation of the Rainbow, is a rare tract, by no less distinguished an author than B. de Spinoza. It was for a long time supposed to be lost, if not burned; it is here printed in exact facsimile from a copy published at the Hague in 1687. Bound up with it is another rarity, similarly printed, entitled "Reeckening van Kanssen," or Calculation of Chances. No reference to this is made by Todhunter. There is a slight probability of this tract having proceeded from the same hand, as Dr. De Haan cites a reference to the forty-third letter in the collected works of Spinoza.

The third reprint is of a very rare book by A. Girard: "Invention nouvelle en l'Algèbre, tant pour la solution des équations, que pour recognoistre le nombre des solutions qu'elles reçoivent, avec plusieurs choses qui sont nécessaires à la perfection de ceste divine science" (Amsterdam, 1629). M. Marie writes: "Cet ouvrage est surtout remarquable par les idées justes que l'auteur émet au sujet des racines négatives des équations et de leur usage en géométrie."

The last two tracts have not been before printed: they are both the work of Simon Stevin, and are entitled "Van de Spiegeling der Singkonst" (*i.e.* Miroir de l'Art du Chant), and "Vande Molens." There is a full account prefixed to the former of these works, and we learn that the latter contains "le calcul de 19 moulins à vent, suivant la méthode usitée et suivant une nouvelle méthode de Simon Stevin lui-même, qui consiste à indiquer les roues, les dents et les pignons, afin de satisfaire à quelques conditions données."

Thanks are due to Dr. de Haan for the great care with which he has brought out these facsimiles, and we think he will certainly reap the reward he seeks. We quote his words in the last of these volumes: "J'ose espérer que la réproduction de ces ouvrages d'un homme si renommé pourra intéresser ceux qui s'occupent de l'histoire des sciences."

ON CERTAIN SPECTRAL IMAGES PRODUCED BY A ROTATING VACUUM-TUBE

THE beautiful effects produced by the rotation of a vacuum-tube when illuminated by a series of electrical discharges from an induction-coil are well known. The tube is generally attached to a horizontal axis, which is turned rapidly by means of a multiplying wheel; the images due to successive discharges which, if the tube were at rest, would be superposed, are thus caused to occupy different parts of the retina, and if the discharges follow one another at the rate of n per second, the number of images simultaneously visible will be about $n/8$, since the luminous image produced by each separate flash persists for about an eighth of a second after the flash itself has ceased. The result of these effects is the appearance of a gorgeous revolving star.

If the tube is made to rotate very slowly, there occurs a different and very curious phenomenon, which, so far as I know, has never hitherto been noticed. The tube used in my experiments was thirteen inches long, and contained various devices in uranium glass; the induction-coil had a resistance of 1400 ohms, and was worked by a single large bichromate cell. When the rotation is performed at about the rate of one turn in three seconds, the luminous images of the tube are almost superposed, forming a bunch which is slightly spread out at the ends. But about 40° behind the bunch, and separated from it by an interval of darkness, comes a *ghost*. This ghost is in shape an exact reproduction of the tube: it is very clearly defined, and distinctly shows every detail of the uranium glass devices. But the colour is entirely changed, the violet tint of the luminous bulb and the bright green fluorescence of the uranium glass being replaced by a uniform steel gray. If the rotation is stopped, the ghost still moves slowly on, and, after the lapse of about half a second, disappears in coalescing with the luminous tube. The phenomenon may be diagrammatically represented by the letter X, the thick stroke being the bunch of luminous images, and the thin stroke the spectral attendant. The direction of the motion is supposed to be opposite to that of the hands of a watch when seen from above. If the rate of rotation is too slow, the ghost approaches the luminous bunch so closely as to be obscured by its superior brilliancy; while, if it is too fast, the image becomes blurred and ill-defined. The strength of the inducing current should be regulated by trial. With too strong a current the effect is the same as when the rotation is too slow; with too weak a current the image is rendered feeble. Generally speaking, the best results are obtained with a somewhat weak current.

The experiment has been witnessed by a dozen persons, all of whom, with the exception of one adult, and the doubtful exception of a child, at once saw the spectral image. It is almost ludicrously difficult for those who are able to see it, to understand how any one else could possibly fail to do so.

This curious effect clearly belongs to the class of spectral images or "ocular spectra," which result from looking at a bright object, persistence of vision in the ordinary sense of the term having nothing to do with it. I proved this to be the case in a very simple manner. The vacuum tube being at rest in a feebly-lighted room, I concentrated my gaze upon a certain small portion of it while the discharge was passing. The current was then interrupted, and the luminous image was almost instantly replaced by a corresponding image which appeared to be intensely black upon a less dark background. After a period which I estimated at from a quarter to half a second (probably more nearly the latter), the black image again became luminous, assuming the characteristic steel gray colour: this luminous impression lasted but for a small fraction of a second, and the series of phenomena terminated with its disappearance. I found the effect to be most clearly marked when a narrow portion of the tube was observed; the definition of the spectral image was then exceedingly sharp, even the striæ being represented with perfect distinctness. It was also found desirable to make the preliminary illumination as short as possible, a single flash being generally sufficient to produce the phenomena. This is more easily effected by a judicious manipulation of the contact-breaker than by means of a key, or of the commutator attached to the coil. I may add that it is by no means certain that a person who is altogether new to the subject will at first be able to see the appearances last described, even when he knows exactly what to expect. They belong to a class of phenomena which in ordinary life we habitually train ourselves to disregard, and our persistent neglect makes it difficult to perceive them when we desire to do so. With a little patient attention the difficulty will probably disappear.[1] It was probably owing to my constant habit of studying visual impressions that the appearance of the ghost attracted my notice in the first instance.

The series of phenomena seem to be due to an affection of the optic nerve which is of an oscillatory character. Abnormal darkness follows as a reaction after the luminosity, and again after abnormal darkness there is a rebound into a feebler luminosity. Following this idea I have endeavoured to detect the existence of a second ghost as the result of a further rebound, but hitherto without success.

It is an interesting fact, as proved by these experiments, that the formation of a spectral image does not occur until the expiration of a measurable interval of time after the exciting cause has ceased to operate.

SHELFORD BIDWELL

JUPITER

DURING the present opposition of this planet, the details of the belts and spots have continued to furnish materials of great interest. Some very obvious modifications have occurred since the previous year, and several curious new features have become conspicuous. The great red spot has surprised us by its extended duration. As early as 1882 it lost such a considerable depth of tone that its obliteration seemed imminent, but it has lingered on, until now its existence appears likely to be indefinitely prolonged, though under visible conditions far less imposing than at an earlier stage. All that at present remains of this remarkable formation is a dusky elliptic ring, darkest at the following end, and only well seen under good definition. Whether this ellipse is identical with similar appearances delineated by Dawes in 1857, Huggins in 1858, and Gledhill in 1869, 1870, and 1871 is involved in doubt, because of the lack of intermediate observations. We have no definite information as to what became of the various objects alluded to. It is very possible that they severally represent an object of considerable permanency. The changes such as observed may have been induced by atmospheric interference. There is every indication that the dense vaporous envelopes of this planet are rapidly variable, especially in the zone included by the two equatorial belts, and that the chief features undergo singular fluctuations, some of which may possibly be of periodical character.

The particular objects drawn by Dawes and others suggest a close relationship to the red spot as it now appears. There is far from being an actual coincidence either in the positions or forms of the features here sought to be connected, but small differences must actually occur in results based on estimation. A sufficient likeness is established between them to show that further investigation may have an interesting outcome as affirming the theory of recurrent markings of identical form. There is, however, an inability to trace the history of these singular objects, owing to the meagre number of observations available. This is a circumstance much to be regretted. Markings of specially interesting character deserve something more than mere record. They should be persistently watched during several oppositions, if possible, for it is only by this continuity of records that the really important questions affecting them admit of settlement. The red

[1] The adult who failed to see the ghost is totally unable to perceive the subjective images in complementary colours, which generally result from gazing at brightly-coloured objects. Her general powers of vision are decidedly above the average, and she is in no degree colour-blind. The doubtful child is a daughter of this adult. A younger child can certainly see the phenomenon.

spot has now been followed since 1878, and though apparently on the verge of absolute extinction, it may yet linger on a considerable time in its present feeble aspect until possibly it is again enabled to obtrude upon general notice as an object of great prominence. It may not return under precisely the same outline as formerly, or exhibit the same depth of tone or degree of colouring, for, doubtless, some new development is to be anticipated on this disturbed region of the planet. In case of any distinct reappearance it will be important to determine that it occurred from the exact position so long tenanted by the old spot. The motion of this feature has been so thoroughly followed during the last seven years, that it will be feasible to compute its predicted place with great nicety in future months. In the mean time, and until the spot finally withdraws from reach, the same necessity exists as before of recording the times of its passages across the central meridian of Jupiter. And even assuming the total extinction of the spot, and that its place immediately south of the great equatorial south belt should resume the unbroken zonal arrangement existing in other longitudes, it will be necessary to re-examine this region occasionally for traces of any subsequent outbreak from the same focus.

During the last three years this object has given a rotation period of 9h. 55m. 39·1s., which has been steadily maintained throughout each opposition, subject to some minor disturbances partly due to errors of observation. The first few years of its existence it showed an increasing retardation of motion, which lengthened the period from 9h. 55m. 34s. to that already quoted, but, contemporarily with the decay of the spot in 1882, the velocity ceased to slacken, and the results accumulated during the past few oppositions prove it to have been equable in a marked degree.

With reference to the equatorial white spot some striking phenomena have been presented during the past winter. Between October 4, 1884, and January 13, 1885, its motion appears to have increased in an alarming ratio. The spot continued to rush on far in advance of its computed places, and all the while exhibited a more brilliant appearance than at any preceding epoch since the autumn of 1880, when it first came under systematic observation. The form and appearance of the spot have been so special as to prevent any confusion in mistaking it for other white spots in nearly the same latitude. Between October 4 and January 13, 1885, the rotation period was 9h. 49m. 51·95s., but the great increase in velocity evidently occurred towards the end of November. Between November 21, 1884, and January 13, 1885, the period was only 9h. 49m. 38·45s., or 34 seconds less than the mean period of 9h. 50m. 12·25s. shown by the same spot during the two preceding years.

When the first intimation of this great increase of speed forced itself upon my notice, I at once resolved to obtain as many observations as possible, in order to assure myself more certainly of the fact. Much cloudy, wet weather ensued, but I observed the spot on fourteen occasions between November 27 and January 13. A lengthened period of overcast skies then supervened, and I saw nothing more of Jupiter until January 27, when the place of the spot, computed on the basis of my prior observations, appeared absolutely vacant. About 15° E. there was, however, a remarkably brilliant spot, the exact counterpart of the one previously observed. Then arose the question of identity. Could the velocity have become so much retarded in the fortnight's interval from January 13 to 27 as to have occasioned so considerable a displacement in longitude? From my observation on January 13 and several preceding nights the spot had shown an increasing disposition to slacken, and, from records obtained in previous years, the motion was known to fluctuate in the most unaccountable manner. In the seventeen days from September 30 to October 17, 1881, I noted the spot underwent a sudden translation of 11°·6 in the direction of east longitude. The fact was independently confirmed by Prof. Hough at Chicago and Mr. Stanley Williams at Brighton. The most obvious departures from the mean rate of motion have been detected in other instances, and I am therefore led to conclude that the objects observed on January 13 and 27, 1885, were, notwithstanding their discordance of position, really identical objects. The consistent brilliancy of the marking alluded to, for several months before the cloudy period set in, is entirely opposed to the idea that it could have suddenly disappeared. And the real displacement is not so large as the limiting observations suggest. Deriving a mean from my results near January 13 and 27, I obtain the following figures :—

1885	Spot precedes 1st meridian m.	Long. (878°·34)
Jan. 7 to 13, mean of 7 obs.	64·0 ...	321·0
Jan. 27 to Feb. 6, mean of 6 obs. ...	46·4 ...	331·4

Adopting this mean, we practically eliminate errors in single observations, and in the present case it is fortunate I obtained so many transits just before and after the period of cloud. The real displacement is seen from this comparison to be only 10°·7, which is quite within the limits of previous experience. And if the fact of identity had not been rendered a very tenable hypothesis by past observation, I should have regarded the brilliant appearance of the spot and its comparative isolation as conclusive. Moreover, during the period that this object continued moving so rapidly, I often carefully examined the place where, had no change occurred, it must have been presented, but no object having a remote likeness to the old spot could be detected. Having observed this feature on the central meridian on more than 200 nights, I am familiar with its usual aspect, and could not possibly have overlooked it, on the many occasions when I looked for it in vain, had the spot retained the approximate place assigned to it from the observations of preceding years.

Let us now analyse the degree and period of the remarkable velocity alluded to. Arranging my observations into short intervals, the following are the rotation-periods severally derived from them :—

1884	Interval in Minutes	Spot gained on 1st. Mer. m.	Spot gained in Long. °	Number of Rotations.	Period. h. m. s.
Oct. 4 to Nov. 7 ...	48,985 ...	6·5 ...	4·0 ...	83 ...	9 50 7·55
Nov. 7 to Nov. 21 ...	20,064 ...	3·5 ...	2·1 ...	34 ...	9 50 6·07
Nov. 21 to Nov. 27 ...	8838 ...	15·1 ...	9 2 ...	15 ...	9 49 11·85
Nov. 27 to Dec. 9 ...	17,098 ...	17·4 ...	10·6 ...	29 ...	9 49 36·25
Dec. 9 to Dec. 18 ...	12,970 ...	13·8 ...	8·5 ...	22 ...	9 49 34·61
Dec. 18 to Dec. 24 ...	8843 ...	9·3 ...	5·6 ...	15 ...	9 49 35·05
Dec. 24 to Dec. 31 ...	10,023 ...	9·5 ...	5·8 ...	17 ...	9 49 38·72
Dec. 31 to Jan. 8 ...	11,208 ...	4·6 ...	2 8 ...	19 ...	9 49 57·73
1885					
Jan. 8 to Jan. 13 ...	7078 ...	3·5 ...	2·2 ...	12 ...	9 49 54·75
		Lost	Lost		
Jan. 13 to Jan. 27 ...	20,089 ...	24·9 ...	15·2 ...	34 ...	9 50 56·19
Jan. 27 to April 19 ...	118,042 ...	9·7 ...	5·7 ...	200 ...	9 50 15·16

The period of really great acceleration extended over forty days (November 21 to December 31), and it is remarkable that in the mean time the spot had completed exactly one revolution of Jupiter relatively to the red spot. In fact, the sudden increase and diminution of velocity occurred with the white spot following the red about 2h. 44m., so that there was a difference of 100° in the longitude. The maximum speed appears to have been shown between November 21 and 27, when the rotation-period was one minute less than the mean of the two preceding years. But my observation of November 21 was considered rather late, and the interval being a very short one of only six days, would originate a rather large error. But the four short intervals, from November 27 to December 31, exhibit a singular consistency in the resulting periods, the mean being 9h. 49m. 36·16s., which proves the real increase of speed to have been 36·09s. in each rotation; and, if we amalgamate the two preceding periods, from November 7 to November 27, we get a mean of 9h. 49m. 38·96s., which is closely accordant.

In the forty days, November 21 to December 31, the spot gained 65·1m. = 39·7° upon Mr. Marth's central meridian (*Monthly Notices*, vol. xliv. No. 9), based on the period of 9h. 50m. 12·25s. The spot must therefore have moved 28,700 miles to the westward at the rate of 717 miles per terrestrial day, and 294 miles per Jovian day. Then after January 13 it suddenly retrograded if we accept the

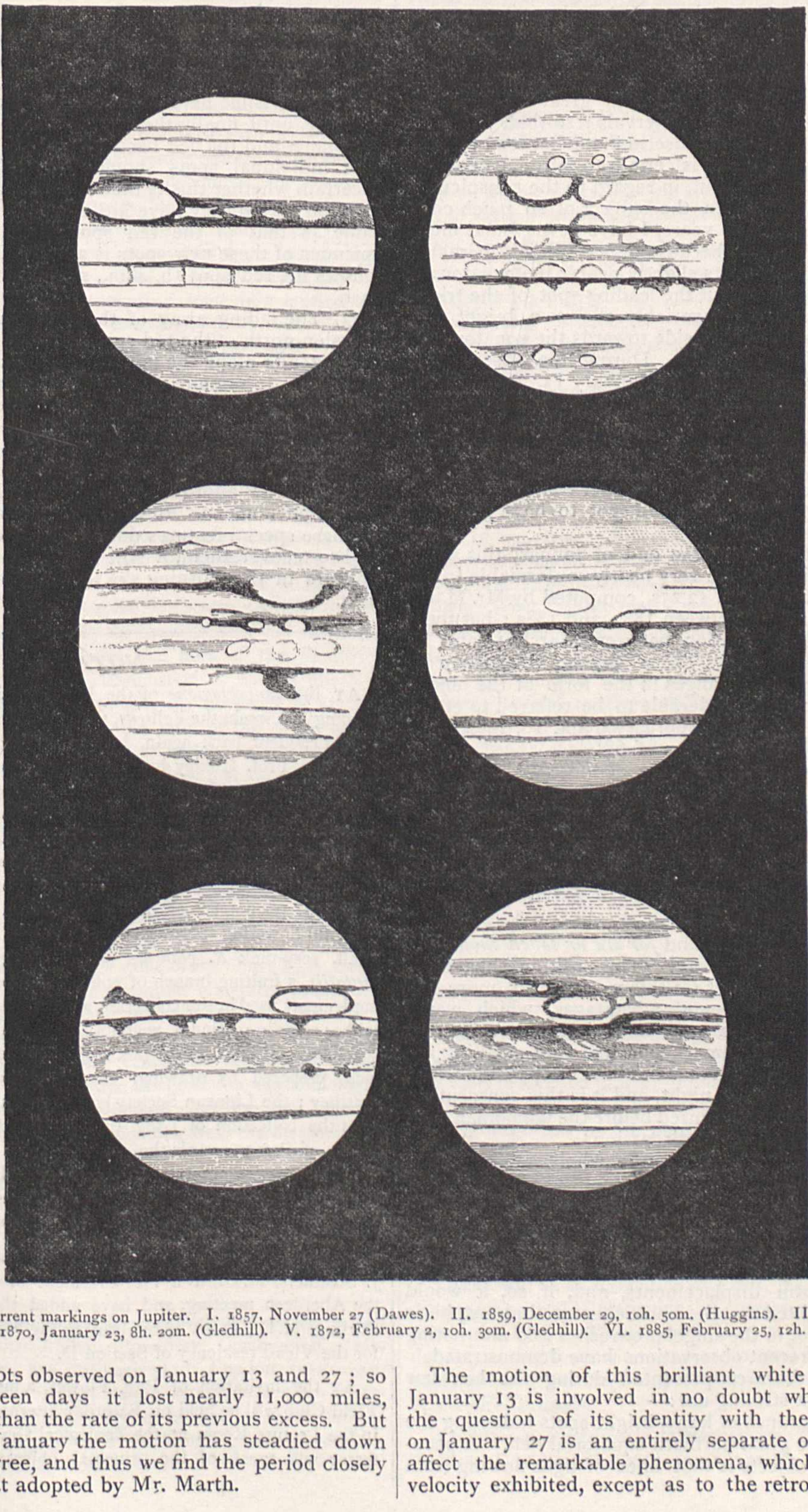


FIG. 1.—Probably recurrent markings on Jupiter. I. 1857, November 27 (Dawes). II. 1859, December 29, 10h. 50m. (Huggins). III. 1858, March 2, 9h. (Huggins). IV. 1870, January 23, 8h. 20m. (Gledhill). V. 1872, February 2, 10h. 30m. (Gledhill). VI. 1885, February 25, 12h. 50m. (Denning).

identity of the spots observed on January 13 and 27; so that in the fourteen days it lost nearly 11,000 miles, which is greater than the rate of its previous excess. But since the end of January the motion has steadied down to its normal degree, and thus we find the period closely agreeing with that adopted by Mr. Marth.

The motion of this brilliant white spot prior to January 13 is involved in no doubt whatever, so that the question of its identity with the one observed on January 27 is an entirely separate one, and cannot affect the remarkable phenomena, which the increased velocity exhibited, except as to the retrogressive motion which subsequently occurred. The question of identity may be definitely settled if any observations of the spot during the interval from January 13 to 27 are forthcoming from foreign observatories. In this part of England the sky was densely overcast at night during the whole of that time. If Prof. Hough at Chicago or some other systematic student of the planet can supply the missing links for the period referred to, it will be most important to ascertain how far they corroborate the assumed identity of the markings in question.

These white spots are liable to great variations in apparent brilliancy at short intervals; so that, unless an observer is very careful to discriminate between objects approximately situated, he is certain to introduce complications into his results. But, in regard to the conspicuous white spot which has been the subject of so much comment during the last few years, I have never found much difficulty in following it, because of its special character. Occasionally smaller spots slightly nearer the equator are seen on each side of it, but the leading spot of the trio is so bright and almost invariably shows a bright trail running from its north-east side towards the equator, that it may be readily identified. During the observations between October 4, 1884, and January 13, 1885, of the present opposition the extreme brilliancy of the spot was very noticeable, and the observations were pursued without any liability to error. I fear, however, that, morning observations being rendered necessary by the position of the planet in November and December will have enabled the singular vagaries of the white spot to have generally eluded notice.

It is curious that since the end of January this white spot has maintained a rate very nearly conformable to the first meridian of 9h. 50m. 12·25s., computed by Mr. Marth from the observations between 1882 and 1884; but there occurred a sudden deviation between March 14 and 18, amounting to some 8°. These singular displacements cannot be induced by changes in the form of the object, and they are far too considerable to be referred to errors of observation. Between February 9 and 16, 1882, Prof. Hough noticed an acceleration of $6\frac{3}{4}$°.

The verification and true cause of these variations can only be efficiently sought out by frequent and very accurate observation. Our own climate is very ill-adapted to an investigation of this kind where the most essential point consists in closely consecutive results. What we need is an almost unbroken series. It is to be earnestly hoped that some attention will be devoted to this important work at the Lick Observatory, where "the elevation is 4200 feet above the sea, and *for six or seven months of the year every night is clear!* The position thus commands natural advantages (in this work of far more importance than instrumental advantages) which would enable it to obtain some most valuable evidence bearing on the question of the remarkable variations affecting the white spots on Jupiter. Near the time of opposition they might be observed every night, and it is this consecutive, close treatment that is required before the phenomena will really admit of satisfactory discussion.

The question arises whether the whole southern belt partakes in these erratic and apparently frequent variations of speed, or whether they are confined to proper motions affecting the individual spots at different times. If several markings were made the subject of contemporary study it might soon be determined whether they exhibited uniform displacements, and, if so, it would have to be admitted that the whole equatorial atmospheric current is subject to the singular onrushes and alternating lulls which our recent observations have demonstrated.

Of the new features presented during the last few months the most striking are:—

(1) The appearance of large, bright spots indenting the north edge of the great northern equatorial belt. A peculiarity of these objects is that lines of light flowing from their west sides divide the dark belt and finally emerge near the equator, where they became indefinite. These spots show a rotation period only a few seconds less than the red spot.

(2) The outbreak of dark, reddish spots, elongated in longitude, upon the narrow belt which became visible in 1882, immediately outlying the great belt. The depression north of the red spot was formed by the ends of this belt suddenly dipping northwards before reaching the spot where they became blended with the old belt. The spots now visible here are very plain and will probably increase until finally their material is dispersed around the planet and the belt becomes much darker than before. The individual spots should be carefully watched to ascertain whether this is their ultimate development. The rotation period they have hitherto shown is precisely the same as that of the red spot. One of the most conspicuous of these new spots is about 10,000 miles long; it follows the red spot 1h. 48m., so that its longitude is 66° east.

(3) The fading away of the west shoulder of the depression north of the red spot. This is now very obvious, and extends along the narrow belt far to the west of the red spot. It remains to be seen whether this decadence will continue now that various other regions of the belt exhibit a confluent eruption of dark spots.

The several features referred to are of extreme interest, as suggestive of peculiar forms of atmospheric disturbance and as affording fresh materials for students of Jovian phenomena. It will be necessary to follow each of these special features during the two ensuing months, and to recover them, if still visible, when the planet reappears in the morning sky towards the end of October next.

W. F. DENNING

NOTES

AT the *conversazione* of the Royal Society on Wednesday evening last week, the Fellows, we are sure, were all glad to see their President back again, in renewed health, after his long absence. Prof. Huxley had to welcome a very large number of guests, and some of the objects exhibited were of much interest. Prof. H. N. Moseley exhibited a collection of Pueblo Indian pottery, charms, prayer-sticks, &c., from Zûni, New Mexico; Gen. Strachey, an instrument for drawing curves of sines adapted to graphical representation of the harmonic components of periodical phenomena; Mr. W. T. Thiselton Dyer lent some beautiful flowering specimens of Himalayan rhododendrons (the small, rosy-pink *R. glaucum* and the large, velvety-white *R. nuttalli*), a fruiting branch of coffee, and the various vessels and implements used in the collection and preparation of Para india-rubber; iridio-platinum weights, with a density of 21·5660, absolutely adjusted, and a piece of platinum wire ·00075 of an inch, prepared by drawing, &c., were exhibited by Mr. G. Matthey; the Linnean Society lent a remarkable set of drawings from the collection of Lady Impey, at Calcutta, painted by a native of Patna towards the end of the last century, and still in perfect preservation; the Anthropological Institute contributed ethnographic photographs of various races; and there were many highly interesting philosophical instruments shown.

THE Council of the British Association have nominated Prof. J. Struthers, M.D., as a Vice-President of the Association for the Aberdeen meeting, and have added the name of Prof. J. Stirling, M.D., D.Sc. (Aberdeen) to the list of those nominated for the Vice-Presidency of Section D.

AT the invitation of Prof. Flower, a meeting of the Essex Field Club will be held on Saturday afternoon, May 16, at 3.30, in the Lecture Room at the Zoological Gardens, when the Professor will speak of the principal objects of interest in the

Gardens, and will afterwards conduct the party to visit them in order, and give a demonstration of the most remarkable species.

A LETTER of Mr. Miklucho Maclay is inserted in the *Isvestija* of the Russian Geographical Society (1834, vi.), in which he expresses his regret that he cannot yet return to Russia, and explains the plan he has adopted for the publication of his reports. He wishes to have them published in two different parts, the first to contain (*a*) a statement of the reasons for any voyage or important excursion which he has undertaken, (*b*) a detailed narrative, and (*c*) scientific results of each of them; the second part to contain the scientific results concerning (*a*) anthropology, (*b*) ethnology, (*c*) zoology and comparative anatomy, (*d*) meteorology. In this manner Maclay hopes to suit both those who desire a general view of the outcome of his travels and those who wish to make themselves more particularly acquainted with the scientific results. By the way it may be mentioned that he has already described some new species, viz. (1) *Dorcopsis Chalmersii*, (2) *D. Macklayi*, (3) *Macropus Jukesii*, (4) *M. gracilis*, (5) *M. tibol*, (6) *Brachymelis garagassi*, (7) *Mus yelve*.

THE following, from *Science*, is a complete list of the papers read at the meeting of the National Academy of Sciences, April 21-24:—J. S. Billings and Dr. Matthews, U.S.A., methods of measuring the cubic capacity of crania; S. H. Scudder, winged insects from a palæontological point of view; A. S. Packard, the Syncarida, a hitherto undescribed group of extinct malocostracous Crustacea; the Gampsonychidæ, an undescribed family of fossil schizopod Crustacea; the Anthracaridæ, a family of carboniferous macrurous decapod Crustacea, allied to the Eryonidæ; Alexander Agassiz, the coral reefs of the Sandwich Islands; the origin of the fauna and flora of the Sandwich Islands; T. Sterry Hunt, the classification of natural silicates; Elias Loomis, the cause of the progressive movement of areas of low pressure; C. B. Comstock, the ratio of the metre to the yard; C. H. F. Peters, an account of certain stars observed by Flamsteed, supposed to have disappeared; J. E. Hilgard and A. Lindenkohl, the submarine geology of the approaches to New York; Theodore Gill, the orders of fishes; J. W. Powell, the organisation of the tribe; G. W. Hill, on certain lunar inequalities due to the action of Jupiter, and discovered by Mr. E. Neison; E. D. Cope, the pretertiary Vertebrata of Brazil; the phylogeny of the placental Mammalia; C. A. Young, some recent observations upon the rotation and surface-markings of Jupiter; H. A. Rowland, on the value of the ohm; F. A. Genth and Gerhard vom Rath, on the vanadium minerals—vanadinite, endlichite, and descloizite—and on iodyrite, from the Sierra Grande mine, Lake Valley, New Mexico; A. N. Skinner (by invitation), on the total solar eclipse of August 28, 1886; Theodore Gill and John A. Ryder, the evolution and homologies of the flukes of cetaceans and sirenians; Ira Remsen, chemical action in a magnetic field; A. Graham Bell, the measurement of hearing-power; A. Graham Bell and F. Della Torre, on the possibility of obtaining echoes from ships and icebergs in a fog. The following biographical notices of deceased members were also presented: of Dr. J. J. Woodward, U.S.A., by J. S. Billings; of Gen. A. A. Humphreys, U.S.A., by H. L. Abbot; and of William Stimpson, by Theodore Gill.

BOTANY, as well as geology, we are pleased to notice, is well represented upon the Afghan Boundary Commission. Mr. Condie Stephen, who has just arrived in London, speaking of the Penjdeh Valley or Koosh Valley, stated to a press representative that Dr. Aitchison, who has charge of the botany of the Expedition, is delighted with the country, and has made a very large and valuable collection.

THE *Times* Calcutta Correspondent telegraphs that the Indian Government has at last begun to fulfil a promise made years ago to the Asiatic Society, that a systematic zoological exploration of the depths of the Indian seas should be undertaken, in connection with a survey of the coasts. "A skilled naturalist, Dr. Giles, has been attached to the surveying steamer *Investigator*, which is supplied with proper appliances for deep-sea dredging. During a recent cruise in the Bay of Bengal some casts were made with very interesting results. Some of the animals found appear to be new, and have been sent home for examination. The dredgings also proved that the depression of the bottom, near the mouth of the Hooghly, known as the Swatch, regarding which much speculation had been indulged in, was merely a deep submarine valley, forming part of the original basin of the Bay of Bengal—as Sir Charles Lyall long ago suggested."

A PORTION of the work of Protestant missionaries in China, which has attracted little attention in this country, and which, nevertheless, is of great importance, is the preparation of school- and text-books in Chinese. For this purpose Protestant missionaries of all nationalities and denominations have united. At a general conference held in Shanghai in 1877, a committee of eight of the leading missionaries was appointed to superintend the preparation and publication of the series. The work has now been going on for eight years, and the Committee are able to report that over forty works have been issued, and that thirty more are in various stages of progress. In addition, four numbers have been issued of an "outline series" compiled with the object of supplying Chinese schools with small and simple treatises on scientific subjects at cheap rates, suitable either as elementary school-books or as popular tracts for general distribution. What "cheap rates" mean will appear from the fact that the outlines of astronomy costs rather less than a penny, that of political and physical geography and geology about twopence each. The larger works embrace anatomy, in five volumes; ancient religions and philosophies in three; arithmetic, charts of astronomy, birds and mammals, with accompanying handbooks (these charts, from the prices, are obviously intended for the walls of schools); chemistry, political economy, geology, universal history, international law (a translation of Bluntschli, it appears), zoology, and several on biblical topics. Those in preparation include treatises on various branches of elementary mathematics, botany, ethnology, hygiene, jurisprudence, logic, mathematical physics, meteorology, mineralogy, philology, and forty wall-charts with accompanying hand-books. These works, it must be remembered, have first to be compiled with a special view to the knowledge usually possessed by Chinese children, and then to be translated, representing in each case two distinct tasks. That the missionaries in China and elsewhere have schools where they teach the young is well known, but it will probably be a surprise to many to find that, in addition to their ordinary labours as preachers and teachers, the missionaries in China have had to undertake a task of such magnitude as the creation of school literature on all subjects of human knowledge, from arithmetic to jurisprudence, and from anatomy to logic. The statement on this subject is taken, it should be added, from the *Chinese Recorder* of Shanghai, a magazine which is itself a monument to the learning and enterprise of Protestant missionaries in China.

THERE will be an Exhibition of Plans, Maps, and Models in connection with the International Congress on Inland Navigation to be held in Brussels from May 24 to June 2. Those desiring to contribute are requested to send in their exhibits at once, addressed, carriage-free, to Mr. A. Gobert, 212, Rue de la Victoire, Brussels.

AN interesting scheme in connection with the Bedford School is that of higher education for adults by means of evening lectures on literary and scientific subjects, at nominal fees. The lecturers are drawn for the most part from the staff of Bedford School. Among the scientific subjects included in the course are mathematics, geology, physical geography, and botany. Bedford is fortunate in having amongst its residents men qualified and willing to organise and carry out an excellent plan of this nature for its benefit.

THE British Consul at Leghorn in his report for the past year makes some interesting observations on coral in the Mediterranean. Some centuries back the Mediterranean coral fisheries were carried on exclusively by the Spaniards, and the principal establishments engaged in the manufacture of coral ornaments were in the hands of Jews residing in Spain. Towards the close of the sixteenth century, to escape the persecutions to which they were exposed, a large number of these merchants removed to Leghorn, in order to enjoy the secure asylum afforded by the liberal enactments of Ferdinando di Medici. Crews were obtained from the Neapolitan coast, principally from Torre del Greco; hence this place at an early period became the chief seat of the coral fishery, and most of the boats engaged in it are still fitted out at that port, although the manufacture of coral ornaments and beads is carried on principally at Leghorn and Genoa. These ornaments are met with in almost every part of the world, and in many countries, even in Europe, coral is believed to be possessed of a peculiar charm. In Asia and Africa it is regarded with a sort of religious veneration, while in India it is largely used for the adornment of corpses when prepared for cremation. But the present situation of the coral trade is disastrous. In 1880, a coral bank several kilometres in length was discovered near the island of Sciacca, on the coast of Sicily, and consequently the yield of raw material has been far in excess of the demand, and the reef is still very far from being exhausted. A great depreciation in value has ensued, and as a consequence an extensive trade has sprung up in coral with Africa, where the natives now purchase coral ornaments in place of glass beads of Venetian and German manufacture. The raw coral comes from Naples, and is worked at Leghorn by women into beads, British India and Egypt being the chief customers for them.

ON April 24 Mr. Edward Berdoe, M.R.C.S., read a paper at University College, Gower Street, before the Browning Society, on "Browning as a Scientific Poet." The paper, as reported in the *Lancet*, opened with an exhaustive argument to prove that the progress of science need not, as some had said, tend to the destruction of the poetic art; that, in fact, some of the greatest poets had enriched their verse by the study of natural phenomena—Lucretius, Haller, Milton, and Goethe, and in our own times Tennyson and Browning, while students of natural and physical science had not found their exact acquaintance with natural laws impede the luxuriant growth of their poetic fancy. Many of Browning's most beautiful similes were the result of his intimate acquaintance with anatomy, physiology, and chemistry; and the use he constantly makes of figures drawn from the science of optics has enabled him to illustrate his favourite optimism by much beautiful imagery. The poet of the future will be denied his former "power of dealing capriciously with facts," but this restraint, Mr. Berdoe argued, would not repress the poetic spirit. Mr. Berdoe, in conclusion, claimed for Mr. Browning that he is essentially the poet for the scientific man: abreast of the highest culture of his time, and in close touch with the great aims of science.

HERR SCHWEIGER, writing from Widdin to the *Monatsschrift für den Orient*, refers to baldness amongst Orientals. In Europe the idea is general that baldness is the prerogative of scholars; in the East, on the other hand, it is the common characteristic of two races—the Spanish Jews and the Turks, whose nervous system has never been overwrought by any devotion to serious studies. In some measure to explain the origin of this phenomenon we must commence at the cradles of the two peoples living side by side. The indolence of Oriental women is well known and is manifested in sins of omission rather than of commission. The Oriental mother neglects the principal duties to her offspring. During the first eight days of its earthly career the infant is sprinkled with a little tepid water once a day by some old woman, then wrapped in coloured rags to save the trouble of frequent changes, the head being wrapped in a well-wadded cap tied under the chin. This process is repeated during the succeeding weeks once every two days, until finally it has become too toilsome even for this repetition, and is abandoned altogether, through fear, it is said, that the child would catch cold from frequent washings. Superstition has added its force to laziness, for the women believe that the head of an infant should never be washed, as the scab produced by the dirt is good for the eyes. This dirt, mixed with the secretions from the sebaceous and other glands, becomes the home of numerous animal and vegetable parasites, which prevent the development of hair and destroy that already grown. The open air, which might assist in destroying these parasites, is, however, carefully excluded by the custom which is imperative among Semitic peoples of never, by day or night, or upon any occasion whatsoever, taking off the head-covering. At night the fez is changed for a linen cap of similar shape. This perpetual covering naturally retards the growth of the hair, and transmission and propagation do their work. Herr Schweiger, who has lived in the East for many years, first noticed chronic baldness amongst the lower classes of the Turks, especially the so-called Spaniols of Salonica.

THE National Fish Culture Association's hatchery at South Kensington is now gradually becoming depleted of fry, which are being transmitted to public waters gratuitously, and to the fishery at Delaford belonging to the Association. The spawning and hatching season has been very prosperous and successful, there being but a very low minimum mortality amongst the fish produced.

THE Aquarium at the International Inventions Exhibition is assuming a more complete aspect, and has been an attractive feature with visitors from the first. An Aquarium Handbook is now in the press and will be shortly published by Messrs. Clowes and Sons, containing a natural history of the fish in captivity and a series of articles upon the culture of fish, the management of aquaria, &c.

ON April 22 a meteor was seen descending in a straight line from the zenith at Fogelsta railway station in Östergötland, Sweden, and fall some distance off. On the station-master proceeding to the spot he found a stone, about the size of a hand, and brown in colour, which smelt strongly of phosphorus when struck against a hard object. It was split into three pieces, each being forwarded to a museum.

THE *Calcutta Gazette* has published a resolution of the Government directing the institution of an inquiry, under a specially selected officer, into the castes and occupations of the people of Bengal. The results of this inquiry should be of great ethnographical value.

THE exceptionally heavy rainfall at Bergen on October 25, 1884, when 74 mm. were registered for the twenty-four hours, was commented on at the time by the Scandinavian press as affording confirmatory evidence of the truth of the popular opinion that this town is the rainiest place in Norway. This notion, however, like many other traditional beliefs, has been dissipated by the test of carefully-conducted scientific observations, for we learn from *Naturen* that the annual mean of its rainfall is exceeded by that of two among the other seventy Norwegian meteorological stations. Thus while at Bergen 1722 mm. are measured annually, the rainfall at Domsten and Florö amounts respectively to 1951 mm. and 1873 mm. It has further been shown that 105 mm. rain were registered at Holmedal on the Söndfjord, on the same day that the rainfall at Bergen reached 74 mm., the highest recorded since rain-measurements have been made there. There are in fact eighteen instances given by the meteorological reports in which the rainfall has elsewhere exceeded the latter measure. Among these the most remarkable have been supplied by Ullensvang and Flesje, at the former of which stations there fell in one day (December 8, 1884) 113 mm. rain, while at the latter 112 mm. were registered for the twenty-four hours on March 15, 1882. These downfalls, the highest recorded in Norway since the observations were begun in 1875, have been exceeded, according to Dr. Hamberg of Stockholm, at the Swedish station of Hernösand, where 118·5 mm. rain fell on August 19, 1878. Facts such as these effectually refute the opinion, alike strenuously maintained by natives and foreigners, that more rain falls at Bergen both in the year and in the course of one day than at any other place in Scandinavia. Such, however, is the character of the annual distribution of rain in this locality, that the chances are about equally in favour of a wet or a dry day.

IN reporting to the Empress of China the occurrence of a violent earthquake at the town of Pu-erh on November 14 last year, the Viceroy of Yunnan observes with humility that this awful visitation is to be regarded as a penalty of Heaven for his own inefficiency and incompetency and that of his staff. They will, the memorialist promises, endeavour to take the lesson to heart and earnestly amend their ways. Pu-erh will be remembered by readers of Mr. Colquhoun's "Across Chrysê" as an important town on the borders of the Shan States, with a large trade in tea. The earthquake here referred to is also worth notice as showing that seismic activity during the past winter was manifested over a vast area, and indeed seems to have affected the greater part of the Old World. At Pu-erh the shock lasted an hour, causing the collapse of a large number of houses, temples, and public buildings, while many lives were lost, and much injury was caused to the inhabitants.

M. LÉO ERRERA calls attention in the *Bulletin Scientifique du Département du Nord* to the value of Indian ink, on account of its harmlessness and its intense coloration, for the study of certain microscopic organisms. He has succeeded in keeping infusoria, &c., alive for several days in the liquid, the carbonic matter not appearing to affect them in the slightest degree. For making durable preparations ink diluted with water should be gradually replaced by that diluted with glycerine. Many organisms which are distinguished with difficulty in water, are easily observed in water charged with Indian ink; this is especially the case with many *Algæ*. M. Errera thinks that this new method could probably be applied with advantage to the study of the digestion of the infusoria, and to the movements of ciliated organisms.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus* ♀) from West Africa, presented by Mrs. Wall; a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Miss Margaret Ellis; a Getulen Ground-Squirrel (*Xerus getulus*) from North-West Africa, presented by Mr. W. Cook; a Grey Ichneumon (*Herpestes griseus* ♀) from India, presented by Mrs. Dundas; two Martinican Doves (*Zenaida martinicana*) from Bahamas, presented by Mrs. Blake; two Horned Lizards (*Phrynosoma cornutum*) from Texas, presented by Mr. J. G. Witte; a Dorsal Squirrel (*Sciurus hypopyrrhus*) from Central America, an Indian Mynah (*Acridotheres ginginianus*), four White-backed Pigeons (*Columba leuconota*), a Black Hill-Squirrel (*Sciurus macrurus*) from India, two Chinese Jay-Thrushes (*Garrulax chinensis*) from China, a Sun Bittern (*Eurypyga helias*) from Brazil, two Greek Partridges (*Caccabis saxatilis*), South European, a Double-banded Sand-Grouse (*Pterocles bicinctus*) from Senegal, a Talapoin Monkey (*Cercopithecus talapoin*) from West Africa, a Negro Tamarin (*Midas ursulus*), a Humboldt's Lagothrix (*Lagothrix humboldti* ♂), a Rosy-billed Duck (*Metopiana peposaca* ♀) from South America, a Viscacha (*Lagostomus trichodactylus*), a Scorpion Mud-Terrapin (*Cinosternon scorpioides*) from Buenos Ayres, a Gadwell (*Chaulelasmus strepera* ♂), nine Spotted Salamanders (*Salamandra maculosa*), European, purchased; a Crossoptilon (*Crossoptilon mantchuricum* ♂) from Northern China, received in exchange; a Gayal (*Bibos frontalis*), two Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE HARVARD COLLEGE OBSERVATORY, U.S.—The thirty-ninth Annual Report of this Institution has been issued, and with it Prof. Pickering's summary of observations of variable stars in 1884, made agreeably to the plan suggested by him in a communication to the American Academy of Arts and Sciences (vol. xix. p. 296). Thirteen observers, private and professional, have co-operated in these observations, amongst them Mr. Knott, of Cuckfield, and Mr. T. W. Backhouse, of Sunderland. In the summary referred to, the positions of the stars for 1875, the limits of variation and the periods, as far as reliably determined, are repeated from the circular of last year, and these particulars are followed by a statement of the number of observations of each star, made by the various observers in the course of 1884, so that it is easy to see which objects most require attention. It is certain that in this branch of observational astronomy there is ample work for a much larger number of co-operators, which it may be hoped that Prof. Pickering will succeed in enlisting amongst our amateurs, and eventually it may be possible to particularise the objects which each one may undertake to watch effectively, so as to secure observations of the whole or the majority of the list in each year.

With regard to the general proceedings of the Harvard Observatory, it is stated that photometric observations of the eclipses of Jupiter's satellites have been continued upon the system adopted in 1878, and 284 eclipses have now been thus observed, forty-seven since the end of October, 1883. The revision of the zone-observations of stars between 50′ and 60′ north of the equator has been completed during the year. Selections of stars for standards of stellar magnitude have been made for regions extending four minutes (time) in right ascension, and ten minutes in declination, and additional photometric methods of measurement are under consideration for determining such magnitudes with satisfactory precision. Observations of comets, of the spectra and colours of stars, and a tentative revision of the magnitudes of the *Durchmusterung*, have also formed a part of the year's work. We do not learn from the report that any attempt has been made to repeat the valuable series of observations on the rings of Saturn, made by the Bonds, &c., with the Harvard 15-inch refractor, when the planet was previously situated in the position it occupied in 1884; but the class of observations more especially attended to at present may have rendered this impracticable. Vol. xiv. parts 1 and 2 of the *Annals* have been published; the latter part has been circulated very recently.

TEMPEL'S COMET (1867 II.).—Up to the 7th inst. it does not appear that the editor of the *Astronomische Nachrichten* had received any notice of the re-observation of this comet. Doubtless, of the last degree of faintness, it could only have been commanded last month by instruments of the highest order. In the next period of absence of moonlight the theoretical brightness will have diminished. The comet will be due in perihelion again in the spring of 1892, a more favourable condition for the observation of this body than has existed in the present year.

NEW NEBULÆ.—M. Stephan publishes positions and descriptions of 100 nebulæ discovered at Marseilles in the years 1883–85, in addition to the large number previously detected at that observatory. Not the least notable characteristic of M. Stephan's catalogues is the precision of the places given in them. He mentions that on October 1 and 2, 1882, neither the nebula Dreyer-Schultz 5085 nor *h* 12 were perceptible in the positions assigned to them by the discoverers.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *MAY* 17–23

(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 May 17

Sun rises, 4h. 7m.; souths, 11h. 56m. 10·8s.; sets, 19h. 46m.; decl. on meridian, 19° 26′ N.: Sidereal Time at Sunset, 11h. 29m.

Moon (at First Quarter May 21, 6h.) rises, 6h. 59m.; souths, 14h. 53m.; sets, 22h. 44m.; decl. on meridian, 18° 7′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	3 37	10 30	17 23	9 41 N.
Venus	4 18	12 10	20 3	19 55 N.
Mars	3 24	10 36	17 48	13 13 N.
Jupiter	11 0	18 15	1 30*	13 38 N.
Saturn	5 43	13 51	21 59	22 18 N.

* Indicates that the setting is that of the following day.

Occultations of Stars by the Moon

May	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
19	α Cancri	4	22 52	23 15	48 359
21	B.A.C. 3407	6	0 21	1 12†	125 276
21	35 Sextantis	6	20 48	21 18	26 340

† Is below horizon at Greenwich.

Phenomena of Jupiter's Satellites

May	h. m.		May	h. m.	
17	23 21	II. occ. disap.	21	0 21	I. occ. disap.
19	20 28	II. tr. egr.		21 41	I. tr. ing.
20	21 33	III. occ. reap.	22	0 1	I. tr. egr.
	23 10	III. ecl. disap.		22 22	I. ecl. reap.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

May 21, 3h.—Jupiter in conjunction with and 4° 17′ north of the Moon.

THE IRON AND STEEL INSTITUTE

THE Iron and Steel Institute met on Wednesday, the 7th inst., when Dr. Percy gave the presidential address. After inviting the co-operation of the members in supplying him with materials for the new edition of his work on "Iron and Steel," and referring to Mr. Lowthian Bell's recent valuable work on the same subject, Dr. Percy drew attention to the existing universal depression, due, in his opinion, to over-production. "Darwinianism prevails in the manufacturing world as it does in the natural world, however painful and unwelcome may be that truth—only the fittest will survive. The struggle may be severe and to many persons disastrous, but so long as supply exceeds demand, it is inevitable, and the result is not doubtful."

In the matter of technical education he regretted that a few of its professed friends should have indiscreetly attempted to imbue all our artisans with the notion that the one thing which at present they urgently need is technical education, and that it will be certain to benefit them all alike, whereas in some trades, such as that of the file-cutter, the marvellous skill which is alike the surprise and admiration of all is to be obtained only by the practice of his art. He referred with pleasure to the judicious and enlightened way in which Sir Bernhard Samuelson, M.P., had advocated technical education in its widest sense, and rejoiced over the liberality of the founders of the Owens College (now the Victoria University) in Manchester, the Mason College in Birmingham, and the Firth College in Sheffield, and of the Whitworth Scholarships, through whose aid scientific instruction is placed within the reach of the artisan class.

The major portion of the address was devoted to the physical and chemical properties of iron and steel, and the learned President's remarks brought out in strong relief the prevailing want of knowledge. How comes it, he inquires, that the force of cohesion should be increased by mechanical treatment, which, *à priori*, might be supposed would tend in greater or less degree to produce disaggregation? Why is iron or steel wire increased in strength by wire-drawing? What is the cause of the physical changes which some metals and alloys have been observed to undergo spontaneously while at rest and under ordinary atmospheric conditions?

"It is not many years since that we had to grope about to discover an analysis of iron ore or of pig iron, whereas now we are actually overwhelmed with such analyses. We are deluged with percentages of carbon, graphitic or combined, of silicon and manganese, of sulphur and phosphorus. We are bewildered by this vast accumulation of material. What is now wanted is the man to reduce it to law and order, to evolve from it principles for our sure guidance. But the problem is so intricate and complex that no common brain can solve it. What are the physical properties of pure iron after fusion? What are the chemical and physical properties of compounds of pure iron and pure silicon in various proportions? What are the modes of existence of manganese, silicon, and phosphorus when present together in pig iron? What is the *modus operandi* of manganese in the manufacture of iron and steel? Why are animal matters or certain other substances rich in nitrogen, required in case-hardening iron? Is any nitrogen or any compound of it imparted to the case-hardened part of the iron? These and such like questions the metallurgist asks of the natural philosopher and chemist, and has failed hitherto to receive a reply."

Having concluded what may be called the technical part of his address, Dr. Percy treated the question of the extent to which the Government of a country should engage in manufacture, and stated "that, if it could be shown that the people as a whole would be benefited by the Government's engaging in manufacture, then the Government was bound to take that course." Treating the various cases of armour-plates, steel for guns, and steel for ship-plates, he showed that in each case, owing to competition, co-operative management, and other causes, private industry was always able to produce articles as good as and cheaper than the Government.

The address was listened to with the greatest attention throughout, both on account of the inherent interest of the matter and the great oratorical skill employed in its delivery. The closing paragraphs are of such universal interest that we quote them verbatim:—

"Everything in this world, nay, there is reason to believe everything in the universe itself, is changing from moment to moment. There is, as I have stated in print long ago, nothing constant but change, however paradoxical that statement may appear. Every drop of rain that falls, for instance, exerts a levelling action on the hills and mountains, and carries down with it in its course to the ocean a minute yet sensible portion of earthy material. In the moral world the like incessant change is going on, and no one can predict what the final result ef that change will be. Our globe may, it seems to me, be fitly compared with the laboratory of the philosopher. The one, to our finite understandings, may appear the scene of social and political experiments, just as the other is the scene of chemical and physical experiments. But of this we may be sure, that invariable and irresistible law guides all things, immaterial as well as material. When I reflect on the intricate social problems of the day, the solution of which excites dread in the minds of many, I fancy I see the social molecules, if I may use such an expression, actively at work in rearranging and adjusting themselves to new conditions, and producing results as surprising as they are remarkable. The mysterious forces, whatever they may be, which regulate the movements of those molecules, are as certain in their operation as those which determine the course of the planets in their orbits. Both are equally uncontrollable by the agency of man, and politicians will in vain struggle against them.

"There is a question that must often occur to us, namely, what will Great Britain be when our vast reservoir of material force, coal, is exhausted—a result which many members of the Iron and Steel Institute are doing their utmost to accelerate? The time must come when, in consequence of that exhaustion, Great Britain will cease to be a great manufacturing nation, unless some new source of force should be discovered, which there is not the least reason to anticipate. But, as I wrote many years ago, however mournful and unwelcome this proposition may be, we have the satisfaction of knowing that we are now laying the foundations of prosperous and mighty kingdoms in various parts of the world, which we hope will be the strongholds of virtue, of order, and of freedom. When our great manufactories shall have crumbled into ruins, and their sites have become green pastures or golden corn-fields, the old country may yet be precious in the eyes of her children. Every spot of her soil will be classic, and command reverential respect. There is no other land more worthy of everlasting remembrance, whether as to its heroes, its poets, its philosophers, its statesmen, or its philanthropists. The glory of Old England may, after all, not depart. On the sites of her soot-stained Birminghams and Manchesters, new and splendid cities may arise, where the merchant-princes of Anglo-Saxon descent, from the remotest regions of the globe, shall rejoice to dwell and end their days in peace."

After the address the President presented the Bessemer Medal to Mr. Lowthian Bell for delivery to Prof. Åkermann, after which the papers were read. The first paper read was that of Mr. Lowthian Bell, on "The Blast-Furnace Value of Coke, from which the Products of Distillation from the Coal used in its Manufacture have been collected." The experiments which formed the foundation of the paper were made upon the same coal coked in the beehive and Simon Carvé's oven, the total quantity of coke operated upon being 5605 tons; it was found that the beehive coke was about 10 per cent. more economical, although the other was 13·83 per cent. denser. In order to ascertain the cause of the inferiority, samples were finely ground and analysed. Similar samples were exposed for half an hour to the full heat—sufficient to soften porcelain—of a gas blast-furnace, access of air being excluded by placing the crucible containing the sample within a larger one and covering it with charcoal. From the loss of weight and the analysis of the original and residual coke, and from the previously-ascertained moisture, it was found that 5·23 per cent. of the Simon Carvé's coke was expelled by ignition, and 3·27 per cent. of the beehive. This accounts for an inferiority of 1·96 per cent. only out of about 10 per cent. It is, however, a well-known fact that certain forms of carbon are less easily burnt than others, and the author sought to account for the superiority of beehive coke in this manner, and found it to be due to the less solvent action of carbonic acid upon it.

At the Wednesday evening meeting Dr. H. C. Sorby, F.R.S., gave an account of his microscopical examination of the structure of iron and steel. His results were based upon the examination of flat surfaces, carefully ground and polished, as the study of fractured surfaces is unsatisfactory, not only on account of optical difficulties, but because a fracture shows the line of weakness between the crystals and not their internal structure. In some cases the surfaces were acted upon by very dilute nitric acid to develop the structure; in others it was found best to polish with dry rouge on parchment, and not to use acid. Thin glass covers were afterwards mounted over the surface with Canada balsam. The objects thus prepared were examined by means of two special kinds of surface illumination, viz. first the side parabolic reflector now common, but which the author believes was originally made for this purpose, which gives oblique light; and secondly, by means of a small silver reflector covering half the object-glass, which throws the light directly down on the object, from which it is reflected back through the other half of the lens. With oblique illumination a polished surface looks black, but, with direct, bright and metallic. A truly black substance looks black in both cases. A magnifying power of about sixty linear is most generally suitable, but the sections will bear a higher perfectly well. The lecturer exhibited photographs and drawings of the microscopic appearance of the surfaces, the peculiarities of which he described.

The following is a summary of some of the chief results:—Iron containing little or no carbon, and of uniform character, shows little, if any change, when acted upon by dilute acid, and no well-marked structure is developed. Hammered blooms show an intimate mixture of varying crystals of iron, with minute or larger portions of slag. In iron bars rolled *hot*, the slag is drawn out into long thin rods, which in some cases are so numerous as to form a very considerable portion of the whole bulk, whilst the iron shows no elongation of the ultimate crystals, the metal apparently recrystallising on cooling. When hammered *cold*, the crystals are compressed, broken up, and elongated in the line of the bar. Many specimens of malleable iron show clearly that two constituents are present, viz. iron, and a compound of iron and carbon, which has a pearly structure; one of these is like the main constituent of such bar iron as contains little or no carbon, having no trace of linear marking, after being acted upon by dilute acid, whereas the other constituent shows linear markings, varying in distance, but often about 1–20,000th of an inch apart, which, when the acid has acted to a proper extent, gives rise to all the splendid colours of mother-of-pearl, the tints being raised when the section is seen in water, and still more so when mounted in balsam. By oblique and direct illumination the colours are nearly complementary. Swedish iron partly converted into blister steel by cementation, shows a mixture of well-formed crystals of free iron and of the pearly compound in the centre; around this a ring of the pearly compound, with colours of great variety and beauty; whilst on the outside is a part in which occurs a network of veins of an extremely hard substance, giving an intensely brilliant reflection and no trace of colour, which seems to contain more carbon than the pearly constituent. The three constituents just described are totally distinct from one another. There is no more passage from one to the other than there is between the mica, felspar, and quartz of granite.

The varying character of ingots of soft and hard steel to a great extent depends on the varying proportion of the three principal constituents. Soft Bessemer steel is seen to be a mixture of free iron and the pearly compound. In medium steel this latter occurs almost alone, whereas in hard steel there is little, if any, free iron, but numerous thin plates of the very hard compound. Besides these three constituents in steel, the microscope gives evidence in cast-iron of the presence of graphite and silicon. The specimen of spiegeleisen studied, consisted mainly of the intensely hard compound, crystallised in large plates, the inter-spaces being filled up with a mixture of very much smaller crystals with a little of the pearly substance, so as to have a most beautiful and fine-grained structure. Taken, then, as a whole, the various kinds of iron and steel are seen to be varying mixtures of three or four out of six or seven substances having very different properties, viz. free iron, the pearly compound with carbon, the intensely hard compounds, probably with more carbon; the residual, probably variable, substance; graphite; possibly crystallised silicon; slag, including fused iron oxide.

On the second day the attention of the meeting was occupied with the subject of the coking of coal by different processes and the recovery of bye-products. Mr. Head's paper contained a description of a modified form of the Siemens old type gas-producer, in which the latter result is effected by dividing the gas-producer by means of a vertical wall into two compartments, one of which receives the hydrocarbons—the volatile constituents of the coal—and the other the carbonic oxide formed by the decomposition of its solid carbonaceous matter. Two other papers referred to results obtained in connection with the Simon-Carvé's coking process. Prof. Armstrong's note with reference to the method's proposed for coking coal and recovering volatile matter has much scientific interest, and we propose to refer to it shortly. The problem consists in as complete a recovery as possible of the matters latent in coal, in the most economical manner and advantageous forms, the treatment depending upon the class of coal acted upon. The author considers the compounds in coal to be mainly of two kinds—phenolic compounds, which are the primary source of the phenols (carbolic acid, &c.) contained in coal tar; and paraffinoid compounds, capable of yielding hydrocarbons such as are obtained on distilling shale; the high-temperature tars such as are obtained at gas-works, not being primary but secondary products of distillation, may be considered final products, the quality of which it will be impossible to improve, whereas the object should be to produce low-temperature tars, which by after-treatment might be made to produce a large proportion of benzene and other valuable products.

The author's idea of a theoretically perfect coking oven is one more or less like the present beehive, with the upper part extended. Heat should be *radiated* upon the surface of the charge of coal, which would soon become coked, thus forming a protecting layer, below which distillation would take place, the products of distillation being sucked away as rapidly as possible through the cool bottom of the oven. The products of combustion which penetrate below would carry no oxygen with them. On this account, and on account of the large volume of steam and other gases generated within the mass, and of the low temperature, the ammonia would probably almost entirely escape destruction. The gas would be of low illuminating quality, but would be available for carbonising, oil and ammonia being removed from it by efficient scrubbing. The author was of opinion that nothing was known practically of what happens when coal is distilled, and that the coking of coals and manufacture of gas were now only empirical operations, and could not be conducted scientifically, with our present imperfect knowledge, but that the interests involved were so great, the subject being one of national importance, that failure to initiate and execute the necessary systematic experiments without further loss of time would be inexcusable.

On the last day of the meeting Mr. Carnegie's paper on "Natural Gas Fuel and its Application to Manufacturing Purposes" was read. This fuel is found in the Pittsburg district, and one of the wells is estimated as yielding 30,000,000 cubic feet of gas in the twenty-four hours; the pressure of the gas as it issues from the mouth of the well is about 200 lbs. to the square inch, and even at the works, nine miles from the wells, it is 75 lbs. per square inch. Eleven lines of pipe convey the gas from the various wells to the manufacturing establishments in and around Pittsburg. The number of men whose labour will be dispensed with when gas is generally used is 5000. In the steel-rail mills, for instance, where before would have been seen thirty stokers, stripped to the waist, firing boilers which require a supply of about 400 tons of coal in twenty-four hours—ninety firemen in all being employed, each working eight hours—there would now be found one man walking around the boiler-house, simply watching the water-gauges, and not a particle of smoke is to be seen.

Dr. Hermann Wedding's paper on "The Properties of Malleable Iron deduced from its Microscopic Structure" draws attention to the value of microscopic analysis, as, though the chemical and physical properties of iron are closely connected, the one cannot be directly deduced from a knowledge of the other, nor do either of these aid in acquiring a knowledge of the mechanical properties. The pieces of iron to be tested are carefully polished, and then etched with very dilute nitric acid. After etching, the section is carefully heated, whereupon the portions attacked acquire varying tints, mostly golden-yellow, purple-red, violet, or dark blue. It is the difference of colour that is characteristic. As regards the formation of grains and fibres, the size of grain increases with slowness of cooling, and decreases with increase in the proportion of carbon up to 2 per cent. Each individual grain in malleable iron is ductile, the malleability of the entire piece depending on that of the separate grains, which are drawn out into fibres; the strength of fibrous iron depending on the fact that, like the individual hemp-fibres in a rope, the fibres lie with their ends in various sections. The microscope shows, further, that none of these wires or fibres is directly connected with its neighbours, either in a longitudinal or lateral direction. In fact each fibre may, by careful etching, be picked out like those of a muscle in the human body. The paper treats also of the constitution of individual iron crystals and of welding. The general result of the analysis shows that the strength of a finished piece of iron depends on the sectional area of the mass of iron it contains, the slag inclusions in weld-iron and blow-holes in ingot-iron being deducted.

It was announced that the autumn meeting of the Institute would be held at Glasgow.

SUNLIGHT AND THE EARTH'S ATMOSPHERE[1]

II.

We have been compared to creatures living at the bottom of the sea who frame their deceptive traditional notions of what the sun is like from the feeble changed rays which sift down to them. Though such creatures could not rise to the surface, they might swim up towards it, and if these rays grew hotter, brighter, and bluer as they ascended, it would be almost within the capacity of a fish's mind to guess that they are still brighter and bluer at the top.

Since we children of the earth, while dwelling on it, are always at the bottom of a sea, though of another sort, the most direct method of proof I spoke of, is merely to goup as far as we can and observe what happens, though as we are men, and not fishes, something more may fairly be expected of our intelligence than of theirs.

We will not only guess, but measure and reason, and in particular we will first, while still at the bottom of the mountain, draw the light and heat out into a spectrum, and analyse every part of it by some method that will enable us to explore the invisible as well as record the visible. Then we will ascend many miles into the air, meeting the rays on the way down, before the sifting process has done its whole work, and there analyse the light all over again, so as to be able to learn the different proportions in which the different rays have been absorbed, and, by studying the action on each separate ray, to prove the state of things which must have existed before this sifting—this selective absorption—began.

It may seem at first that we cannot ascend far enough to do much good, since the surface of our aërial ocean is hundreds of miles overhead; but we must remember that the air grows thinner as we ascend, the lower atmosphere being so much denser, that about one-half the whole substance or mass of it lies within the first four miles, which is a less height than the tops of some mountains. Every high mountain, however, will not do, for ours must not only be very high, but very steep, so that the station we choose at the bottom may be almost under the station we are afterwards to occupy at the top.

Besides we are not going to climb a lofty lonely summit like tourists to spend an hour, but to spend weeks; so that we must have fire and shelter, and above all we must have dry air to get clear skies. First I thought of the Peak of Teneriffe, but afterwards some point in the territories of the United States seemed preferable, particularly as the Government offered to give the Expedition, through the Signal Service, and under the direction of its head, General Hazen, material help in transportation and a military escort, if needed, any where in its own dominions. No summit in the eastern part of the United States rises much over 7000 feet, and though the great Rocky Mountains reach double this, their tops are the home of fog and mist, so that the desired conditions, if met at all, could only be found on the other side of the Continent in Southern California, where the summits of the Sierra Nevadas rise precipitously out of the dry air of the great wastes in lonely peaks, which look eastward down from a height of nearly 15,000 feet upon the desert lands.

This remote region was, at the time I speak of, almost unexplored, and its highest peak, Mount Whitney, had been but once or twice ascended, but was represented to be all we desired could we once climb it. As there was great doubt whether our apparatus, weighing several thousand pounds, could possibly be taken to the top, and we had to travel 3000 miles even to get where the chief difficulties would begin, and make a desert journey of 150 miles after leaving the cars, it may be asked why we committed ourselves to such an immense journey to face such unknown risks of failure. The answer must be that mountains of easy ascent and 15,000 feet high are not to be found at our doors, and that these risks were involved in the nature of our novel experiment, so that we started out from no love of mere adventure, but from necessity, much into the unknown. The liberality of a citizen of Pittsburgh, to whose encouragement the enterprise was due, had furnished the costly and delicate apparatus for the expedition, and that of the trans-continental railroads, enabled us to take this precious freight along in a private car, which carried a kitchen, a steward, a cook, and an ample larder besides.

In this we crossed the entire continent from ocean to ocean, stopped at San Francisco for the military escort, went 300 miles south so as to get below the mountains, and then turned eastward again on to the desert, with the Sierras to the north of us, after a journey which would have been unalloyed pleasure except for the anticipation of what was coming as soon as we left our car. I do not indeed know that one feels the triumphs of civilisation over the opposing forces of Nature anywhere more than by the sharp contrasts which the marvellous luxury of recent railroad accommodation gives to the life of the desert. When one is in the centre of one of the great barren regions of the globe, and, after looking out from the windows of the flying train on its scorched wastes for lonely leagues of habitless desolation, turns to his well-furnished dinner-table, and the fruit and ices of his desert, he need not envy the heroes of Oriental story who were carried across dreadful solitudes in a single night on the backs of flying genii. Ours brought us over 3000 miles to the Mojave desert. It was growing hotter and hotter when the train stopped in the midst of vast sandwastes a little after midnight. Roused from our sleep, we stepped on to the brown sand and saw our luxurious car roll away in the distance, experiencing a transition from the conditions of civilisation to those almost of barbarism, as sharp as could well be imagined. We

[1] Lecture delivered at the Royal Institution, April 17, 1885, by S. P. Langley. Communicated by the author. Continued from p. 20.

commenced our slow toil northward with a thermometer at 110° in the shade, if any shade there be in the shadeless desert, which seemed to be chiefly inhabited by rattlesnakes of an ashen gray colour, and a peculiarly venomous bite. There is no water save at the rarest intervals, and the soil at a distance seems as though strewed with sheets of salt, which aids the delusive show of the mirage. These are, in fact, the ancient beds of dried-up salt lakes or dead seas, some of them being below the level of the ocean; and such a one on our right, though only about twenty miles wide, has earned the name of "Death Valley," from the number of human beings who have perished in it. Formerly an emigrant train, when emigrants crossed the Continent in caravans, had passed through the great Arizona deserts in safety until after their half-year's journey, their eyes were gladdened by the snowy peaks of the Sierras looking delusively near. The goal of their long toil seemed before them; only this one more valley lay between, and into this they descended, thinking to cross it in a day—but they never crossed it. Afterwards the long line of wagons was found with the skeletons of the animals in the harness, and by them those of men, women, and little children dead of thirst, and some relics of the tragedy remained at the time of our journey. I cite this as an indirect evidence of the phenomenal dryness of the region—a dryness which, so far, served our object, which was, in part, to get rid as much as possible of that water-vapour which is so well known to be a powerful absorber of the solar heat.

Everything has an end, and so had that journey, which finally brought us to the goal of our long travel, at the foot of the highest peak of the Sierras, Mount Whitney, which rose above us in tremendous precipices, that looked hopelessly insurmountable and wonderfully near. The whole savage mountain region in its slow rises from the west, and its descent to the desert plains in the east, is more like the chain called the Apennines, in the moon, than anything I know on the earth. The summits are jagged peaks like Alpine "needles," looking in the thin air so delusively near, that, coming on such a scene unprepared, one would almost say they were large grey stones a few fields off, with an occasional little white patch on the top, that might be a handkerchief or a sheet of paper dropped there. But the telescope showed that the seeming stones were of the height of many Snowdons piled on one another, and the white patches occasional snow-fields, looking how invitingly cool, from the torrid heat of the desert, where we were encamped by a little rivulet that ran down from some unseen ice-lake in that upper air. Here we pitched our tents and fell to work (for you remember we must have two stations, a low and a high one, to compare the results), and here we laboured three weeks in almost intolerable heat, the instruments having to be constantly swept clear of the red desert dust which the hot wind brought. Close by these tents a thermometer covered by a single sheet of glass, and surrounded by wool, rose to 237° in the sun, and sometimes in the tent, which was darkened for the study of separate rays, the heat was absolutely beyond human endurance. Finally, our apparatus was taken apart and packed in small pieces on the backs of mules, who were to carry it by a ten days' journey through the mountains to the other side of the rocky wall which, though only ten or twelve miles distant, arose miles above our heads; and, leaving these mule trains to go with the escort by this longer route, I started with a guide by a nearer way to those white gleams in the upper skies, that had daily tantalised us below in the desert with suggestions of delicious, unattainable cold. That desert sun had tanned our faces to a leather-like brown, and the change to the cooler air as we ascended was at first delightful. At an altitude of 5000 feet we came to a wretched band of nearly naked savages, crouched around their camp-fire, and at 6000 found the first scattered trees; and here the feeble suggestion of a path stopped, and we descended a ravine to the bed of a mountain stream, up which we forced our way, cutting through the fallen trees with an axe, fighting for every foot of advance, and finally passing what seemed impassable. It was interesting to speculate as to the fate of our siderostat mirrors and other precious freight, now somewhere on a similar road, but quite useless. We were committed now, and had to make the best of it—and, besides, I had begun to have my attention directed to a more personal subject. This was, that the colder it grew the more the sun burnt the skin—quite literally burnt, I may say, so that by the end of the third day my face and hands, case-hardened, as I thought, in the desert, began to look as if they had been seared with red-hot irons, here in the cold where the thermometer had fallen to freezing at night; and still as we ascended the paradoxical effect increased: the colder it grew about us, the hotter the sun blazed above.

We have all heard probably of this curious effect of burning in the midst of cold, and some of us may have experienced it in the Alps, where it may be aided by reflection from the snow, which we did not have about us at any time except in scattered patches, but here by the end of the fourth day my face was scarcely recognisable, and it almost seemed as though sunbeams up here were different things, and contained something which the air filters out before they reach us in our customary abodes. Radiation here is increased by the absence of water vapour too, and on the whole this intimate personal experience fell in almost too well with our anticipations that the air is an even more elaborate trap to catch the sunbeams than had been surmised, and that this effect of selective absorption and radiation was intimately connected with that change of the primal energies and primal colour of the sun which we had climbed towards it to study.

On the fourth day, after break-neck ascents and descents, we finally ascended by a ravine, down which leaped a cataract, till, at nightfall, we reached our upper camp, which was pitched by a little lake, one of the sources of the water-fall, at a height of about 12,000 feet, but where we seemed in the bottom of a valley, nearly surrounded as we were by an amphitheatre of rocky walls which rose perpendicularly to the height of Gibraltar from the sea, and cut off all view of the desert below or even of the peak above us.

The air was wonderfully clear, so that the sun set in a yellow rather than an orange sky, which was reflected in the little ice-rimmed lakes and from occasional snow-fields on the distant waste of lonely mountain summits on the west.

The mule train sent off before by another route, had not arrived when we got to the mountain camp, and we realised that we were far from the appliances of civilisation by our inability to learn about our chief apparatus, for here, without post or telegraph, we were as completely cut off from all knowledge of what might be going on with it in the next mountain ravine as a ship at sea is of the fate of a vessel that sailed before from the same port. During the enforced idleness we ascended the peak nearly 3000 feet above us, with our lighter apparatus, leaving the question of the ultimate use of the heavy ones to be settled later. There seemed little prospect of carrying it up, as we climbed where the granite walls had been split by the earthquakes, letting a stream of great rocks, like a stone river, flow down through the interstices by which we ascended, and, in fact, the heavier apparatus was not carried above the mountain camp.

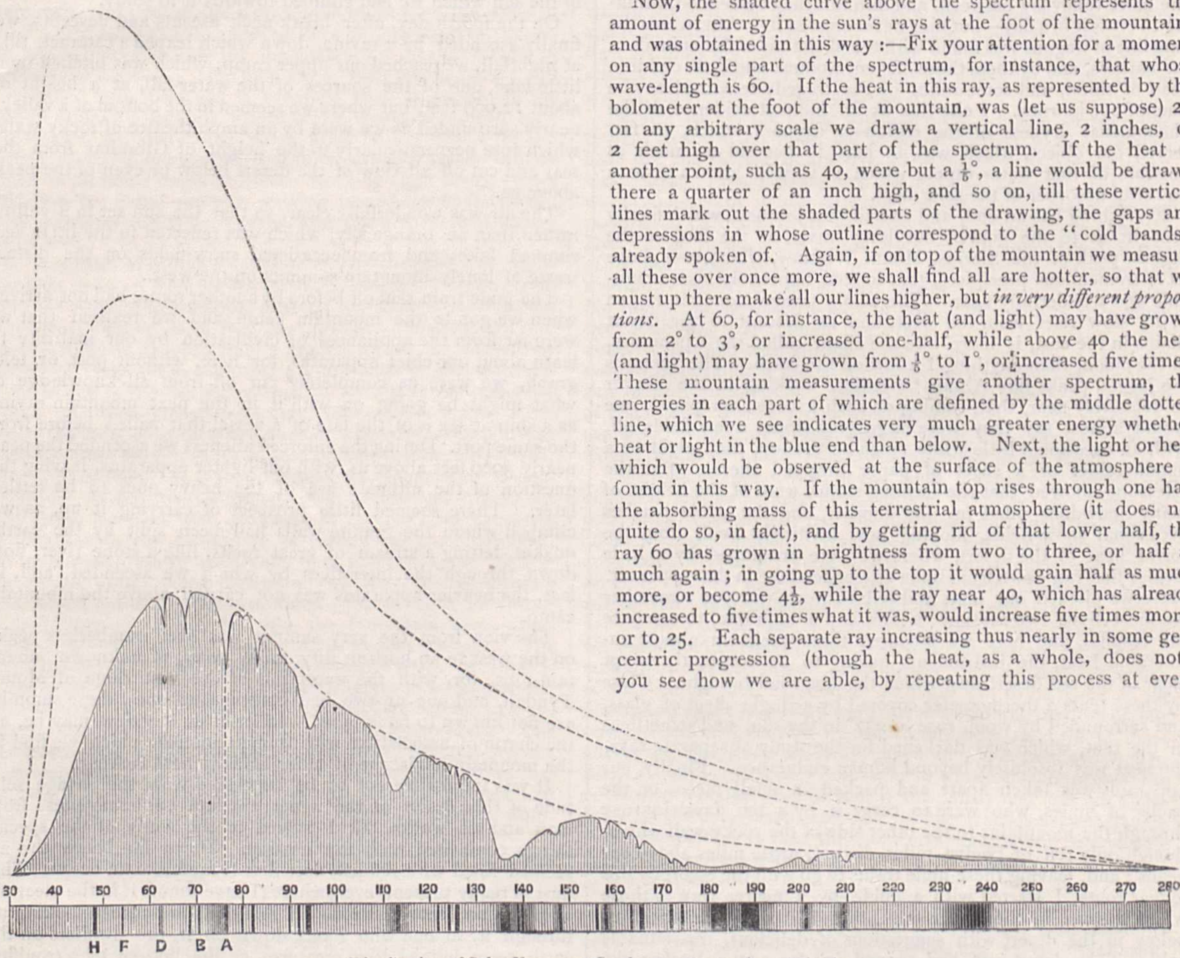
The view from the very summit was over numberless peaks on the west to an horizon fifty miles away, of unknown mountain-tops, for, with the exception of the vast ridge of Mount Tyndall, and one or two less conspicuous ones, these summits are not known to fame, and, wonderful as the view may be, all the charm of association with human interest which we find in the mountain landscape of older lands is here lacking.

It was impossible not to be impressed with the savage solitude of this desert of the upper air, and our remoteness from man and his works, but I turned to the study of the special things connected with my mission. Down far below the air seemed filled with reddish dust that looked like an ocean. This dust is really present everywhere (I have found it in the clear air of Etna), and though we do not realise its presence in looking up through it, to one who looks down on it, the dwellers on the earth seem indeed like creatures at the bottom of a troubled ocean. We had certainly risen towards the surface, for about us the air was of exquisite purity, and above us the sky was of such a deep violet blue, as I have never seen in Egypt or Sicily, and yet even this was not absolutely pure, for separately invisible, the existence of fine particles could yet be inferred from their action on the light near the sun's edge, so that even here we had not got absolutely above that dust shell which seems to encircle our whole planet. But we certainly felt ourselves not only in an upper, but a different region. We were on the ridge of the continent, and the winds which tore by had little in common with the air below, and were bearing past us (according to the geologists) dust which had once formed part of the soil of China, and been carried across the Pacific Ocean; for here we were lifted into the great encircling currents of the globe, and, "near to the sun in lonely lands," were in the right conditions to study the differences between his rays at the surface and at the bottom of that turbid sea where we had left the rest of mankind. We descended the peak and hailed with joy the first arrival of our mule trains with the requisite apparatus at the mountain camp, and found that it had suffered less than might be expected, considering the pathless character of the wilderness. We went to work to build piers and mount telescopes and siderostats, in the scene shown by the next illustration on the screen, taken from a sketch of my own, where these rocks in the immediate foreground rise to thrice the height of St. Paul's. We suffered from cold (the ice forming 3 inches deep in the tents at night) and from mountain sickness, but we were too busy to pay much attention to bodily comfort, and worked with desperate energy to utilise the remaining autumn days, which were all too short.

Here, as below, the sunlight entered a darkened tent, and was spread into a spectrum, which was explored throughout by the bolometer, measuring, on the same separate rays which we had studied below in the desert, all of which were different up here, all having grown stronger, but in very different proportions. On the screen is the spectrum as seen in the desert, drawn on a conventional scale, neither prismatic nor normal, but such that the intensity of the energy shall be the same in each part, as it is represented here by these equal perpendiculars in every colour. Fix your attention on these three as types, and you will see better what we found on the mountain, and what we inferred as to the state of things still higher up, at the surface of the aëreal sea.

You will obtain, perhaps, a clearer idea, however, from the following statement, where I use, not the exact figures used in calculation, but round numbers, to illustrate the process employed. I may premise that the visible spectrum extends from H (in the extreme blue) to A (in the deepest red), or from near 40 (the ray of forty one hundredth thousandths of a millimetre in wave-length) to near 80. All below 80, to the right, is the invisible infra-red spectrum.

Now, the shaded curve above the spectrum represents the amount of energy in the sun's rays at the foot of the mountain, and was obtained in this way:—Fix your attention for a moment on any single part of the spectrum, for instance, that whose wave-length is 60. If the heat in this ray, as represented by the bolometer at the foot of the mountain, was (let us suppose) 2°, on any arbitrary scale we draw a vertical line, 2 inches, or 2 feet high over that part of the spectrum. If the heat at another point, such as 40, were but a $\frac{1}{8}$°, a line would be drawn there a quarter of an inch high, and so on, till these vertical lines mark out the shaded parts of the drawing, the gaps and depressions in whose outline correspond to the "cold bands" already spoken of. Again, if on top of the mountain we measure all these over once more, we shall find all are hotter, so that we must up there make all our lines higher, but *in very different proportions*. At 60, for instance, the heat (and light) may have grown from 2° to 3°, or increased one-half, while above 40 the heat (and light) may have grown from $\frac{1}{8}$° to 1°, or increased five times. These mountain measurements give another spectrum, the energies in each part of which are defined by the middle dotted line, which we see indicates very much greater energy whether heat or light in the blue end than below. Next, the light or heat which would be observed at the surface of the atmosphere is found in this way. If the mountain top rises through one half the absorbing mass of this terrestrial atmosphere (it does not quite do so, in fact), and by getting rid of that lower half, the ray 60 has grown in brightness from two to three, or half as much again; in going up to the top it would gain half as much more, or become 4½, while the ray near 40, which has already increased to five times what it was, would increase five times more, or to 25. Each separate ray increasing thus nearly in some geocentric progression (though the heat, as a whole, does not), you see how we are able, by repeating this process at every



Distribution of Solar Energy at Sea-level and at various Altitudes.

point, to build up our outer or highest curve, which represents the light and heat at the surface of the atmosphere. These have grown out of all proportion at the blue end, as you see by the outer dotted curve, and now we have attained, by actual measurement, that evidence which we sought, and by thus reproducing the spectrum outside the atmosphere, and then recombining the colours by like methods to those you have seen on the screen, we finally get the true colour of the sun, which tends, broadly speaking, to blue.

It is so seldom that the physical investigator meets any novel fact quite unawares, or finds anything except that in the field where he is seeking, that he must count it an unusual experience to come unexpectedly on even the smallest discovery. This experience I had on one of the last days of work on the spectrum on the mountain. I was engaged in exploring that great invisible heat region, still but so partially known, or, rather, I was mapping in that great "dark continent" of the spectrum, and by the aid of the exquisite sky and the new instrument (the bolometer) found I could carry the survey further than any had been before. I substituted the prism for the grating, and measured on in that unknown region till I had passed the Ultima Thule of previous travellers, and finally came to what seemed the very end of the invisible heat spectrum beyond what had previously been known. This was in itself a return for much trouble, and I was about rising from my task when it occurred to me to advance the bolometer still farther, and I shall not forget the surprise and emotion with which I found new and yet unrecognised regions below,—a new invisible spectrum beyond the farthest limits of the old one.

I will anticipate here by saying that after we got down to lower earth again the explorations and mapping of this new region was continued. The amount of solar energy included in this new extension of the invisible region is much less than that of the visible spectrum, while its length upon the wave-length scale is equal to all that previously known, visible and invisible, as you will see better by this view, having the same thing on the normal as well as the prismatic scale. If it be asked which of these is correct, the answer is "both of them." Both rightly interpreted mean just the same thing, but in the lower one we can more conveniently compare the ground of the researches of others with these. These great gaps I was at first in doubt about, but more recent researches at Alleghany make it probable that they are caused by absorption in our own atmosphere, and not in that of the sun.

We would gladly have stayed longer, in spite of physical discomfort, but the formidable descent and the ensuing desert journey were before us, and certainly the reign of perpetual winter around us grew as hard to bear as the heats of the desert summer had been. On September 10 we sent our instruments and the escort back by the former route, and, ourselves unencumbered, started on the adventurous descent of the eastern precipices by a downward climb, which, if successful, would carry us to the plains in a single day. I at least shall never forget that day, nor the scenery of more than Alpine grandeur which we passed in our descent, after first climbing by frozen lakes in the northern shadow of the great peak, till we crossed the eastern ridges, through a door so narrow that only one could pass it at a time, by clinging with hands and feet as he swung round the shoulder of the rocks—to find that he had passed in a single minute from the view of winter to summer, the prospect of the snowy peaks behind shut out, and instantly exchanged for that below of the glowing valley and the little oasis where the tents of the lower camp were still pitched, the tents themselves invisible, but the oasis looking like a green scarf dropped on the broad floor of the desert. We climbed still downward by scenery unique in my recollection. This view of the ravine on the screen is little more than a memorandum made by one of the party in a few minutes' halt part-way down, as we followed the ice-stream between the tremendous walls of the defile which rose 2000 feet, and between which we still descended, till, toward night, the ice-brook had grown into a mountain torrent, and, looking up the long vista of our day's descent, we saw it terminated by the Peak of Whitney, once more lonely in the fading light of the upper sky.

This site, in some respects unequalled for a physical observatory, is likely, I am glad to say, to be utilised, the President of the United States having, on the proper representation of its value to science, ordered the reservation for such purposes of an area of 100 square miles about and inclusive of Mount Whitney.

There is little more to add about the journey back to civilisation, where we began to gather the results of our observation, and to reduce them—to smelt, so to speak, the metal from the ore we had brought home—a slow but necessary process, which has occupied a large part of two years.

The results stated in the broadest way mean that the sun is blue—but mean a great deal more than that; this blueness in itself being perhaps a curious fact only, but in what it implies, of practical moment.

We deduce in connection with it a new value of the solar heat, so far altering the old estimates that we now find it capable of melting a shell of ice sixty yards thick annually over the whole earth, or, what may seem more intelligible on its practical bearings, of exerting over one horse power for each square yard of the normally exposed surface. We have studied the distribution of this heat in a spectrum whose limits on the normal scale our explorations have carried to an extent of rather more than twice what was previously known, and we have found that the total loss by absorption from atmosphere is nearly double what has been heretofore supposed.

We have found it probable that the human race owes its existence and preservation even more to the heatstoring action of the atmosphere than has been believed.

The direct determination of the effect of water-vapour in this did not come within our scope; but that the importance of the blanketing action of our atmospheric constituents has been in no way overstated, may be inferred when I add that we have found by our experiments that if the planet were allowed to radiate freely into space without any protecting veil, its sunlit surface would probably fall, even in the tropics, below the temperature of freezing mercury.

I will not go on enumerating the results of these investigations, but they all flow from the fact, which they in turn confirm, that this apparently limpid sea above our heads, and about us, is carrying on a wonderfully intricate work on the sunbeam, and on the heat returned from the soil, picking out selected parts in hundreds of places, sorting out incessantly at a task which would keep the sorting demons of Maxwell busy, and as one result, changing the sunbeam on its way down to us in the way we have seen.

I have alluded to the practical utilities of these researches, but practical or not, I hope we may feel that such facts as we have been considering about sunlight and the earth's atmosphere may be stones useful in the future edifice of science, and that if not in our own hands then in those of others, when our day is over, they may find the best justification for the trouble of their search, in the fact that they prove of some use to man.

May I add an expression of my personal gratification in the opportunity with which you have honoured me of bringing these researches before the Royal Institution, and of my thanks for the kindness with which you have associated yourselves for an hour, in retrospect at least, with that climb toward the stars which we have made together, to find, from light in its fullness, what unsuspected agencies are at work to produce for us the light of common day.

ZOOLOGICAL RESEARCH[1]

THE *Vettor Pisani* is soon expected in our port, on her return from a long voyage of no little scientific importance. We think we cannot better hail her arrival than by publishing that portion of Prof. Dohrn's report in which he speaks of the scientific mission fulfilled by this vessel—a mission which, besides meeting with a success far surpassing the highest expectations, has redounded not a little to the benefit of our "Stazione Zoologica."

The time has now arrived, writes the illustrious Professor, for me to speak of an event which took place towards the end of 1881, and which has since borne no inconsiderable fruit. And this, in its turn, takes me back to a conversation which I had in 1878 with the Italian Minister of Marine. I had already proposed that, instead of sending out a young naturalist on board the frigates which sail around the world, a young naval officer should be sent to the "Stazione Zoologica," where, in about four months, he might pick up so much knowledge as would enable him to collect and preserve specimens of marine animals. Owing to a change in the Ministry, my proposition, though accepted in the main, was forgotten; and I only succeeded in getting it put into execution in 1881.

On December 27, 1881, a young naval lieutenant, Signor Gaetano Chierchia, a Neapolitan by birth, introduced himself to me with these words: "I have been sent by the Ministry to learn under your direction at the 'Stazione Zoologica' how to collect and preserve specimens of marine animals. I present myself accordingly, and beg to be allowed to begin work at once." These few words, modest, yet full of energy, made a deep impression on me; for they not only marked the beginning of a new epoch in the active life of the Zoological Station, but also promised a more intimate connection between it and the officers of the Italian navy—an intimacy to which I had looked forward from the very day in which I conceived the idea of the future floating Zoological Station.

With the same modest energy which characterised his first interview with me, Signor Chierchia continued for four months his studies under the special direction of the Curator, Salvatore Lobianco; and all the employes and naturalists of the Zoological Station were astounded at the rapid progress he made in a field so entirely new to him. And when the moment came for establishing my laboratory on board the corvette *Vettor Pisani* (which came most appositely to Naples), and there had been put on board all the fishing apparatus, chemical reagents, alcohol, glass vessels, &c., we accompanied him as a dear friend, and looked forward to results which should mark a distinct advance in the culture of our science. And our expectations, far from being disappointed, were widely surpassed. After only five months there arrived the first consignment—the product of deep-sea work, of dredging and coast-fishery along the shores of Gibraltar, Brazil, and Montevideo. The whole collection was in excellent preservation, carefully labelled and packed, and accompanied by a minute report as to the place and circumstances of each find. And I do not for a moment hesitate to affirm that never has so important a collection of oceanic

[1] From the *Pungolo*, April 23, 1885. Naples, Italy.

animals before reached Europe. Scarce four months had elapsed when there arrived a second consignment, still more extensive than the first, and the result of collections made during a voyage from Montevideo to Cape Horn, around the islands of the Patagonian archipelago (a course which the obliging commander of the corvette, Capt. Palumbo, had followed at my especial desire).

This collection, too, contained most interesting specimens, among which are especially worthy of mention a vast number of tubes filled with the produce of deep-sea fishing (pelagic products). In the same way there have come to hand two other consignments from the Peruvian coast, from the Galapagos Isles, from the coast of Panama; and also some most interesting animals found in small pools and rivers in Peru. Among these, of special importance are two complete series of embryonic forms—first, of a Peruvian ray, and secondly of a toad, which Lieut. Chierchia, at my desire, and to aid my studies in the history of the origin of vertebrate animals, reared with great care, and kept in an excellent state of preservation. In this he was assisted by Dionigi Franzese, who had been trained in the Zoological Station, and had embarked as a sailor on board the *Vettor Pisani*. The *Vettor Pisani* continued its course from Peru across the ocean towards the Philippine Islands and China, and we may look for a new shipment of specimens. In this we have a striking confirmation of my opinion that zoology might receive material aid in its work from naval officers trained for the purpose, rather than from the employment of young naturalists. The example thus presented has been followed by other individuals, and already three more naval cfficers, Lieuts. Cercone, Orsini, and Colombo, have been trained in the same way at the Zoological Station. It is a matter for regret that the first-mentioned has made but one voyage, a short one towards the West Indies, in which violent gales were encountered. The result of his researches may be seen at the "Station." Lieut. Orsini is in the colony of Assab, at the mouth of the Red Sea, and has despatched thence a valuable and well-preserved collection. Lieut. Colombo is the only one of the three whose studies have been of a more extensive and continuous nature, and for them opportunitp has on several occasions been given him by the Minister of Marine. On board the vessel attached to the Hydrographical Survey, commanded by Capt. Magnaghi (equally well known as a man of science and an officer), he has made excellent collections in the Mediterranean itself, and has now returned once more to the "Stazione" to further prosecute his studies there.

From the very first it has been my intention to invite the naval services of other nations to join us in this line of research, and accordingly, in the autumn of 1882, I proposed to the German Minister of Marine that he should send a naval officer or surgeon to Naples to receive a training such as I have indicated. The head of the Admiralty then, Herr Von Stosch, accepted my proposal, and sent a naval surgeon, Dr. Sander, for four months to Naples. In the autumn of the following year Dr. Sander embarked on board the frigate *Prinz Adalbert* for Eastern Asia. We still await its arrival, and hope for valuable results from the expedition.

A preliminary conversation which I had last summer at St. Petersburg with the head of the staff of the Russian Marine Admiral Tchichatchoff, leaves room for hope that Russia too will consent to join us in the matter, and that so in the course of a few years we may look for a still further and wider development of this connection between the "Stazione Zoologica" and the various marine war services of the world. From such a connection great advantages would accrue, not only to science in general, but also to the naturalists of those several countries, which in their turn would be the richer for the collections made by their respective navies.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—There will be an examination in certain branches of natural science for minor scholarships at Downing College, on Tuesday, June 2 next, and following days. Persons who have not entered at any college in the University are eligible to the minor scholarships, which will be of the value of from 40*l*. to 70*l*. per annum, and tenable until their holders are of standing to compete for a Foundation Scholarship. Further information will be given by Dr. Perkins or the Rev. J. C. Saunders, tutors of the College.

SCIENTIFIC SERIALS

Annalen der Physik und Chimie, No. 3, March, 1885.—Prof. R. W. Bunsen, on capillary absorption of gas. Shows a direct dependence between the capillary pressures and the volumes of gas absorbed. This discovery, doubtless, has important relations in physiological processes. Prof. G. Quincke, electric researches (No. 10), on the measurement of magnetic forces by hydrostatic pressure. The author adopts the formula

$$p = \mathfrak{K}_1 H_1^2/8\pi,$$

where H_1 is the intensity of the magnetic field, and $\mathfrak{K}_1$ a "dimagnetisation constant" analogous to the dielectric constant in the analogous formula for the pressure in the electric field. Observations have been made on many magnetic liquids to ascertain the numerical values of this constant.—O. Lummer, on the theory and form of some newly-observed interference curves. These relate to certain phenomena of thick plates.—C. Christiansen, researches on the optical properties of finely-divided bodies.—W. Möller, on Wild's photometer.—E. and L. Natanson, on the dissociation of the vapour of hyponitrous acid.—M. Thiesen, researches on the equation of state; a discussion of the laws of gaseous pressure.—Prof. L. Pfaundler, on the action of strongly-compressed carbonic acid on glass under the influence of light. W. Voigt, reply to Prof. Wüllner's remarks respecting Jamin's observations on metallic reflection.

Journal of the Russian Chemical and Physical Society, vol. xvi. fasc. 9.—On the oxidation of acetones (second memoir), by G. Wagner. The behaviour of ketones to chromic acid mixture are described, and the general laws of their oxidation are deduced.—On the action of the iodides of allyl and zinc on epichloridrine, by M. Lopatkin.—On isopropyl allyl dimethyl carbinol, by M. Kononovitch.—On the relation between diamagnetism and the temperature of fusion of bodies, by P. Bachmetieff. The absolute heat of fusion being represented by the equation $W = (t + 273) cs + bs$, where c is the specific heat, b the latent heat of fusion, and s the specific weight of the body; then, the series $(t + 273) s$ being taken according to the figures of Regnault and M. Carnelley—it appears to be in reverse order to Faraday's diamagnetic series, the bodies appearing in the following series which culminates with Bi and Sb:—K, Na, P, Br, S, Mg, Ca, I, Al, In, Sn, Bi, Sb, Zn, Cd, Pb, Ag, Cu, Pd, An, Ur, W, Pt, Ir, Os.—On the atmospheres of planets, the temperature of the sun in cosmic space, and the earth's atmosphere, by E. Rogovsky.—On some new demonstrations of the conditions for a minimum of deviation of a prism, by N. Poltschikoff.—A note in answer to M. Stankevitch, by the same.—Studies in cosmical physics: III. the heating of meteorites when falling on to the earth, by Th. Schwedoff.—Answering to an objection made at the British Association of 1882 by Sir William Thomson to his cosmic theory of hail, the author discusses the heat which a meteoric stone may receive when piercing our atmosphere. He shows by several examples, by our experience of meteorites, and by M. Daubrée's testimony, that they never have been brought to fusion. The meteorite must be compared to a fire syringe (*Briquet pneumatique*), which condensates the air and raises its temperature, remaining nearly cold itself when its conducting power is feeble. The *vis viva* of the meteorite is spent in piercing the layers of air—that is, in bringing them into motion (like a bullet which would spend its force in piercing 1000 sheets of paper before reaching the target), and to admit that its *vis viva* be transformed into heat, would be to forget the force spent in piercing the air.—Index to the sixteenth volume.

Bulletin de la Société des Naturalistes de Moscou, 1884, No. 2.—Materials for the flora of Central Asia, by Prof. N. Sorokine. After having twice visited several parts of Russian Turkistan and the delta of the Amu-daria, M. Sorokine returned with a rich collection of phenogams, which proved this part of the Central Asian flora to be very rich, original, and interesting. The department of Gasteromycetes alone offered the greatest interest, on account of its containing forms peculiar to Algeria, Egypt, Cuba, and so on. There are even several indices which would seem to indicate that the Aral-Caspian region has been a centre of dispersion of several forms, whose sporæ were transported by winds across the Red Sea to Africa, and thence to Spain and France. The whole work of the author could not be published at once, on account of its numerous plates. The description of the Chytridiaceæ has appeared in the *Archives botaniques du Nord de la France*, the remainder will appear in the Moscow *Bulletin*, which contains now the descriptions, with five plates, of the Hypodermei and the Gasteromycetes.—Plantæ Raddeanæ Monopetalæ, by Ferd. von Herder (continued).—Solution of a problem of the theory of comets, by N. Joukovski (Russian). The geocentric position of a particle of the tail which has left the nucleus since a given time under the action of a given repulsive force, to determine the displacement of the particle for a given change in the repulsive force—such is the problem treated. —Analyses of salt and mud from a volcano of Trans-Caucasia. —An essay on the solution of the geodetical problem, by Th. Sloudsky (in French). The already-known formulæ already give the possibility of embodying all anomalies less than 30″ in latitude and less than 15 oscillations of the pendulum in twenty-fours against the calculated ones. The author tries, however, to give a more theoretical formula, which might at the same time embody larger anomalies.—List of the herbaria of the Moscow University and of the Society of Naturalists, by J. Goroshankin.—Studies on the averages of the relative moistness, by Dr. K. Weihrauch (continued; in German).—Necrology and Annual Report.

Rendiconti del R. Istituto Lombardo, March 26.—History of the first century (1783–1883) of the Reale Istituto, by G. B. Venturi.—On the persistence of the thymus gland in children and adults, by Prof. Giovanni Zoja.—Account of a successful operation performed on a young girl for the purpose of closing an open sore on the left cheek produced by a severe attack of typhoid fever.—Further notes on conformable representations in higher mathematical analysis, by Prof. Giulio Ascoli.—Meteorological observations made at the Royal Observatory of Brera, Milan, during the month of March.

Rivista Scientifico-Industriale, March 31.—A new explanation of the red crepuscular lights that have been attributed to the Krakatoa eruption, by Prof. Carlo Marangoni.—Variations in the electric resistance of solid and pure metallic wires according to the temperature (continued), by Prof. Angelo Emo.—A visitation of caterpillars (*Lithosia caniola*, Hl.) in Florence during the present season, by P. Bargagli.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, April 23.—"On the Changes produced by Magnetisation in the Length of Rods of Iron, Steel, and Nickel." By Shelford Bidwell, M.A., LL.B.

The earliest systematic experiments on the effects produced by magnetisation upon the length of iron and steel bars are those of Joule, an account of which is published in the *Phil. Mag.* of 1847. Joule's experiments have many times been repeated, and his general results confirmed. In particular, Prof. A. M. Mayer carried out a series of very careful observations with apparatus of elaborate construction and great delicacy. The conclusions at which he arrived were in accord with those of Joule, so far as regards iron; in the case of steel there was some apparent discrepancy, which, however, might to a great extent be accounted for by differences in the quality of the metal used and in the manner of conducting the experiments. In 1882 Prof. Barrett published in NATURE an account of some experiments which he had made, not only on iron but also on bars of nickel and cobalt, with the view of ascertaining the effect of magnetisation upon their length.

The knowledge on the subject up to the present time may be summarised as follows:—

(1) Magnetisation causes in iron bars an elongation, the amount of which varies up to a certain point as the square of the magnetising force. When the saturation-point is approached the elongation is less than this law would require. The effect is greater in proportion to the softness of the metal.

(2) When a rod or wire of iron is stretched by a weight, the elongating effect of magnetisation is diminished; and if the ratio of the weight to the section of the wire exceeds a certain limit, magnetisation causes retraction instead of elongation.

(3) Soft steel behaves like iron, but the elongation for a given magnetising force is smaller (Joule). Hard steel is slightly elongated, both when the magnetising current is made and when it is interrupted, provided that the strength of the successive currents is gradually increased (Joule). The first application of the magnetising force causes elongation of a steel bar if it is tempered blue, and retraction if it is tempered yellow: subsequent applications of the *same* external magnetising force cause temporary retraction, whether the temper of the steel is blue or yellow (Mayer).

(4) The lengh of a nickel bar is diminished by magnetisation, the maximum retraction being twice as great as the maximum elongation of iron (Barrett).

In order that the results of Joule and Mayer might be comparable with those obtained by the author, he made an attempt to estimate the magnetising forces with which they worked. From data contained in their paper, it was calculated that the strongest magnetising force used by Joule was about 126 units, while the strongest used by Mayer did not on the highest probable estimate exceed 118 units. In the author's experiments the magnetising force was carried up to about 312 units. The metal rods, too, were much smaller than any which had been before used for the purpose, ranging in diameter from 1·40 to 6·25 mm. Their length was in every case 100 mm., and the apparatus was capable of measuring with tolerable certainty an elongation or retraction equal to a ten-millionth part of this length.

By using thinner iron rods and greater magnetising forces than those previously employed, the following curious and interesting fact was established. If the magnetisation be carried beyond a certain critical point, the consequent elongation, instead of remaining stationary at a maximum, becomes diminished, the diminution increasing with the magnetising force. If the force is sufficiently increased, a point is arrived at where the original length of the rod is totally unaffected by magnetisation; and if the magnetisation be carried still further, the original length of the rod will be reduced. It also appeared that the position of the critical point in steel depended in a very remarkable manner upon the hardness or temper of the metal; considerable light is thus thrown on the apparently anomalous results obtained by Joule and by Mayer. Further experiments disclosed strong reason for believing that the value of the critical magnetising force in a thin iron rod was greatly reduced by stretching; this would explain the fact that Joule obtained opposite effects with stretched and unstretched wires.

By ascertaining the relative values of the temporary moments induced by gradually increasing external magnetising forces, an attempt was made to connect the point of maximum elongation with a definite phase of the magnetisation of the several rods in which the elongation had been observed.

Though more experiments must be made before it is possible to generalise from them with perfect safety, the results so far obtained by the author indicate the laws given below. The elongations and magnetisations referred to are temporary only; before the beginning of an experiment the rod was permanently magnetised by passing through the magnetising coil a current equal to the strongest subsequently used. In iron the greatest elongation due to permanent magnetisation was generally found to be about one-third of the total elongation, while in nickel the permanent retraction amounted only to about one-twenty-fifth part of the whole.

I. IRON

(1) The length of an iron rod is increased by magnetisation up to a certain critical value of the magnetising force, when a maximum elongation is reached.

(2) If the critical value of the magnetising force is exceeded, the elongation is diminished until with a sufficiently powerful magnetising force the original length of the rod is unaffected, and, if the force is still further increased, the rod undergoes retraction. Shortly after the critical point is passed, the elongation diminishes in proportion as the magnetising force increases. The greatest actual retraction hitherto observed was equal to about half the maximum elongation, but there was no indication of a limit, and a stronger magnetising force would have produced further retraction.

(3) The value of the external magnetising force corresponding to maximum elongation is for a given rod approximately equal to twice its value at the "turning point."

Definition.—The turning point in the magnetisation of an iron bar is reached when the temporary moment begins to increase less rapidly than the external magnetising force.

(4) The external force corresponding to the point of maximum elongation increases (when the quality of the iron is the same) with the diameter of the rod. So also does its value at the turning point.

(5) The amount of the maximum elongation appears to vary inversely as the square root of the diameter of the rod, when the quality of the iron is the same.

(6) The turning point, and therefore presumably the point of maximum elongation, occurs with a smaller magnetising force when the rod is stretched than when it is unstretched.

II. STEEL

(7) In soft steel magnetisation produces elongation, which, as in the case of iron, increases up to a certain value of the magnetising force, and afterwards diminishes. The maximum elongation is less than in iron, and the rate of diminution after the maximum is passed is also less.

(8) The critical value of the magnetising force for a steel rod diminishes with increasing hardness up to a certain point, corresponding to a yellow temper; after which it increases, and with very hard steel becomes very high. There is therefore a critical degree of hardness for which the critical magnetising force is a minimum; in steel of a yellow temper the value of the critical magnetising force is lower than in steel which is either softer or harder.

(9) In soft steel a strong magnetising force subsequently diminished may cause a greater temporary elongation than the diminished force is capable of producing if applied in the first place.

(10) A temporary elongation when once produced in soft steel may be maintained by a magnetising force which is itself too small to originate any perceptible elongation.

III. NICKEL

(11) Nickel continues to retract with magnetising forces far exceeding those which produce the maximum elongation of iron. The greatest observed retraction of nickel is more than three times the maximum observed elongation of iron, and the limit has not yet been reached.

(12) A nickel wire stretched by a weight undergoes retraction when magnetised.

Anthropological Institute, April 28.—Francis Galton, F.R.S., President, in the chair.—Mr. A. L. Lewis read a paper on the past and present condition of certain rude stone monuments in Westmoreland. The highest point of the railway between Lancaster and Carlisle is a little to the south of the village and station of Shap, in Westmoreland, where there were formerly some very extensive rude stone monuments, now unfortunately almost entirely destroyed. Allusion is made to them by Camden and Dr. Stukeley, and a circle is said to have been destroyed when the railway was made; some remains of this circle may be seen from the train, but only a few stones are left on the spot. The most interesting monument now remaining in the vicinity of Shap is situated at a place called Gunnerskeld, two or three miles to the north, and consists of two irregular, concentric, slightly oval rings, about 50 and 100 feet in diameter respectively, the longest diameters being from north to south.—A paper by Admiral F. S. Tremlett on quadrilateral constructions near Carnac was read. These inclosures were explored by the late Mr. James Miln; in each case the boundary walls are formed of coarse, undressed stones, put together without any kind of cement, and having built up in them a series of small menhirs; they also contained beehive structures for cremation, reddened and become friable from the effects of great heat. It would appear that the cremation had been perfect, as not a particle of calcined bone was found in either of the inclosures.—A paper by M. Jean L'Heureux on the Kekip-Sesoators, or ancient sacrificial stone of the North-West Territory of Canada, was read. Elevated two hundred feet above the level of the surrounding plain, Kekip-Sesoators, the Hill of the Blood Sacrifice, stands like a huge pyramidal mound commanding an extensive view of both Red Deer and Bow River Valleys. A natural platform of about one hundred feet crowns its summit; at the north end of the platform, resting upon the soil, is the Sesoators, a rough boulder of fine-grained quartzose, fifteen inches high and about fourteen in diameter; upon its surface are sculptured half an inch deep the crescent figure of the moon with a shining star over it. Two small concave basins about two inches in diameter are hollowed into the stone, one in the centre of the star, the other about seven inches from it in a straight line; around them are traced various hieroglyphic signs, and all over the surface are numerous small circlets, which remind one of the sacrificial stone of Mexico. Here at a time of private or public necessity, when extraordinary blessings are sought, comes a solitary warrior, himself the priest and the victim; from the time of sunset he sits in solemn vigil gazing in the far east for the coming of the star-god of his ancestors; and when the first ray of the morning star lights the distant horizon, he lays a finger of his left hand on the top of the stone and cuts it off, leaving the blood to flow into the basin. He then presents the bleeding finger to the morning star, and, leaving it in the basin of the star-like figure, retraces his steps towards the lake at the foot of the hill, where he dresses his wound, and at sunrise enters his own village, where he is received with triumphant honours. Amongst the Blackfeet these self-inflicted wounds ranked equal to those received in battle, and are always mentioned first in the public recital of the warrior's great deeds in the national feast of Ocan.

Geologists' Association, May 1.—William Topley, F.G.S., President, in the chair.—A paper was read on wingless birds—recent and fossil—and on birds as a class, by Dr. Henry Woodward, F.R.S. The author prefaced his remarks on wingless birds by giving first a brief account of the characters of birds as a class. He described the peculiarities of the skull and the fore- and hind-limb, the cervical, thoracic, sacral, and caudal vertebræ, with the shoulder-girdle and pelvis. He compared the highly-specialised fore-limbs in existing birds with that of *Archæopteryx*, the former, with three rudimentary digits, having the metacarpal bones anchylosed together; the latter, with three free digits in each manus, armed with claws. He compared the bones of the hind-limb of an adult *Iguanodon* with those of a young *Dinornis*, and showed how closely the characters observable in the former are repeated in the latter. Many interesting analogies were also pointed out in the form of the ilium, ischium, and pubis in *Struthio* and Iguanodon. The *Archæopteryx*, although possessing so many points of divergence from the Avian type, was shown to be the earliest known ancestor of the great division of *Carinatæ* (birds with a keel to the sternum) to which nearly all modern (flying) birds belong. For the *Ratitæ* (or boat-breasted birds), to which division the Ostrich, Rhea, Emu, Cassowary, Apteryx, Dinornis, Æpyornis, &c., belong, an earlier ancestor must be sought. The author contended that, on the evidence before us we have a right to claim a higher antiquity for the *Ratitæ* than for the *Carinatæ*, not only from the present wide distribution of this division of the class, but also from the fossil evidence which embraces for the Struthious order even a still larger geographical area than that shown from existing species. And if we are at liberty to add to this the evidence of the footprints of bipedal animals in the Trias (which agree with the tracks of birds in the number of digits in the foot), then these footprints may be taken as further evidence of their priority in geological time. For the primitive forms of this class we must evidently look to the palæozoic rocks.

Zoological Society, May 5.—Prof. Alfred Newton, F.R.S., Vice-President, in the chair.—A communication was read from Mr. Jean Stolzmann, containing observations on the theory of sexual dimorphism.—Mr. J. Bland Sutton, F.Z.S., read a paper on hypertrophy and its value in evolution, in which he attempted to show that material changes in structure might be the result of what was originally a pathological condition.—Mr. E. T. Newton, F.Z.S., read a paper on the remains of a gigantic species of bird (*Gastornis klasseni*), which had been obtained by Mr. H. M. Klaassen from the "Woolwich and Reading Beds" of the lower Eocene series. The author observed that these fossils proved that in early Eocene times England was inhabited by a race of birds which equalled in their proportions some of the more massive forms of the New Zealand moas.—A communication was read from Mr. R. B. Sharpe, F.Z.S., containing the description of a new species of Hornbill from the Island of Palawan, which he proposed to name *Anthracoceros lemprieri*.—Prof. E. Ray Lankester, F.R.S., read some notes on the right cardiac valve of the specimens of *Apteryx* dissected by Sir Richard Owen in 1841.—A communication was read from Lieut.-Col. C. Swinhoe, F.Z.S., being the third of his series of papers on the Lepidoptera of Bombay and the Deccan. The present paper treated of the second portion of the Heterocera.—A communication was read from Dr. St. George Mivart, F.R.S., containing a correction of a statement concerning the structure of *Viverricula*, contained in a former paper.

MANCHESTER

Literary and Philosophical Society, Feb. 16.—Thomas Alcock, M.D., in the chair.—A proposed revision of the species and varieties of the sub-genus Cylinder (Montfort) of Conus (L.), by Mr. J. Cosmo Melvill, M.A., F.L.S.

March 10.—Prof. W. C. Williamson, LL.D., F.R.S., President, in the chair.—On making sea-water potable, by Thomas Kay, President of the Stockport Natural History Society. Communicated by F. J. Faraday, F.L.S.

March 16.—Thomas Alcock, M.D., in the chair.—On the breeding of the Reed Warbler (*Acrocephalus arundinaceus*) in

Cheshire, by Francis Nicholson, F.Z.S.—On *Lagena crenata*, by Dr. Alcock.—The Post-Glacial Shell-beds at Uddevalla, Sweden, by Mark Stirrup, F.G.S.

PARIS

Academy of Sciences, May 4.—M. Bouley, President, in the chair.—Summary of the meteorological observations made during the year at four stations on the Upper Rhine and in the Vosges district (Schlucht, Munster, Colmar, and Thann), by M. G. A. Hirn. Tables are given of the actinometric observations, of the prevailing winds with their mean and greatest velocities, of the mean and extreme temperature, of the atmospheric pressure and rainfall for each month of the year at all these stations. During the period in question the most salient phenomena were the severe frosts of the month of April, which proved very destructive, especially to the vines, and the sudden and violent hurricane of July 16, which swept with tremendous rapidity over the Vosges, almost unaccompanied by rain, and with very little thunder.—Remarks on the influence exercised by seismatic disturbances on Phylloxera, by M. S. Villalongue. The case is mentioned of a vineyard near Malaga affected by this parasite and supposed to have been destroyed, which nevertheless broke into leaf with fresh vigour after the earthquakes which recently devastated the southern provinces of Spain.—Application of the general laws of the theory of the partition of numbers to numerical functions, by M. N. Bougaieff.—On an easy method of controlling the velocity of electric motor currents (one illustration), by M. Marcel Deprez.—Note on the suppression of the nitrous vapours of the Bunsen pile, and on a new pile which becomes depolarised in the atmosphere, by M. A. d'Arsonval.—On a new variety in the anomalous group of Cyclocephalians, by M. A. Lavocat. This variety, for which the term "ophthalmocephalous" is proposed, is illustrated by the recent case of a still-born lamb, in which nose and eyes were entirely absent, and, in place of the orbits, showing in the median plane a cavity formed by the union of the two temporal fosses. At the same time the tongue, the ears, and all the parts corresponding with these organs were in the normal state.—On the system of canalisation present in the cellules of plants, and on the continuity of the protoplasm in vegetation, by M. L. Olivier. In opposition to the generally accepted views, the author infers from his microscopic studies that in the thickness of the membranous walls of plants there is a highly developed network of canals, by means of which the continuity of the protoplasm is effected throughout the cellular system.—An attempt to determine the relative age of the Grand'-Combe Carboniferous deposits by means of their fossil vegetation, by M. R. Zeiller.

ROME

Reale Accademia dei Lincei, January 4.—On pleasurable and periodic respiration. Prof. Mosso communicated an abstract of a memoir in which he expounds various observations made by him on respiration. By means of tracings taken from a man in a state of complete rest, he has recognised that in the respiratory movements periods of greater or less depth in breathing alternate with one another, and that such periods are observable in all animals, especially during sleep. The author has likewise ascertained that man breathes a greater quantity of air than is necessary, and it is that respiration that he calls pleasurable (*respirazione di lusso*). It is in consequence of this excess in the ordinary breathing that a man does not increase the extent of his respiratory movements in ascending a mountain or in undergoing a change of atmospheric pressure. Prof. Mosso has determined the limit of this pleasurable respiration which is manifested in sleep when no cause would render it necessary. According to the pauses which the periodic respiration undergoes, the author divides it into *remittent* (*remittente*) and *intermittent* (*intermittente*). These pauses do not depend on the movements of the blood-vessels nor on psychical factors. It is a recognised fact that respiration has not a single centre, but that various muscles subserve this function independently of each other. Prof. Mosso concludes that not only is periodic respiration a normal physiological phenomenon, but that it is nothing else than the respiration of Cheyne and Stokes, which has hitherto been looked upon as a morbid condition. The author closes his own paper with a critical review of the theories of the nature of the movements of respiration.—Other communications:—Dr. Piccini described the analyses and the methods of preparation of certain fluor salts of titanium, corresponding to the sesquioxide, which had been obtained by him.—Drs. Ciamician and Silber described the results of the action of nitric acid on pyril-methyl-ketone.—Drs. Ciamician and Magnagui communicated a first note on the action of carbonyl chloride on the potassic compound of pyrrol.—The sanction of the Academy was likewise given to the printing, in the *Atti Academici*, of a memoir by Prof. Belloni, in which the author describes the olfactory and olfactory-auditory apparatus of the teleosteans (the *nuclei rotundi* of Fritsch).—The Secretary, Signor Blaserna, read a communication by Signor Laure, in which the author insists on the necessity of paying great attention to the barometric variations in cases of earthquakes and volcanic eruptions.

January 18.—Articles belonging to the Stone Age discovered in the commune of Breonio Veronese. Prof. Pigorini observed that of all the localities containing remains of the Stone Age Breonio Veronese is the most interesting and the richest, on account of its numerous caves in which primitive man has left his traces. The numerous flint implements found in that locality were attributed by ancient writers to the Cimbri. Some of these have common forms, but others are of very singular shape, and the use of the latter cannot be determined. The importance of such articles, which are found also in the sepulchres of the Stone Age near the caves, but which are there reproduced almost in miniature, consists in the fact that articles of the same form are found among the remains belonging to the prehistoric American stations, which leads us to surmise the existence of a bond of connection in the earliest times between the inhabitants of the Old World and the New. Prof. Pigorini, while dwelling on the great value of the collection of such curiously-shaped articles made by Signor S. de Stefani, and described by him before the Congress at Venice, was glad to be able to announce to the Academy that the collection had been acquired by Prof. Landberg, whose attachment to Italy and whose philanthropic character were well known, and that it was his generous intention to present the collection to the Prehistoric and Ethnographical Museum at Rome. This valuable scientific material is thus to remain in Italy.—On the observations on the solar maculæ and faculæ made in the Observatory of the Collegio Romano in 1884. From the observations made, Signor Tacchini believed that he could conclude that the solar activity was diminishing and that it would very soon reach its minimum. Comparing the observations of 1883 with those of 1884, he found that in 1884 chromospherical phenomena attained a considerable development. Signor Tacchini, although he has not yet completed his labours in reducing the observations, i sof opinion that 1884 will have to be remembered as a year of maximum frequency of hydrogenic perturbations, but he intends to return to the question when he has completed the calculations relating to it.—On an ancient vase representing Sappho.—Signor Comparetti read some preliminary notes regarding an ancient vase belonging to the collection of the Archæological Society of Athens. On this vase, the drawing on which is rather rude, Sappho is represented in the midst of her disciples, she herself being in the act of reading some epic lines written on a roll held in her hand. This vase belongs to the fourth century B.C., and hence to the period in which Sappho was most popular in the refined and gallant society of Athens. According to Prof. Comparetti, the two disciples who are listening to Sappho, must, judging from their names which are written on the vase, be two Athenian hetæræ.—Discovery of an ancient encyclopædia, and the plagiarism practised on it. Signor Narducci announced that he had discovered in the Biblioteca Angelica, at Rome, a parchment MS. belonging to the end of the thirteenth century, containing in its first 129 pages an encyclopædia, hitherto unknown, compiled by Egidio Colonna, of Rome. After giving an account of the contents of this work, Signor Narducci drew attention to the shameless manner in which the encyclopædia of Colonna had been plagiarised by the Englishman Bartholomew Glanville, commonly called *Bartholomeus Anglicus*, who flourished about 1630. This writer acquired the greatest reputation by a book of his called "Liber de proprietatibus rerum," which is in great part copied word for word from the encyclopædia of Colonna.—Other communications: Signor Fiorelli gave an account of the excavations of antiquities made during the month of December.—Dr. Nasini made a communication regarding some researches he had made on the atomic refraction of sulphur, and on the higher value of that refraction.—Dr. Piccini read a note containing some general considerations on peroxides of the type of peroxide of hydrogen, and made a communication as to the continuation of his researches on a new series of titanium compounds.

February 1.—On the hydrogenic protuberances of the sun, observed at the Royal Observatory of the College of Rome in 1884.—Prof. Tacchini, in continuation of his previous note to the effect that 1884 must be considered as a year in which the phenomena of the chromosphere had attained their maximum development, presented the results of observations made by him on 242 days. From these it appeared that the number of the protuberances increased from March to October. In order to get rid of the anomalies which are met with in various observations, and to obtain a curve representing the course of the phenomena in the quinquennial period 1880 to 1884, Prof. Tacchini has taken as monthly means the means of three months, considering each month along with the month before and after it. The curve so constructed shows three culminating points or periods of maximum activity, these corresponding to July, 1880, September to October, 1881, and March, 1884, which last is the highest in the whole series. The maximum of the protuberances follows that of the sunspots, and recent observations make it probable that 1885 will be a year of greater activity in the chromosphere and solar atmosphere.—On the degree of precision in the determination of the density of gases. Dr. Agamennone stated that the first to experiment with a certain amount of success on the density of gases were the physicists Dumas and Boussingault, and that Regnault had introduced the most important improvements in the methods of working adopted by them. He observed, however, that even these improved methods of Regnault were not exempt from certain errors, the nature of which the author pointed out and described, indicating the precautions that had to be used in the various operations of weighing, in order to avoid some of these errors by taking advantage of the accurate instruments which we possess at the present day. The author insisted specially on the constant source of error proceeding from the property which glass has of condensing gases on its surface, and on the exactness of measurement required in determining the pressure at which the gas to be weighed is contained in the vessel in which the weighing is effected. Dr. Agamennone has repeated in the Royal Physical Institute of Rome all the experiments of Regnault, and, correcting an error found in one of the experiments of that physicist, he finds that for the value of the weight of a litre of air, which, according to the corrections made by Kohlrausch and Lasch, would be 1·292756 grammes, there ought to be substituted 1·292767 grammes—a determination which, according to Dr. Agamennone, is subject to a maximum uncertainty of about ± 0·0005 gramme, and to a mean uncertainty of ± 0·000067 gramme.—Determination of the density of the air. Dr. Agamennone having in his previous paper shown how in the determination of the density of gases the errors affecting the final result proceed from the measurements of weight and pressure, announced that he had executed two series of experiments for the determination of the density of the air, making use of weights and pressures separated from one another by pretty wide limits. The pressures employed in the two series of experiments were: (1) that of the atmosphere; and (2) one of two atmospheres. The author, after describing his methods of procedure and the precautions taken by him, communicated his results, which showed a great difference between the mean values of his two series, and that because the air under pressure departs from Mariotte's law. Dr. Agamennone concludes that when the density of a gas is to be determined, the gas being weighed in a compressed state, it is necessary above all to know by direct experiments the variations in volume of the gas operated on, and to know what amount of condensation there is on the walls of the vessel in which the gas is compressed. For the determination of the deviation of a gas from Mariotte's law, which is a matter of so much importance in researches of this kind, the gas might be weighed at different pressures in a resisting vessel with a sufficiently delicate balance. Some experiments of Regnault have shown this method to be sufficiently satisfactory.—Consequences of a new hypothesis of Kohlrausch on thermo-electric phenomena. Dr. Battelli, after giving a *résumé* of the theoretical explanations offered by Thomson and Tait to account for the results obtained experimentally in thermo-electric phenomena, stated also the hypothesis of Kohlrausch on the electrical transport of heat, and showed how, from the conclusions of Kohlrausch, all the formulæ confirmed by experiment might be deduced.—Other communications:—Drs. Ciamician and Silber have continued their studies on the compounds of pyrrol, and explained minutely the method by which they had succeeded in converting pyrrol into pyridin.—Prof. Cassani communicated a paper on the angles of linear spaces.—Dr. Tonelli presented a note on the analytical representation of certain singular functions.—An abstract was communicated of a memoir by Messrs. Vanecek, entitled "Sur la Génération des Surfaces et des Courbes gauches par les Faisceaux de Surfaces."

February 15.—On the worship of stone weapons in the Neolithic age. Signor Pigorini exhibited a singular flint implement which had been found in one of the caves in the commune of Breonio Veronese, referred to the Neolithic age. It has the triangular form of a lance- or arrow-head, but is of rather large dimensions. It weighs, in fact, 1·710 kilo., and one of the equal sides of the triangle is more than 21 cm. in length. It cannot be supposed that this colossal spear-head could have been used as a weapon, chiefly because its dimensions would have required a shaft of quite unmanageable size, but also because the cavity at its base would have rendered the shafting extremely fragile. Signor Pigorini called to mind how, even at the present day, the common people attributed a celestial origin to the weapons of stone—a superstition which also existed among the ancients; but there are proofs that at the very time when these weapons were made they were held as emblems of divinity. There was, in fact, in the Neolithic age, a worship of the axe, since specimens of that weapon are found, of dimensions so small or so large, like that of Breonio Veronese, that they cannot be regarded as anything else than votive offerings.—Concerning a fragment of a manuscript of Cicero belonging to the ninth century. Signor Narducci found, in the Vatican Library, a valuable manuscript containing numerous Ciceronian fragments collected by a certain Hadvardo. Signor Narducci transcribed the manuscript page by page, in the hope that, by collating it with the works of Cicero, now known, he might find some fragments of lost books of the great orator. After identifying each of the fragments, he found that the compiler had not had at his disposal any of the works of Cicero known in the Middle Ages, but not at the present day. Signor Narducci gave a short specimen of the manuscript, with the various readings found at the present day in the most esteemed versions of the various works of Cicero, and he announced that Prof. Schwenke is preparing a critical study of the manuscript in question.

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