THURSDAY, JULY 28, 1881

MISS GORDON CUMMING'S "FIJI"

At Home in Fiji. By C. F. Gordon Cumming. In Two Volumes. With Map and Illustrations. Second Edition. (London: Blackwood and Sons, 1881.)

MISS GORDON CUMMING is a most indefatigable traveller, daunted by no hardships or discomforts, ready to push her way anywhere, and as happy and contented almost in a Fijian dwelling as if at home. She has travelled over most of the world, and being a most skilful draughtswoman, has, like Miss North, brought back with her a vast series of large coloured sketches of all the principal points of interest visited by her. Whilst however Miss North's fine and most instructive collection is executed in oils, the author of the present work sketches in water colours. Miss Gordon Cumming's drawings are very beautiful and, as all those who have been fortunate enough to see them can testify, extremely faithful representations of the scenes which they depict, and she has sketched some of the most interesting scenes existing, such as the hot springs and geysers of New Zealand, the ruined ancient cities of Ceylon, the summit of Adam's peak at sunrise, with the curious coloured edged shadow then cast by the mountain, and the ever-surging lava lakes of Kilauea in Hawaii. She went to Fiji as companion to Lady Gordon on the appointment of Sir Arthur Gordon as first governor of the islands in the beginning of 1875. She stayed there more than a year and a half, seeing a great deal of the people and constantly travelling in various parts of the group. The present book is a bright and pleasant account of what she saw and did. She made a large series of sketches, and seven of these, reproduced by the autotype process, illustrate the present work. Any one who knows Fiji will at once recognise the minute accuracy with which they represent the scenery of that beautiful group, though they are, of course, but feeble substitutes for the coloured originals.

It is pleasing to learn that the Wesleyan missionaries, to whom the entire credit of the civilisation of the Fijis is due, expressed their satisfaction at the annexation when it actually took place. They certainly had very serious apprehensions as to its effect on the well-being of the native population some years before, when the matter was only under consideration. It is a pity indeed that the hoary old cannibal Thackombau was taken down to Sydney to bring back the measles to his islands and thus destroy a third of the population. The difficulties of the problem with which Sir Arthur Gordon had to deal at the outset of his governorship were greatly enhanced and complicated by the effects of this terrible mishap. It is pleasing to learn that old Thackombau is still as fond of his bible as when we saw him seven years ago; he cannot read it, apparently, but, as our authoress tells us, "it makes him feel so good." No doubt if he could read some of the battle scenes in Kings he would feel better still.

Fijians seem to be rather a failure as domestic servants.

"Day after day you must show them exactly how everything is to be done, and may be certain that each time it will be done wrong, and that the moment your back is turned they will proceed to bruise up a bit of tobacco in a banana leaf and deliberately smoke their cigarette before touching the work you have given them. Probably they will follow you to ask where the matches are, and the only answer to any remonstrance is 'malua' (by and by), a universal principle which is the bane of Fijian life. They are honest, though sometimes they cannot resist borrowing large English bath towels, which make most tempting *sulus* (kilts), and nice cambric handkerchiefs are a tempting covering for carefully dressed hair. It would be right and proper that they should use things belonging to their own chiefs, so we need not wonder that they cannot always discriminate."

The authoress was especially struck by the absence of flowers in the island, and describes this fact as all the more striking to her after a vogage direct from Australia (Sydney), where the whole country was aflame with blossom. She walked day after day till she was weary without finding as many flowers as would fill a small vase. She bears testimony, on the other hand, to the profusion of ferns. Mr. Wallace has dwelt in his work on "Island Life" on the causes to which this absence of flowers in oceanic islands is due. Miss Gordon Cumming's testimony on the matter is interesting.

Sir Arthur Gordon was punctilious in matters of native etiquette, and constantly attended kaava yangona drinkings. It is quite new to us to learn that the process of preparing kaava by chewing in Fiji was imported from Tonga, and that in the interior the old custom of grating the pepper root survives. If this statement is correct the process must have come from Tonga some time ago, for the root is only grated there now by order of the missionaries, who introduced this method in order to prevent the spread of disease occurring in consequence of the chewing. As chewing was the method adopted originally all over Polynesia, it would be strange if Fiji had been an exception in the matter.

Some remarks are made in the work on the so-called *orthodox* mode of Fijian spelling, that is to say, the strange mode of spelling which the missionaries have thought fit to adopt. According to this spelling Thackombau is spelt Cacobau, *c* being used instead of *th*, and an *n* sound, which invariably occurs before *d*, *g*, and *q*, being omitted in the spelling. There seems nothing to be gained and all to be lost by this arrangement, a mere going out of the way to create a difficulty, unless indeed it be a device to prevent the Fijians when taught to read and write Fijian from being able to read English.

Amongst the crowds of plantation labourers from all parts of Polynesia the authoress specially mentions the Tokelau islanders, "with their long straight hair, large dark eyes, and sallow faces." There is something very peculiar in the Tokelau race, and we believe there is much of importance yet to be made out with regard to it. Every visitor to Levuka cannot help being struck at once by the very marked difference in appearance between the Tokelau men and women and all other Polynesians and Melanesians taken together amongst the labour population of the place. They alone of all the islanders can be recognised in any crowd at once by any one without any fear of mistake. They have a Mongolian look, and we cannot help thinking there is something remarkable in their origin, although their language is very closely allied to Samoan.

A lively account is given of a Palolo fishery, which

the authoress was lucky enough to witness. There is a great deal in the book about cannibalism. A representation of one of the well-known so-called cannibal forks adorns the covers of the books. These forks are so much prized by visitors as curiosities that we caught a boy on the Rewa River making a couple of trade ones, and have got one of them now in our possession. It is a mistake to suppose that they were never used for eating any food except long pig (*bokola*). A young chief of one of the mountain tribes was asked whether women joined practically in the delights of cannibal feasts: he said, "I'd like to see the woman that would not eat her full share." He bore testimony to the superiority of long over short pig as food.

An interesting account is given of one of the native missionary meetings and of the set dances (*meke*) which take place at them. One of the most curious dances described is one representing a tide rising on a reef:—

"The idea to be conveyed is that of a tide gradually rising on a reef, till at length there remains only a little coral isle, round which the angry breakers rage, flinging their white foam on every side. At first the dancers form in long lines and approach silently, to represent the quiet advance of the waves. After a while the lines break up into smaller companies, which advance with outspread hands and bodies bent forward to represent rippling wavelets, the tiniest waves being represented by children. Quicker and quicker they come on, now advancing, now retreating, yet, like true waves, steadily progressing and gradually closing on every side of the imaginary islet round which they play or battle after the manner of breakers, springing high in mid-air, and flinging their arms far above their heads to represent the action of spray. As they leap and toss their heads, the soft white *masi* or native cloth (which for greater effect they wear as a turban with long streamers, and also wear round the waist, whence it floats in long scarf-like ends) trembles and flutters in the breeze. The whole effect is most artistic, and the orchestra do their part by imitating the roar of the surf on the reef—a sound which to them has been a never-ceasing lullaby from the hour of their birth."

The Fijians are, with little doubt, the best dancers in the world, and it is interesting to contrast their condition in this respect with that of ourselves, amongst whom dancing has degenerated in proportion as music has become highly developed, until it may almost be said that practically only one dance survives amongst us, and that a monotonous performance, which, by a very slight revival, is just being promoted from two to three steps. Yet Englishmen can dance when the Fijians teach them. All the dancers were of course fantastically painted.

"We were chiefly puzzled and attracted by one very fine fellow, all painted black, with a huge wreath and neck garland of scarlet hybiscus and green leaves, and rattling garters made of many hanging strings of large cockle-shells, and the usual *liku* (a sort of kilt or waist drapery) of fringes of coloured pandamus leaves. Of course he carried a club, and was barefooted. This man distinguished himself greatly, and afterwards acted the part of a huge dog in a dance where all the children appeared on all fours as cats. Eventually we discovered him to be a European known as Jack Cassell."

When the short war with the Kai Volos, the till then unsubdued cannibals of the mountainous interior of Viti Levu, took place, all the chiefs sent small detachments of fighting men to the governor to help in the fight. One hundred and fifty such men came from Mbau. They marched up on to the governor's lawn armed with Tower muskets, and performed the wildest war *meke*, ending with unearthly yells. They then advanced two or three at a time, brandishing their weapons, and trying who could make the most valiant boast concerning his intended progress. One cried, "I go to the mountains, my feet shall eat the grass." This was to express his eager speed. Another, "I long to be gone, I crave to meet the foes. You need not fear; here is your safeguard." "This is only a musket," cried another, "but I carry it." Said the next, "We go to war; what hinders that we should fill all the ovens?"—a hungry cannibal ally that. One company which advanced with more stately gait, "This is Bau, that is enough."

It makes our legs tingle now a little to hear that a boy was torn and killed by one of the freshwater sharks, *Carcharias Gangeticus*, inhabiting the great Kewa River in Viti Levu during Miss Gordon Cumming's stay there, for we spent most of one night in and out of the water of the river not so long ago, pushing off our boat as she grounded constantly with the falling tide. We trusted to the sharks in the upper part of the river being only small ones, but the boy was killed at a distance of thirty miles from its mouth. The authoress had bathed in the river herself occasionally. She does not seem to be aware that the shark in question regularly inhabits the fresh water.

We cannot follow the authoress in her account of Fijian feasts, Fijian puddings—twenty-one feet in circumference—Fijian weddings, where the bride's dress is so cumbrous that it is carried by her friends to the church and put on outside on the shore under the cocoanut trees; of the hot springs of Savu Savu, used for cooking and for getting rid of superfluous babies; of the details of the process of making the beautiful Fijian pottery, and many other matters on which we would wish to dwell.

The book loses somewhat in general effect from being retained in the form of a series of letters, an arrangement always somewhat irksome to the general reader. Perhaps also for the taste of many there is a little too much about the missionaries in the book; but as there were 900 Wesleyan chapels in the islands, and, as said before, the missionaries have brought about all the civilisation existing, they necessarily must appear a good deal in such a work. They seem sometimes to excite the admiration of their flock in a rather dangerous direction. An old ex-cannibal crept close to one who apparently is somewhat stout, "and then, as if he could not refrain, he put out his hand and stroked him down the thigh, licking his lips, and exclaiming with delight, 'Oh! but you are nice and fat.'" We always thought that Fijians, like cannibals elsewhere, had found out by experience that white men are comparatively poor eating.

We thank Miss Gordon Cumming much for her very interesting book, but before we close this notice we have one bone to pick with her. She falls into the really unpardonable popular error of talking of coral insects, and even talks of the parrot-fish extracting from the coral the insects on which it feeds. We hope she will learn before a third edition of her work appears that the animals, the skeletons of which are commonly called corals, are no more like any insects than a whale is to a blue-bottle. The fact is, coral skeletons look a little like honeycomb, and so we suppose the popular delusion will flourish for ever.

OUR BOOK SHELF

Practical Botany for Elementary Students. Introductory to the Systematic Study of Flowering Plants. By D. Houston, Science Master, South London Middle-Class School Association. (London: W. Stewart and Co., 1881.)

THIS book differs from Mr. Bettany's (vol. xxiv. p. 235) in being less general in its treatment. It is in fact a series of studies of the coarse anatomy of a number of common plants much on the plan first given in Huxley and Martin's "Elementary Biology." Each study is followed by a technical description, notes on the distinctive characters of a few allied plants, and some miscellaneous matter. "The plants selected are well-known and easily-procured types of the fifteen natural orders included in the Syllabus of the First Stage of Elementary Botany issued by the Science and Art Department, as it is believed that no better selection of natural orders, intended as introductory to the study of classification, could possibly be made." As far as can be judged without working through it, the book is well done, and will be a valuable aid to the teacher if honestly used. Mr. Bettany's plan of teaching the art of describing is soundest. His book can hardly be abused, while with Mr. Houston's there is the risk that incompetent teachers may make their pupils simply learn a large part of it by heart, on the chance of one or more of the plants being set in an examination. Occasionally, where the author abandons the sure ground of personal study, he makes slips. Thus more than half the short list of exotic genera of orchids has the names misspelled. The distribution in time and space of the several orders illustrated is given, though somewhat meagrely. Perhaps in the present state of palæophytology the former is not very important. Under *Orchidaceæ*, for example, the Distribution in Time is given as "not represented," which, apart from the fact that it is a contradiction in terms, means nothing more than that fossils referable to this group of plants have not been found, and are perhaps not likely to be. It may be asked, too, what is the value of the evidence upon which the liliaceous genus *Yucca* is dated back to the Trias?

Von den Umwälzungen im Weltall. Von Rudolf Falb (Vienna, Pesth, and Leipzig: Hartleben, 1881.)

THIS work is divided into three parts, with separate headings: (1) In den Regionen der Sterne; (2) Im Reiche der Wolken; (3) In den Tiefen der Erde. The author, whose name has frequently been mentioned in our columns, has lectured in various German cities on volcanic and cosmological phenomena, and eventually went to South America in order to study the great volcanoes of the Cordilleras. He conceived an earthquake theory, and his South American friends induced him to publish it. The result is the book now before us, which was published in Spanish at Valparaiso as far back as 1877 ("Estudio sobre los templores de tierra fundado en la historia del universo"). After a sojourn in South America extending over three years, Herr Falb returned to Europe, and his earthquake theory was frequently mentioned in the press in connection with the Agram earthquakes. The theory is simple enough in itself, and the author has at least the credit of being most enthusiastic in its support and in adducing as many facts in proving the same as can possibly be found. Whether he succeeds in proving it is another question. According to Herr Falb's view, all earthquakes, or at least by far the larger majority of earthquakes, are of a volcanic origin; or, to express it concisely, "earthquakes are subterraneous eruptions." The basis of this theory is naturally the supposition that the whole interior of the earth is an ocean of incandescent matter. This is affected by the attraction of sun and moon in exactly the same manner as the sea and atmosphere are acted upon. The second division of the book therefore represents sun and moon as the generators of storms and tides; and in the third division, the principal one, we see the cause of earthquakes traced to the influence of sun and moon. There is no doubt that the author has a special gift of representing his subject clearly and popularly; his eloquence keeps the reader interested from the first line to the last. He quotes no less than thirty facts, from which he draws thirteen different inferences in proof of the volcanic nature of earthquakes. We regret that space does not permit us to enter further into details, but we can heartily recommend the book to our readers.

The Quantitative Estimation of Phosphoric Acid. By M. H. Joulie. Translated by J. Barker Smith. (Dulwich: Published by the Author, 1881.)

THE laudation of M. George Ville, with which the translator opens his preface, discouraged us at first from further perusal of this pamphlet on the citro-uranic method of determining phosphoric acid in manures; and when we did peruse these sixty pages, our chief impression was derived from the comical literality with which French idioms had been rendered into English words. But after all a good many useful hints may be gathered by practical analysts from this little book. Of course most agricultural chemists are familiar with the difficulties which beset the fair sampling and preparation of manures for analysis, and they are also acquainted with many special contrivances for overcoming these difficulties. But information as to new and improved methods of operating, and as to modifications of old processes, is always acceptable.

The essence of M. Joulie's method consists in the precipitation of the phosphoric acid in a prepared solution of a manure by means of a solution containing citrates of ammonium and magnesium. The precipitate which forms is thus produced in the presence of the lime as well as of the iron and alumina of the original liquid; we should like further proof that the whole of the phosphoric acid is invariably precipitated under the conditions described by M. Joulie, especially as he directs the solutions, if rich, to be kept no more than two hours before the ammonio-magnesian phosphate is filtered off. The second and final stage in M. Joulie's method is the solution of the precipitated phosphate and its titration by a standard solution of uranium nitrate.

The second part of this pamphlet describes the treatment of manurial phosphates with solutions of ammonium oxalate and ammonium citrate in order to determine their "relative assimilability." We are not aware that M. Joulie was the first to employ these reagents in the analysis of phosphates—his announcement of the use of the oxalate being in 1872, and of the citrate during the next year. Anyhow, we must demur to some of the conclusions which M. Joulie draws from his experiments, nor can we accept as satisfactory the final directions for the "assay of superphosphates" with which the last fifteen pages of his manual are occupied. The determination of the phosphoric acid and phosphate dissolved by distilled, or, if you will, carbonated water, from a superphosphate cannot be safely replaced by a determination of the phosphates soluble in ammonium citrate. For we lack proof that retrograded phosphates are equal in value with monocalcic phosphate, which alone possesses an initial diffusive power when it is introduced into the soil.

The Butterflies of Europe. Illustrated and described by Henry Charles Lang, M.D., F.L.S. Part I. (L. Reeve and Co., 1881.)

WE have received Part I. of this work, the approaching publication of which was announced in these columns a few weeks back. The whole of the species (and some prominent varieties, &c.) inhabiting Europe proper will occupy about twenty monthly parts, each containing sixteen pages of text and four coloured plates. The plates

are chromolithographed from the author's own drawings, which appear to be exceedingly well done. We defer a more extended notice until more parts shall have appeared, especially because the subjects illustrated in the first part are almost the least difficult for the chromolithographic process. The text is clearly printed, but a little more care in writing the short descriptions should be exercised. Thus at the very commencement we read as one of the characters of the family *Papilionidæ*, "Larva cylindrical, not spiny, furnished with two retractile tentacles on the second segment." We doubt if this is correct for *all* the European species of *Papilio;* it certainly is not so if exotic species of the same genus are considered; and almost immediately afterwards the author, in defining the genus *Thais* (one of the *Papilionidæ*), says, "Larvæ armed with spines." Nowhere do we find any reference to the veining of the wings, which certainly should have formed part of the sketch of the principal groups given in the Introduction. The author will do well to consider the importance of this suggestion. We presume the chief object of the work is to enable collectors of European butterflies to name their captures, and especially by means of the figures. For this purpose it promises to be exceedingly well adapted.

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 ensure the appearance even of communications containing interesting and novel facts.*]

Chemical Equivalents

MR. J. P. O'REILLY'S paper in your last number (p. 274) appears to involve a complete misconception of the theory of chemical equivalents. The equivalents are mere ratios, and are not altered by multiplying their representative numbers throughout by any factor, whether π or any other.

In fact we may write the equivalents of hydrogen, carbon, and oxygen as x, $12x$, and $16x$, without troubling ourselves about the value of x. This is not only the theoretical view, but the one actually used in practice. So far, there is nothing new or special about writing, as Mr. O'Reilly does, $x = \frac{1}{8}\pi$.

But then Mr. O'Reilly goes wrong, and gets results which contradict his hypothesis. When he writes $H = \frac{1}{8}\pi$, and $O = 5\pi$, the real inference is that the equivalents of H and O are as 1 : 15, instead of as 1 : 16 which he started from.

If his π-values are to be taken as corresponding with the equivalents, this simply means that the latter are not to be depended upon within a limit of error of 5 per cent. I think the mistake is not in this respect, but in overlooking the circumstance that the chemical equivalents are not absolute values, but ratios.

July 24 C. W. M.

Slow Lightning

HAVING just seen the statement of Prof. Tait (NATURE, vol. xxii. p. 341) quoted, as a final authority, against the possibility of distinguishing the source from the termination of a lightning flash, I wish to record a storm that I saw. On May 19 there had been a brisk, hot south-west wind blowing at Gizeh, off the Libyan Desert, at about or over 100° F.; at near sunset a north wind began to come up against it, and there was heavy thunder and lightning all along the line of the mingling of the winds, extending as far as I could see to east and west, and passing a few miles to the north of the Pyramids: the lightning was solely between the clouds, at a height of about one and a half miles; the air around me was 94°, though almost dark. I sat on a rock in front of the door of my tomb (from which I could see eighteen miles over the Delta) and quietly watched the lightning. To my sight there were distinctly differences in the duration of the flashes: some appearing instantaneous and others in which I could see a spot of light occupying an appreciable interval to travel from one cloud to another; and I should be puzzled to draw a hard and fast line between the classes. Does this moving spot-lightning merge insensibly into the variation, of which I saw a fine case years ago near Guildford, where a spark would slowly sail down in the air and then move over the ground before it disappeared?

In any case can these slow flashes (lasting perhaps half a second), seen as well as instantaneous flashes, be disposed of by that blessed word *subjectivity*, which is so comforting to theorists on many objects? Or may not the confession of our ignorance of the cause of ball-lightning be extended to slow flashes in general, instead of treating them just as meteorites were put out of court a century ago? W. M. FLINDERS PETRIE

Bromley, Kent

[Several instances are recorded by Faraday, Joule, and others of flashes which seemed to last for a sensible time. But they are easily explained by one or other of two *veræ causæ*, viz. (1) oscillatory discharges along the same path, succeeding one another at smaller intervals than one-seventh of a second; or (2) phosphorescent matter in the track of the flash. More definite particulars would be necessary before one could decide which was active in the present case.—ED.]

Thought-Reading

As having a bearing upon the hypothesis that in "thought-reading" the information is transmitted by unconscious muscular exertion, allow me to state a modified form of the experiment I tried in the presence of two or three others with Mr. J. R. Brown, who, a few years ago, attracted considerable attention in various parts of the United States by doing precisely what is related of Mr. Bishop in your issue of June 23 (p. 171). After witnessing experiments of the same kind as those stated by Mr. Romanes and performed under the same conditions, I thought to vary them by using a flexible copper wire as a connecting medium. Selecting one, two or three yards long, I held one end in my hand, while Mr. Brown, winding the other end once or twice around his fingers, held it against his forehead, the wire being all the time kept slack between us. Here evidently there could have been no indications received through muscular movements. Yet in this way Mr. Brown would find things concealed or go to certain points determined upon, though apparently with not quite the same readiness and confidence as when the subject's hand was placed against his forehead. Once he partially failed, selecting, instead of a particular spot on the wall I had fixed my mind upon, a small object near it. The experiment in this form was tried with another as his subject, and with equal, if not better, success. GEO. B. MERRIMAN

Rutger's College, New Jersey, July 11

Optical Phenomena

THE photographic halo phenomena described in NATURE, vol. xxiv. p. 260, seem analogous to some observed by me, and upon which, in the spring, I read a paper (since published in the *Notices*, vol. xli. No. 6) before the Royal Astronomical Society. In this I described that not only the sun's disk and the moon's full and partial phases, but also apertures (of similar shape to these) in the shutter of a dark room, when photographed, were, one and all, surrounded by a strong ring halo not visible to the eye. A correspondent essayed some time since to prove in your journal that this halo only surrounded the moon when at full, but on trial the question proved one of time of exposure; and it now seems pretty clear that whatever may be its form and nature, a very bright object when photographed (especially in relief against a dark ground) is found, if sufficient exposure be given, surrounded on the plate by a halo separated from the object by a dark space. Mr. Cowper Ranyard and others attribute these halos to reflection from the back of the plate, a point on which I have not experimented. The dark spot mentioned in connection with the aperture in the rock is probably a reversal of the brightest light owing to the length of exposure.

In two seconds, with Wratten and Wainwright's instantaneous plates, I have found the sun's image so reversed in a camera landscape, showing as a white spot on the negative and a black dot when printed. J. RAND CAPRON

Guildown, July 23

Symbolic Logic

MR. MCCOLL still expresses surprise at my declining to answer a Yes or No question which he was pleased to put to me in

NATURE (vol. xxiv. p. 124). It was, I should think, almost unique in a scientific journal. It turned upon a contradiction which he had detected between a statement which I never made and the fact that he surely entertained an impression that he had somewhere or other (he did not say where) seen me quoted as holding an opinion at variance with that statement. I did not think that time would be well employed in answering it. Even now he talks of his "quotation or misquotation"; a convenient but unusual latitude of expression for a serious case of the latter of these alternatives. Really I am not in the examination-room, and will not therefore attempt to compress into a few paragraphs the answers I should give upon intricate philosophical points, even were the questions reasonably framed. Moreover I must remind Mr. McColl that he does not profess to write as an impartial inquirer or critic, but asked for the insertion of his letter upon the ground that he conceived himself to have been attacked. I have fully explained the only point upon which he had any claim to call for an answer, and therefore now close the correspondence. J. VENN

Achensee, Tirol

Jupiter

THE great red spot on the planet seems unchanged as I saw it on July 8, while the north temperate zone belt (Gledhill's No. 2) shows a development nearly as striking as the equatorial belts.

Millbrook, Tuam, July 20 J. BIRMINGHAM

New Red Variable

THIS star, which I found on May 22 only 9 magnitude (see NATURE, vol. xxiv. p. 164), progressively increased up to 8 m. on June 6, and is now again no more than 9. Its deep crimson colour is unchanged. It is 2° 51′·7 north of α Cygni, and forms, with three other stars, the southern end of a little inverted and irregular cross. It will probably decrease to complete disappearance, at least from telescopes of moderate power.

Millbrook, Tuam, July 20 J. BIRMINGHAM

A Fireball

ON Wednesday the 20th ult., about midnight, a house at Mont Dore, in the Auvergne, was destroyed by a fireball during a severe thunderstorm. My brother, who has lately arrived from thence, did not see the ball himself, but his valet, an intelligent Italian, saw it distinctly. He describes it as a globe of fire about half a metre in diameter, which approached the house obliquely, seeming to pass over a distance of 200 metres in about half a minute. It entered the door of the house and there burst. My brother heard the explosion as well as his valet, and describes it as a dull thud like that of a smothered blast. The house, which was a wooden one, was set on fire, a child burnt to death, and another inmate seriously, if not mortally, injured. Several inhabitants of Mont Dore are said by the valet to have seen the ball, one of whom lived in the adjacent house.

It will be interesting to readers of NATURE to compare the accounts given by Prof. Tait in NATURE, vol. xxii. p. 409.

19, The Boltons, S.W. JOHN TENNANT

Meteor

ON July 23, at 7.15 p.m. (Irish railway time) a meteor passed, travelling nearly from south to north, being lost in a bank of black cloud. It must have been of considerable brilliancy, as it was quite distinct, although at the time the sun was well above the horizon. July 22 from ten to fourteen brilliant red pencils and thin columns of auroric lights were rising at intervals. There were also auroric lights on July 23 between 11 and 12, but much less brilliant. G. H. KINAHAN

Ovoca, July 24

THE COMET

WE have received the following further communications on this subject:—

The following "Preliminary Note on the Photographic Spectrum of Comet *b* 1881," has been communicated to the Royal Society by Dr. Huggins, F.R.S. (For Dr. Huggins's first note on this subject, see NATURE of June 30.)

ON the evening of June 24, I directed the reflector furnished with the spectroscopic and photographic arrangements described in my paper "On the Photographic Spectra of Stars" (*Phil. Trans.*, 1880, p. 669) to the head of the comet, so that the nucleus should be upon one half of the slit. After one hour's exposure the open half of the slit was closed, the shutter withdrawn from the other half, and the instrument then directed to Arcturus for fifteen minutes.

After development, the plate presented a very distinct spectrum of the comet, together with the spectrum of the star, which I have already described in the paper referred to above.

The spectrum of the comet consists of a pair of bright lines in the ultra-violet region, and a continuous spectrum which can be traced from about F to some distance beyond H.

The bright lines, a little distance beyond H, with an approximate wave-length from 3870 to 3890, appear to belong to the spectrum of carbon (in some form, possibly in combination with hydrogen), which I observed in the spectra of the telescopic comets of 1866 and 1868.

In the continuous spectrum shown in the photograph, the dark lines of Fraunhofer can be seen.

This photographic evidence supports the results of my previous observations in the visible spectra of some telescopic comets. Part of the light from comets is reflected solar light, and another part is light of their own. The spectrum of this light shows the presence in the comet of carbon, possibly in combination with hydrogen.

On the next night, June 25, a second photograph was obtained with an exposure of an hour and a half. This photograph, notwithstanding the longer exposure, is fainter, but shows distinctly the two bright lines and the continuous spectrum, which is too faint to allow the Fraunhofer lines to be seen.

Postscript, July 9, 1881.—I have since measured the photographs of the comet's spectrum, and I find for the two strong bright lines the wave-lengths 3883 and 3870. The less refrangible line is much stronger, and a faint luminosity can be traced from it to a little beyond the second line 3870. There can be, therefore, no doubt that these lines represent the brightest end of the ultra-violet group which appears under certain circumstances in the spectra of the compounds of carbon. Professors Liveing and Dewar have found for the strong line at the beginning of this group the wave-length 3882·7, and for the second line 3870·5.

I am also able to see upon the continuous solar spectrum, a distinct impression of the group of lines between G and *h*, which is usually associated with the group described above. My measures for the less refrangible end of this group give a wave-length of 4230, which agrees as well as can be expected with Professors Liveing and Dewar's measure 4220.

In their paper "On the Spectra of the Compounds of Carbon" (*Proc.* Roy. Soc., vol. xxx. p. 494), Professors Liveing and Dewar show that these two groups indicate the presence of cyanogen, and are not to be seen in the absence of nitrogen. If this be the case, the photograph gives undoubted evidence of the presence of nitrogen in the comet, in addition to the carbon and hydrogen shown to be there by the bright groups in the visible part of the spectrum. On this hypothesis we must further suppose a high temperature in the comet unless the cyanogen is present ready formed.

I should state that Mr. Lockyer regards the two groups in the photograph, and the groups in the visible spectrum, to be due to the vapour of carbon at different heat-levels (*Proc.* Roy. Soc., vol. xxx. p. 461).

It is of importance to mention the strong intensity in the photograph of the lines 3883 and 3870, as compared with the continuous spectrum, and the faint bright group beginning at 4230. At this part of the spectrum, there-

fore, the light emitted by the cometary matter exceeded by many times the reflected solar light. I reserve for the present the theoretical suggestions which arise from the new information which the photographs have given us.

THE second evening of its appearing I examined the head of this comet with a McClean spectroscope (with slit) and also with a Hilger's half-prism instrument (a half-size model of the Greenwich one).

The appearances were mainly those seen by other observers, viz., a bright continuous spectrum from the nucleus and a much fainter one crossed by bright lines from the coma. There were however two points of interest which struck me, as I see by NATURE, vol. xxiv. p. 261, they did M. Thollon in Paris. These were: (*a*) The continuous spectrum from the nucleus had a mottled or striated look, but I could not be certain whether dark lines or bright lines or spaces predominated in causing this effect; (*b*) the presence of shorter and additional lines to the three carbon ones, extending beyond the continuous spectrum.

These appearances, I admit, I only recognised indistinctly and with doubt at the time, but, corroborated as they now seem to be, I do not question that there was some ground for them. With reference to the nucleus spectrum it could only have comprised a small portion of solar light as shown by the few Fraunhofer lines detected by Dr. Huggins and others in it. The residue of the bright stripe has been attributed (because continuous) to some incandescent solid or liquid substance; but is this necessarily the case? Is it not possible that the matter yielding this spectrum is still in a truly gaseous form, and do not the appearances above described rather point to the character of a gas spectrum passing from the line or band condition to the continuous one, under its existing circumstances of ignition, pressure, &c. (whatever these may be)?—an effect not without parallel, I fancy, at least in the case of hydrogen. J. RAND CAPRON

Guildown, July 23

A COMET is now visible here. I saw it last Thursday, June 30, at 3·10 a.m. It was in the west, and appeared to me about 30° from the pole star, and 20° above the horizon. The tail was straight and directed towards the pole star. A local paper says this comet was seen to the east at 8 p.m. the preceding day, and that the tail was 20° in length—it appeared to me only 5°.

I regret I cannot send fuller information, but probably the comet is to be better seen in England.

Karáchi, July 2 F. C. CONSTABLE

SEA-SHORE ALLUVION

IT is somewhat remarkable at the present day to find even professional men, when dealing with works of coast defence, attributing the movement of littoral shingle to the tidal currents.

The late Mr. Palmer, C.E., in a well-known paper read before the Royal Society nearly half a century back, Col. Reid, R.E., in an essay published in the commencement of the series of quarterly papers by officers in the corps of Royal Engineers, Mr. Redman, M.Inst.C.E., in a paper on the South Coast of England, read before that society some thirty years back, and another on the East Coast of England seventeen years back, as well as in very numerous reports made by him for a Government department (the War Office) during the last quarter of a century, have all shown that these shingle formations are in no way affected by the tide, which must exercise only a negative influence, the flood and ebb setting in contrary and opposite directions, equal in duration, and neutralising each other. Shingle moles are in effect resultant on the wind waves alone, and are deposited in two parallel ridges or hummocks locally termed "*fulls*," marking the relative range of neap and spring tides, the crest of the last being normally (except in some exceptional cases such as the *Chesil*) ten feet above high water of spring tides with a broad, gently sloping foreshore of sand down to low water; an abnormal tide, resultant on exceptional gales occurring at rare intervals, sometimes breaches the crest and produces great mischief, as at Seaford on the Sussex coast a few years back, which was inundated by the sea, and where the authorities are about to carry out artificial works of defence.

The prevailing movement in the English Channel is to the eastward, or up Channel, due to the fact that south-west winds prevail for nine months in the year; and along the East Coast the movement is southward, due to the particular trend of the coast and the North Sea offing. It really hardly appears necessary to insist on these well-known facts to any one practically acquainted with the subject, or to hydraulic engineers conversant with the surrounding physical conditions of our tidal harbours, estuaries, and rivers.

Notwithstanding this, strangely enough we find a contemporary journal, the *Engineer*, in a series of articles on the Brighton, Hove, and Shoreham beaches, professedly written for the education of public opinion on the subject, themselves ignoring the fundamental laws governing the motion of this marine alluvion, and attributing it to tidal currents instead of to the wind waves, and yet insisting at the same time that the question, as doubtless it is, is an imperial one, demanding the attention of the Legislature.

Thus, October 3, 1879, "Brighton Beach" (*The Engineer*):—

"A very strong *tidal current* sets up the Channel to the eastward, and sweeps with it the rolling shingle"! (*sic.*)

"So rapidly did this disappear under the influence of this *current* that it became necessary to stay its travel by the erection of heavy timber groynes."

"Knowing what we do also of the effect of *sea currents*, it is in our opinion exceedingly questionable *if their carrying powers* can be arrested by anything short of a check which shall produce almost dead water."

One of the last papers read at the Institution of Civil Engineers, on "Upland and Tidal Scour," also attributes the movement of the Norfolk and Essex beaches to the tidal currents.

Nor are local authorities, highway boards, vestries, district boards, and large landowners any more at one than these would-be educators of public opinion on the subject, for we find farmers as a rule sending down their teams and waggons to the sea-shore during winter slack time to collect boulders and pebbles from the sea moles of Nature's forming; railway companies where allowed, and a convenient communication effected, removing it wholesale for ballast of the iron road; lords of the manor conveying it equally wholesale to shipping craft for ballast, until stopped by the strong arm of the law brought to bear on the question by some Government department.

Local magistrates are equally offenders, as recently, about twelve months back, the magistrates sitting at Canterbury authorised their surveyor, after long discussion, as the order was given with the fear of an impending injunction hanging, "Damocles" like, over their heads, to quarry shingle from the sea-shore at Herne Bay for the repairs of the highways; thus robbing the supply travelling up the estuary of the Thames to the westward (the general movement of the belt of shingle being diverted up such estuaries as those of the Thames, Wash, &c.), the material being at the same time so much wanted along the Blue Town frontage at Sheerness, where grave fears have long prevailed, due to the insufficiency of the sea-shore works of defence. This Canterbury decision, taken in the month of January in last year, appeared to us at the time the extreme of rashness, when the interests to

leeward of the proposed road quarry at Herne Bay were considered. The Trinity Corporation would be affected in reference to the defences of the Reculvers—the two spires of the ancient church having been maintained by them for many years as sea marks with stone slopes and groynes for the protection of the cliff. From the fact of their being to the eastward of Herne Bay they may be said to be to windward of the site, still the hastening of the recession at Herne Bay, which has from natural causes alone increased in a marked degree of late, would tend to increase the projection and consequent exposure at the Reculvers.

Next we have the entire landowning interest of the Isle of Sheppy affected by this Canterbury decision, for its northern seaboard retreats at a rapid rate, evidenced by the recent removal of Warden Church, which had been left on the extreme verge of the cliff, due to the extensive slips in the London clay to the westward, which must of course be aggravated if the natural barrier formed by the sea at the base of the cliff is weakened by cutting off the supply coming from the eastward, tending always in its normal state to travel onwards to increase Garrison Point at Sheerness at the outfall of the Medway.

Lastly we have the whole Mile Town and Sheerness frontages affected, where the Government have erected from time to time sea-walls and groynes for the collection of this very beach that the Canterbury magistrates covet for the repairs of their roads. Nor is Sheerness alone affected, but the Queenborough district also, as was evidenced in the great tide of February, 1791, when the whole of the marsh forming the north-west promontory of the Isle of Sheppy was under water, and great loss and damage sustained.

Canvey Island, on the opposite Essex shore, suffered in a similar manner at the same time.

For some years past this practice of removing littoral gravel has been stopped on the Kentish southern coast since Mr. Redman reported for the War Office on the condition of the beaches at Sandown, Deal, Walmer, Dover, Eastbourne, &c., who strongly urged the suicidal nature of the practice, since which the Government and local authorities have had notice-boards planted along the beach imperatively forbidding the removal of shingle.

This general *leeward* movement of shore detritus, due to the prevailing wind waves, has been of late years so clearly demonstrated by the authorities cited, and accepted generally by marine engineers, that it appears strange to find editorial articles for months in a magazine of wide circulation dealing with engineering science which resuscitate the old and exploded theories on the question which are to be found in early geological works, and these articles, if not accepted, have at least remained hitherto apparently unchallenged.

We would sum up this perhaps somewhat lengthy review of a topic, of no mean importance however, having reference to our insular position, by saying that the passage of the heavier particles (the shingle) of a marine mound or natural mole is due universally to the action of the waves, although attributed by many early geological writers to the ocean currents—and its influence on the tidal harbours of our shores, is very important.

The masses of shingle are heaped up coincident in direction with the waves which sort the material in regular gradation; an alternate renewal and withdrawal, due to change of wind, produces a resultant leeward motion due to the wind the particular coast is most exposed to, and the largest pebbles in all these marine alluvion are universally accumulated on the summit, and to leeward of the prevailing winds, due to their greater momentum and to their being less influenced by the recoil wave, compared with sand and the smaller stones.

At the last meeting of the South-Eastern Railway Company we find the chairman (Sir E. W. Watkin, M.P.) stating in reference to the proposed Lydd Railway and the line to Dungeness, that it not only would secure in the future the shortest route to the Continent, but that it also gave them access to an important bed of shingle, from the sale of which they anticipated great benefit! and that they saw their way to *do a large trade* in its conveyance. It was important for road-making, railway-ballasting, and concrete foundations and walls.

This is the not over scrupulous view of the chairman of a leading railway company of one of the most important natural breakwaters on the south-eastern coast, and the uses to which it may be applied as a quarry for the benefit of his company.

The great land-slip which left Warden Church on the verge of the cliff, causing its ultimate recent removal, occurred in September, 1859, and this had been preceded by a similar great fall to the westward about the year 1856, that of 1859 being in effect a prolongation or extension of the earlier one towards the eastern end of the island. The falls are the result of a gradual subsidence occupying some hours, due to the thorough saturation of the London clay by land drainage down several small chines, and the effect of atmosphere and weather on the face of the cliffs and their degradation at the base by the sea during spring-tides. In effect a broad belt of land moves seaward (not a mere abrasion or undermining of the cliff alone), settles vertically downwards, or spreads out, and slides seawards, presenting a new cliff landward at the last parallel fissure, the moving mass attaining a state of rest in the shape of an under-cliff, with a series of parallel terraces rising and falling in the valley of the fall, with the turf and vegetation undisturbed; and the foreshore and shingle are ploughed up by the fall, forming a kind of "moraine" at the base. After a fall the ordinary waste goes on at an average rate of one yard per annum. Some of the trees near the church had settled down bodily on the prisms of earth to which they were attached, some fifty feet lower in level than when they were *in situ*, showing how gradual and vertical had been the subsidence.

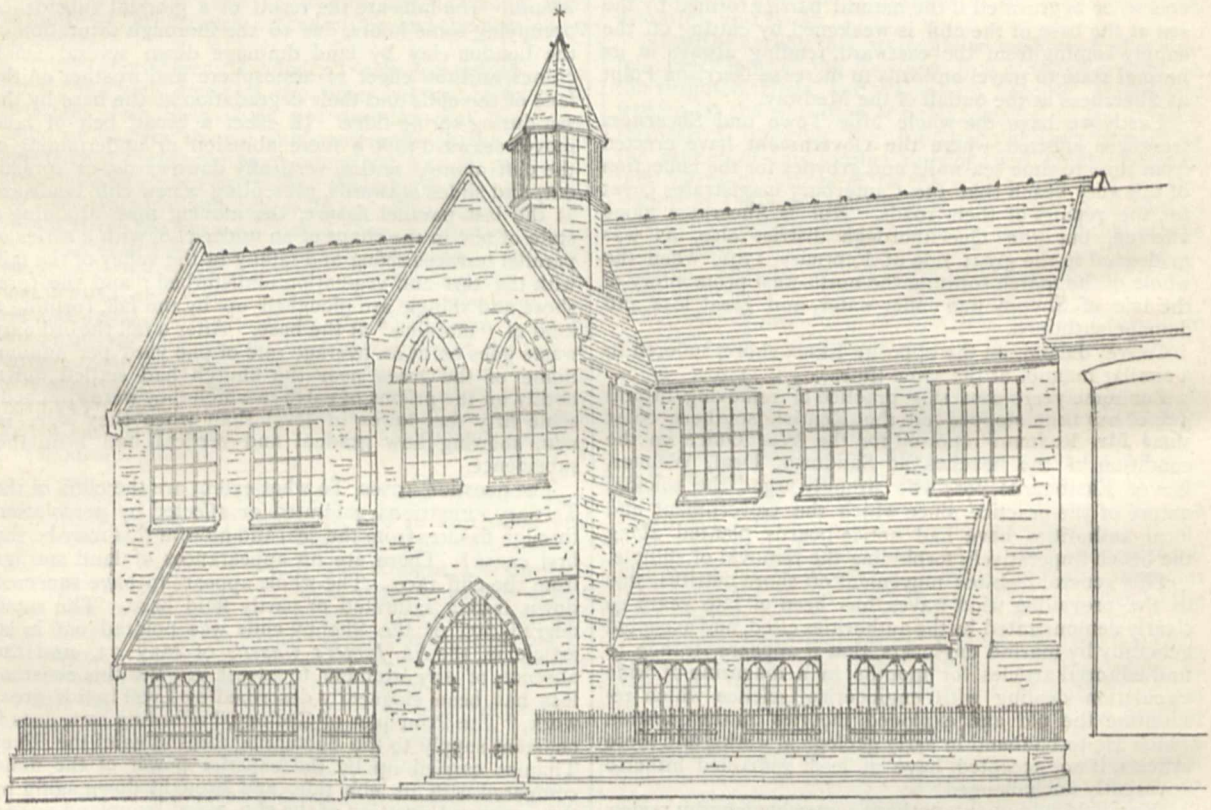
The question arises, To what extent are the cliffs in the Tertiary formations saturated or affected by percolation through fissures from the sea, and how far this may be the first cause? There are no appearances of land springs from the cliff face. The whole appears to have squeezed down into a saturated or partly fluid base. The rapid degradation of the Sheppy cliffs was pointed out in an article in the *St. James's Gazette* of May 23, and the absence of any attempts to arrest it. But this constan loss has been eloquently described by Lyell in his great work, "The Principles of Geology," affording as it does a constant supply to the fluctuating foreshores of the River Thames carried up by the superior power of the flood compared with its ebb tide, and brought down again by the prolonged duration of the ebb, aided by upland waters in steps downwards.

SCIENCE AT ETON

ALTHOUGH Eton still ranks as a purely classical school, and has not established a modern side as her rival Harrow has done, yet the study of science is pursued within her walls to an extent which—in some respects at least—is unequalled at any other school. The numbers of the school vary somewhat on each side of 900 boys, about 120 of whom, constituting the Fourth Form, do no science. About seventy boys more from the Fifth Form make up the Army Class, and do no Science unless they take in Physical Geography and Geology for their final examination. But in the Remove and in the greater part of the Fifth Form, which constitutes the chief mass of the school, two lessons a week in science enter into the regular work of each division.

At the present time the Head-Master has twenty-two Classical Assistants, and the Lower Master two. There are nine Mathematical Masters, and four for science, two

of whom also give a little help in the mathematical, and one in the literary teaching. On emerging from the Fourth Form a boy spends a year in Remove, during which his two weekly science lessons are devoted to Physical Geography (*Erdkunde*). Passing on into the Lower Division of the Fifth Form, he is taught the elements of Mechanics, treated experimentally; and during the next year, spent in "Middle Division," he is occupied with Heat, including the principles of the steam-engine. Except in the case of the Army Class, therefore, science is compulsory during three years of every boy's school life. When he enters the Upper Division of the Fifth Form he may drop science altogether, and devote the two lessons a week to additional mathematics. If he does not do this he has his choice between Chemistry, Geology, Physical Geography, and Biology. Many boys leave the school without reaching any higher stage than this; but those who pass on into the "First Hundred" can either give up science in favour of mathematics or of some literary subject, or, on the other hand, they may take up a second scientific subject, and get an additional two lessons a week. During the present School-time they can select from Chemistry (Metals), Physics (Light), Geology (Elementary and Advanced), Physiography, Botany, and Physiology (Muscle and Nerve). Hence a boy who enters Remove at thirteen and stays at Eton until he is nineteen, has the opportunity of acquiring a considerable amount of elementary scientific knowledge. He hears two lectures a week and writes out an abstract of them which is looked over and corrected. His progress is tested by written examinations, the frequency of which depends upon the master he is "up to." Oral



VIEW OF SOUTH FRONT

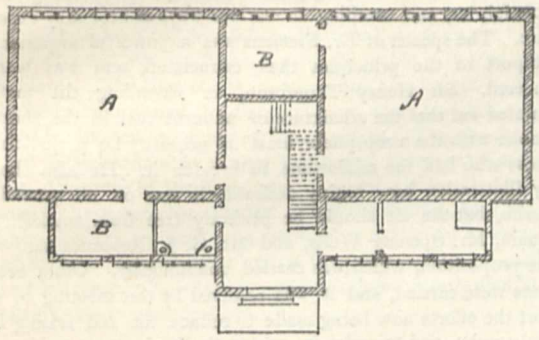
examination is rarely possible except in the upper parts of the school, owing to the necessarily large size of the classes.

At the examinations for promotion which occur every Half, though they are annual as regards individual boys, science is allotted from one-tenth to one-twelfth of the total marks. Although it is not a "pluck subject" like mathematics, yet many a boy who has failed by a few marks in his "general total" regrets not having paid more attention to his science lectures, which would have enabled him to make up the deficit; and the effect is often visible in the improvement in his abstracts during the next School-time.

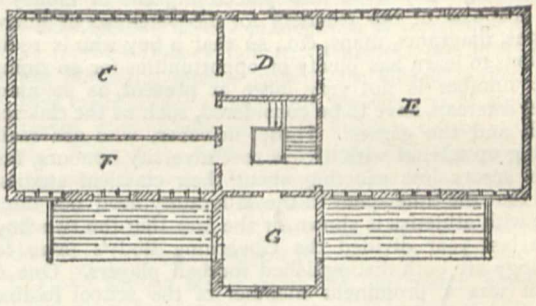
Besides the compulsory science, which is a part of the regular school-work, many boys devote three or four hours of their spare time every week to some form of practical scientific work. Most of them are preparing themselves to try for the prizes given annually by the Governing Body for Chemistry and Physics, Geology and Physical Geography, and Biology respectively. A chemical laboratory, with accommodation for twenty-eight boys at once, has been in use for some years. It owes its existence in great part to the liberality of the present Head-Master, Dr. Hornby, some of the Assistant Masters, and some old Etonians. The laboratory and chemical lecture-room, together with a private laboratory, apparatus-room, store-rooms, &c., form a handsome building in Keate's Lane. Opposite to it is the Round School, formerly used for mathematical teaching, and now converted into a museum. It contains a fine collection of British birds made by the late Provost of King's College, Cambridge, Dr. Thackeray, and presented by him to the school. Some of the specimens are valuable, owing to their being mentioned by Yarrell. There is also a good collection of Lepidoptera made by a former pupil of the school, and presented by his parents after his untimely

death, within two years of his leaving Eton. A tolerably complete series of recent shells has been obtained, and a collection of the more important zoological types is in process of formation. Geology is represented by a fair series of British rocks and fossils, and by remains of the mammoth, hippopotamus, reindeer, and *Bos primigenius*, from the river gravels of the neighbourhood, together with flint implements and neolithic axe-heads which have been dredged out of the river. There are also a few cases of specimens illustrative of volcanic and glacial action, and of the more important processes of Metallurgy, pottery, &c.

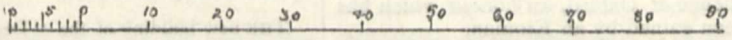
Beyond the laboratory, and separated from it by the racquet-courts, are the new Science Schools, which are



— GROUND-PLAN —

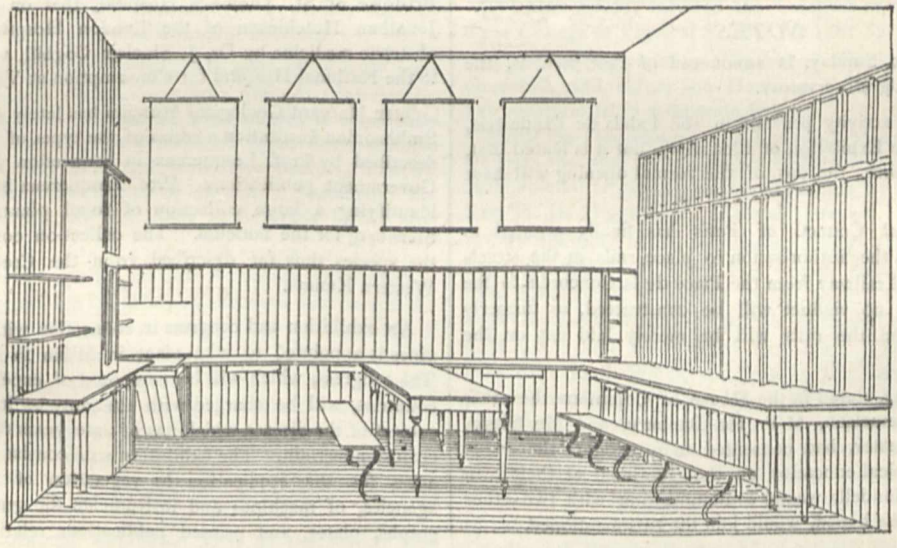


— FIRST-FLOOR-PLAN —



— SCALE OF FEET —

being used this Half for the first time, three out of the four Science Masters having been hitherto accommodated in some discarded mathematical schoolrooms. On the ground floor there are two schoolrooms (A, A), each accommodating forty boys, and two preparation-rooms (B, B) opening into them, besides furnace-room, lavatory, &c. On the first floor are the biological laboratory (C), preparation-room (D), and schoolroom (E), all *en suite*, together with a general apparatus-room (F) and stores room (G). The laboratory, which is 28 feet by 16 feet has accommodation for seventeen boys at once, the table, running along the length of the room, so that the workers shall face the window. Except for the necessary supports, this is continuous along almost the whole of one side of



— GENERAL VIEW OF BIOLOGICAL LABORATORY —

the room. The other side is occupied by shelves and a large cupboard, half of which is divided up into compartments, one for each boy. A sink, a bookshelf, and a large slate occupy three of the corners, the door being at the fourth. The rooms are all panelled with stained deal to a height of about 5 feet from the floor, which leaves ample space for diagrams above.

The building has been designed and erected by Mr. E. Aborn of Eton, at the cost of the Governing Body of the College, of which Prof. Huxley became a member rather more than a year ago as the representative of the Royal Society. At the request of his colleagues he provided Mr. Aborn with a statement of what he thought was required for the proper accommodation of the three houseless Science Masters, and the result is the eminently practical but inexpensive building, with which all who

use it, both boys and masters, are alike pleased. The schoolrooms are the best in the College as regards light and accommodation for teachers and taught, and offer a striking contrast to the dark and uncomfortable rooms which were built a few years ago for the Mathematical Masters.

Besides providing a home for the science-teaching, the Governing Body have also placed a grant of money at the disposal of the teachers for the purchase of microscopes, diagrams, maps, &c., so that a boy who is really anxious to learn has plenty of opportunities for so doing. The number is not very large at present, as so many other interests have to be considered, such as the classical work and the games. Those, however, who are really taking up science with a view to University honours, find their tutors less exacting about their classical studies; and that the time spent in the laboratory need not interfere with athletics is shown by the fact that the two boys who last year divided the Governing Body's prize for Biology are both distinguished football players. One of them was a prominent member of the school football eleven during the past winter, and has this year rowed for the fourth time in the Eton crew at Henley Regatta. His numerous official duties as "captain of the boats" during the last two years have not prevented his acquiring sufficient knowledge to gain him an entrance exhibition for Natural Science at Oxford, an honour which has only once before been gained by an Etonian.

In addition to the Chemical and Biological Laboratories Eton possesses a well-organised School of Practical Mechanics, consisting of a drawing-room, smithy, and shops for carpentry and metal-working, the whole being under the superintendence of a specially-qualified instructor. Much work is done here out of school-hours, oars, bookcases, cupboards, lathes, and a small steam-engine being some of the practical results of this institution, which is now completing the second year of its existence.

NOTES

THE death, on Sunday, is announced of Prof. Bruhns, the Director of Leipzig Observatory.

THE greatest activity prevails in the Palais de l'Industrie, preparing for the Exhibition of Electricity, but it is feared that, in spite of all efforts, the day of the formal opening will have to be postponed.

THE Municipal Council of Paris has finally granted to Siemens Brothers the authorisation to place rails in the streets for their electrical railway from the Place de la Concorde to the Exhibition. But no viaduct will be constructed, as formerly contemplated, and the rails will be merely laid flat on the pavement.

MR. MUNDELLA stated in the House of Commons the other day that Mr. Samuelson, M.P. for Banbury, and Mr. Slagg, M.P. for Manchester, had consented to investigate the whole question of technical education on the Continent at their own expense. Mr. Mundella was in communication with two other gentlemen, who, he hoped, would join the two mentioned.

A PUBLIC meeting will be held on August 8 at the Society of Arts for the purpose of re-organising the Trades Guild of Learning on a larger basis. Among the supporters of the movement is Sir John Lubbock.

A MEETING was held on Tuesday afternoon at Grosvenor House, Park Lane, to receive and consider a report from the Smoke Abatement Committee on the subject of an exhibition and trials of improved heating and smoke-preventing appliances, to be opened at South Kensington in October next. There was a numerous attendance. The exhibition in question will be held n the East and West Arcades and in buildings adjoining the Royal Albert Hall; and gold, silver, and bronze medals, together with certificates of merit, will be awarded upon the report of a special committee. It will be opened on October 24 and closed on November 26. Dr. Siemens moved the first resolution, declaring that the present smoky condition of the atmosphere of London injuriously affects the health and happiness of the community, besides destroying public buildings, deteriorating perishable fabrics, and entailing in various ways unnecessary expenditure. The speech of Dr. Siemens was a powerful argument in support of the principles thus enunciated, and was warmly cheered. Sir Henry Thompson, in seconding the motion, pointed out that the admixture of unburnt fuel in the shape of smoke with the atmosphere must of necessity be prejudicial to those who had the misfortune to breathe it. He also showed by illustration how highly desirable it was on all grounds of health that the air should be perfectly free from smoke. Dr. Quain, Mr. Spencer Wells, and Mr. G. J. Romanes supported the proposition, which was carried unanimously. Other resolutions were carried, and it was resolved by the meeting to support the efforts now being made to reduce the evil arising from coal-smoke, and to assist in raising the funds necessary for constructing and carrying out, on a practical scale, the competitive testing of the various appliances to be shown, and for providing suitable prizes, medals, &c.

THE new building of the "Deutsche Seewarte" at Hamburg will be inaugurated on September 14. The Emperor William will be present, and will at the same time open a Marine Exhibition connected with the building.

THE annual meeting of the British Medical Association has been delayed a week beyond its usual time in consequence of the Medical Congress meeting in London. It will extend from the 9th till the 12th of August, and is to be held at Ryde, Isle of Wight. The address on medicine will be delivered by Dr. J. S. Bristowe of St. Thomas's Hospital, that on surgery by Mr. Jonathan Hutchinson of the London Hospital, and that on obstetric medicine by Dr. J. Sinclair Coghill, visiting physician to the National Hospital for Consumption at Ventnor.

THE Harvard Geological Museum has lately received from the Smithsonian Institution a series of the types of the fossil plants described by Prof. Lesquereux in connection with his various Government publications. Prof. Lesquereux is also engaged in identifying a large collection of fossil plants made by Mr. Sternberg for the museum. The collection contains nearly all the species thus far described from the Cretaceous beds of Western Kansas.

AN exhibition and congress in connection with the culture of vines is appointed to take place in Milan in September next. The congress, which will be composed of experts from various countries, will be charged with the duty of inquiring into the subject of the disease which has of late years rendered the wine crop so uncertain. The exhibition will consist mainly of appliances for the application to vegetation of insect-destroying agencies, of machines and instruments for grafting, of photographs, plates, and printed publications relative to the vine disease, specimens of vine parasites, and numerous other objects serving similar purposes.

ACCORDING to the Mineral Statistics of Victoria for 1880 the quantity of gold raised in the Colony for the past year was 829,121 oz. 5 dwt., being upwards of 70,173 oz. more than in 1879. While there has been a decided increase in the quantity raised in alluvial mines, the main increase has been in the quartz mines, which have yielded 529,195 oz. The increase in alluvial mines is partly due to the opening-up of new gold-producing areas, and partly to the operations of the diamond drills recently imported.

AN interesting discovery has been made in one of the limestone quarries of Stromberg (Rhenish Prussia). In a small cave, such as occur frequently in the calcareous rock, the skeleton of a cave-bear was found. To judge from the thickness and length of the bones the animal must have measured at least 2½ or 3 metres in length and 2 metres in height. The teeth, of which sixteen were found, are of enormous size. Discoveries of this kind however are by no means rare in this neighbourhood, nor indeed in limestone caves generally.

AN earthquake shock was felt in Eastern France on the night of July 21-22 at Aix-les-Bains, Lyons, Grenoble, Chalons, and other places. The time of the phenomenon was 2h. 3s. a.m. at Lyons and Chalons, and the direction from north to south. No accident is reported in either of these places. The shock was also felt in Switzerland in a large number of places, at Geneva, Morges, Lausanne at about 2h. 45m. a.m. local time; indeed it is stated to have been the sharpest felt in the district since 1854. Nowhere has any accident been recorded. A terrible storm was raging in these regions on the 21st, a few hours before the earthquake took place. Spontaneous currents have interrupted also the telegraphic communications.

A SPECIAL library has been established by subscription in Paris for secular education. The subscribers have resolved to adopt a scientific creed, and to prescribe the use of fiction in books written for young people.

MR. RICHARD ANDERSON, the author of the well-known work on "Lightning Conductors," will contribute a short series of articles on "Thunderstorms: their History and Mystery," to the *St. James's Magazine*. The first article will appear in August.

M. BRUGSCH, conservator of the Boulak Museum, has returned from Thebes with the contents of twenty sarcophagi recently discovered behind the ancient Palace of Queen Hatason. Amongst some 5000 antiquities which have been obtained the most remarkable are several mummies in a perfect state of preservation, and of considerable historical interest.

THE boring of the Arlberg tunnel is proceeding with great rapidity. The length finished since June, 1880, is 1720 metres, and an average yearly advance of 2160 metres is confidently expected after a while. The average of Mont Cenis and the St. Gothard was only 1112 and 1670 respectively. The St. Gothard tunnel will be completed by the end of September, but the lines of approach are not likely to be ready before next spring.

THE *Weserzeitung* reports that near the village of Rantrum a quantity of silver has been found buried about one foot deep in the ground. It consists of thirty-four small bars, six fragments of antique silver ornaments, and eight coins; the latter bear Arabic inscriptions, and may probably be dirhems of the Abassidic Caliph of Bagdad, who lived in the eighth century of the present era. The small bars were formerly used as money, and were weighed, before coins had any conventional value. Ornaments were frequently used in the same way. All the objects found were in a vase.

THE seventh Annual Exhibition held by the British Beekeepers' Association was opened at the Horticultural Gardens on Tuesday, and will remain open till Monday next.

A REMARKABLE eruption was recently observed by the passengers of the ss. *Glenelg*, at the northern end of the Bay of Plenty, New Zealand. The water rose suddenly to a height of four feet, and spread over a circle of sixty feet in diameter, throwing up sand, shells, stones, and mud. The steamer was only about twenty yards outside the circle. The water continued boiling for some time.

THE *Italia Centrale*, a paper published at Reggio (Emilia) announces that the most remarkable mud-volcano of the province of Emilia, the Salsa di Querzola, has developed an extraordinary activity for a few days past, and has greatly frightened the neighbouring inhabitants. Loud subterranean noise was heard even in the plains around, incandescent lava was ejected to a height of several metres, and an earthquake was also noticed. Large numbers of tourists and curious inhabitants are proceeding to Regnano to witness the spectacle.

A REMARKABLE natural phenomenon is reported from Cs. Gorbo (Szolnok-Doboka Comitat, Hungary). On June 27 the Buznau Mountain, situated close to the village of Paptelke, suddenly broke in two. The fissure measures 30 to 40 metres in breadth, 25 to 30 metres in depth, and 400 to 500 metres in length. Some of the houses in Paptelke also show cracks, so that the whole seems to have been the effect of an earthquake. A landslip took place at the same time, and a field with an apple-tree in the middle of it has moved about 10 metres nearer to the village. Great excitement prevails in the neighbourhood.

VARIOUS antique bronze arms and implements, altogether weighing about four or five kilogrammes, have been found by forest labourers at a place called Friedhofstannen, in the district of Cattenbühl, near Oberode (Hanover). They were buried in the ground at a very slight depth. The objects consist of battle-axes, a sickle, a knife for taking off the hides of animals, a bracelet, rings. They are supposed to be of Celtic or Phœnician origin. In the neighbourhood of the spot where they were found there is an ancient earth-mound, dating from a very remote period, and inclosed by a circular pit of some 400 yards in circumference, the so-called ring or "kring." Above it was the Hessian fronter fortress of Friedeweh, below it the Spiegelburg.

THE tenth general meeting of the Saxo-Thuringian Apicultural Society will be held at Quedlinburg on July 31–August 2. An exhibition of living bees in hives, also of implements and products of bee-culture, will take place simultaneously.

WE have already received the Calendar of the Newcastle-on-Tyne College of Physical Science for 1881-82.

AN interesting paper on "Prehistoric Hackney" by Mr. J. E. Greenhill, read before the Hackney Natural History Society, has been printed in a separate form.

FROM the *Proceedings* of the Liverpool Naturalists' Field Club we learn that that society has reached its majority. There is the usual account of excursions and an address by the president, the Rev. H. H. Higgins, on "Animal Defences."

THE additions to the Zoological Society's Gardens during the past week include a Silver Fox (*Canis fulvus*, var. *argentata*) from Nova Scotia, presented by Mr. S. R. Platt; three Hedgehogs (*Erinaceus europæus*), British, presented by Mr. W. Dunn, C.M.Z.S.; two Black-tailed Parrakeets (*Polytelis melanurus*) from New South Wales, presented by Mr. Gerald Arbuthnot; a Green Tree Frog (*Hyla arborea*), European, presented by Mrs. Humphrey; six Black and White Geese (*Anseranas melanoleuca*), seven Australian Wild Ducks (*Anas superciliosa*) from Australia, received in exchange. The following, amongst many other insects, may now be seen in the Insectarium:—Perfect specimens of the Swallow-tailed Butterfly (second brood from small larvæ), Camberwell Beauty, Spurge Elephant and Privet Hawk-moths, Northern Brown Butterfly, Chalk-hill Blue Butterfly and Burnet Moth. There are also fine examples of the imago of the Atlas Moth, and larvæ of this moth larger than any yet grown in England.

OUR ASTRONOMICAL COLUMN

ENCKE'S COMET.—The ephemeris of this comet for its approaching re-appearance was issued from Pulkowa last month; but unfortunately the editor of the *Astronomische*

Nachrichten has not considered it was necessary to reprint it in that journal, where the ephemerides for previous appearances have always found a place.

After the death of Dr. von Asten, the calculations for this comet were taken up by Dr. O. Backlund, who has continued the computation of the perturbations by Venus, the Earth, Mars, Jupiter, and Saturn from 1878 to 1881, taking account also of the effect of the so-called resisting-medium on the mean motion and angle of excentricity. The following are the elements of the comet's orbit :—

Epoch 1881, July 2·0 M.T. at Berlin

Mean anomaly	319	26	48″·7		
Longitude of perihelion	158	30	5·5	}	M.Eq.
,, ascending node ...	334	34	3·1	}	1881·0.
Inclination	12	53	0·3	}	
Angle of excentricity	57	43	30·75		
Mean daily sidereal motion ...	1072″·65852				

From these elements we find—

Semi-axis major ... 2·22005	Perihelion dist. ... 0·34301
Semi-axis minor ... 1·18547	Aphelion dist. ... 4·09709
Excentricity ... ... 0·8454969	Period ... ... 1208·21 days

The track of the comet in the heavens at this appearance is a favourable one for observation in this hemisphere. It will be nearest to the earth on October 11, when it will be distant 0·543 of the earth's mean distance from the sun, and situated in the constellation Leo Minor, in the vicinity of the star Fl 21, and the theoretical intensity of light will attain a maximum on November 9, when the comet situated near 89 Virginis will rise about 2h. 15m. before the sun.

The following ephemeris for the month of August is contracted from the accurate one given by Dr. Backlund, and applies to mean midnight at Berlin :—

	R.A. h. m. s.	Decl. ° ′	Log. distance from Sun.	Earth.
August 1 ...	2 56 22 ...	+26 31·0 ...	0·2701 ...	0·2400
3 ...	3 0 23 ...	27 0·3		
5 ...	3 4 31 ...	27 30·2 ...	0·2592 ...	0·2173
7 ...	3 8 46 ...	28 0·7		
9 ...	3 13 9 ...	28 31·9 ...	0·2478 ...	0·1934
11 ...	3 17 41 ...	29 3·9		
13 ...	3 22 22 ...	29 36·6 ...	0·2359 ...	0·1683
15 ...	3 27 14 ...	30 10·2		
17 ...	3 32 18 ...	30 44·5 ...	0·2233 ...	0·1419
19 ...	3 37 35 ...	31 19·8		
21 ...	3 43 6 ...	31 56·0 ...	0·2101 ...	0·1142
23 ...	3 48 53 ...	32 33·1		
25 ...	3 54 58 ...	33 11·2 ...	0·1962 ...	0·0850
27 ...	4 1 23 ...	33 50·2		
29 ...	4 8 10 ...	34 30·3 ...	0·1814 ...	0·0543
31 ...	4 15 23 ...	+35 11·3		

It remains to be seen whether the comet can be perceived with the larger telescopes of the present day with a less intensity of light than 0·24, which was that at the time of its discovery in August, 1848, with the 15-inch refractor at Harvard College, U.S., and which will correspond to about the day of new moon, August 24.

COMET 1881 *c*.—Elements of this comet have been published in circulars issued from Lord Crawford's Observatory at Dun Echt, from which it appears that it will increase very considerably in brightness. The perihelion passage does not take place until August 21. The comet is rapidly approaching the earth.

BIOLOGICAL NOTES

ON SOME NEW LOWER GREEN ALGÆ.—George Klebs publishes some very interesting facts about a number of forms of green Algæ found living within the cell-tissues of some flowering-plants. The painstaking way in which the life-history of these have been worked cannot be too sufficiently admired. For full details the student should refer to the numbers of the *Botanische Zeitung* for April and May, where also will be found excellent coloured illustrations of all the species. In order to call attention to these curious species we give the specific diagnosis in detail :—*Family Protococaceæ. Genus Chlorochytrium.*—Through continued division into two parts each cell becomes resolved into spherical zoospores, which upon leaving the mother-cell conjugate within the gelatinous envelope. The zygozoospores before becoming surrounded with a membrane make their way by means of processes into the intercellular spaces of living plants. During the time favourable for vegetation many generations follow one another in a single year; that nearest to the winter falls into a resting stage. *Chlorochytrium lemnæ.*—This species lives in the widened intercellular spaces of the parenchyma of the *Lemna trisulca :* cells chiefly spherical or elliptical; the part of the growing zygospore which remains in connection with the epidermis becomes a spherical cellulose plug. In the next genus, Endosphæra, through continued division into two, each cell falls into a number of daughter-cells surrounded with a membrane, from which, by further division, the spherical zoospores result; those, taking their origin from the same mother-cell, immediately upon leaving it conjugate; they make their way into living tissues like those of the Chlorochytrium. The formation of zoospores only takes place in the spring; the new generation requires a full year to reach maturity. The species *Endosphæra biennis* lives in the intercellular spaces of the sub-epidermal parenchyma of leaves of *Potamogeton lucens :* its cells are mostly spherical; the part of the germinating zoospore which remains in connection with the epidermis soon dies off. In the genus Phyllobium at the time of maturity, the protoplasm of every cell containing chlorophyll is differentiated into cylindrical or spherical portions, through the changing of some of these into smaller ones, zoospores—both macro and micro are formed—these conjugate. The zygozoospores make their way into the stomates of partly living, partly dead leaves of phanerogams. The development of every cell takes a year. The species *Phyllobium dimorphum* lives in the leaves of *Lysimachia nummularia*, Ajuga, Chlora, &c.; the zygozoospores develop processes which grow into branched green tubes among the vascular bundles belonging to the veins of the leaves. The protoplasm of those zygospores which develop a process forms into either a spherical or longish resting cell, which lasts during the winter, and in the next summer again develops zoospores. According to the surrounding circumstances the processes are well developed or not. They may be quite rudimentary, in which case small tubeless resting cells become formed, which form asexual zoospores. In the genus Scotinosphæra every cell shows at the time of maturity a differentiation of its green protoplasm into cylindrical or spherical bodies; by their conjugating, during which a reddish granular substance is secreted, a single mass is formed, through whose repeated division, during which division the granular substance is gradually again taken up, the zoospores are formed. These are asexual, and make their way into decaying vegetable tissues. Their development lasts a year. *Scotinosphæra paradoxa* lives in the dead or dying tissues of *Lemna trisulca*, and also in species of Hypnum. Its cells are mostly spherical, and the zoospores are spindle-shaped. (*Botanische Zeitung*, May 27, 1881.)

ON THE INFLUENCE OF INTERMITTENT ILLUMINATION ON THE DEVELOPMENT OF CHLOROPHYLL.—Dr. Karl Mikosch and Dr. Adolf Stöhr publish the result of their investigations made in the Physiological Institution of the Vienna University. The results of these they summarise as follows :—If a continuedly-lasting 2·5-minutes illumination of etiolated seedlings of barley or oats is compared with an intermittent illumination in the relation of 1 : 1 lasting five minutes, then one will find that in both cases the light is throughout present an equal time. Now if the chlorophyll-formation takes place at the same time as the illumination, then the working of the continued illumination must exactly correspond at the end of 2·5 minutes with the sum of the single effects of the intermittent illumination. As a matter of fact, however, at the end of the continued illumination there has been either no chlorophyll formed, or at any rate no quantity of it that can be pointed out anywhere. On the other hand, the mass of chlorophyll which is formed during the intermittent illumination is beyond doubt capable of being pointed out with a spectroscope. One must therefore imagine that a certain time elapses between illumination and chlorophyll-formation. From this however it follows :—1. That the chlorophyll-formation is a process of photochemic induction. The first trace of chlorophyll that can be pointed out with a spectroscope appears in seedlings of barley and oats grown in the dark after illumination lasting five minutes; it is a matter of indifference whether it is illuminated the whole time through, or only in the relation of 1 : 1 second. One cannot take for granted that in the one case only the half quantity of chlorophyll is formed when an alcoholic solution even shows the absorption-lines of the chlorophyll spectrum, still this will clearly disappear if the solution is made

half as weak again. Consequently the smallest possible effective light for the formation of chlorophyll is attained by intermittent illumination. During the formation of chlorophyll light is supplied in superabundance by a continued illumination in the same manner as at the heliotropic bendings.

A FRENCH physiologist, M. Gley, has made some delicate experiments on himself with regard to the effects of attention and intellectual work on cerebral circulation. His results confirm those of M. Mosso, and he has added some new observations. He finds that the rhythm of the heart through intellectual work is slightly accelerated; and this increase seems in direct ratio of the intensity of the attention. Thus the pulse was more frequent when the author studied geometry, with which he had little familiarity, than when he studied philosophy, of which he had a good knowledge. While the heart-rhythm is accelerated the carotid artery is dilated during cerebral work, and the carotidian pulse becomes dicrotic. But the radial pulse becomes smaller and less ample. The phenomena of congestion observed in the brain persist a certain time after cerebral activity.

CHEMICAL NOTES

BY the action of methylic iodide, in presence of sodium, on an alcoholic solution of morphine, M. Grimaux has succeeded in producing codeine, identical in properties with the naturally-occurring alkaloid (*Compt. rend.*). If ethylic iodide is employed in place of the methyl salt, a new alkaloid differing in composition from codeine by CH_2, is produced. M. Grimaux proposes to call all the homologous bodies of this series *codeines*, and to distinguish the commonly called codeine as *codomethyline*, the new homologue as *codethyline*, &c.

IN *Gazzetta Chimica Italiana* S. Valente describes a striking lecture experiment illustrative of the fact that chlorine replaces iodine from binary compounds. A jar, 500 c.c. capacity, is filled with dry hydriodic acid gas, and another, 250 c.c. capacity, with dry chlorine, the jars being separated by a glass plate, and the larger being uppermost; on withdrawing the plate decomposition of the hydriodic acid occurs with a flash of rose-coloured flame, and separation of iodine.

SS. BARTOLI AND PAPASOGLI claim to have prepared mellitic and hydromellitic acids by the long-continued electrolysis of water, using carbon electrodes (*Nuovo Cemento*).

S. FUNARO describes two nickeliferous minerals from the Apennines in the *Gazzetta Chim. Ital.*, to one of which he gives the formula $(FeNi)_7S_8$, and to the other the formula $Cu_2R_{10}Sb_4S_{17}$, where R = Cu : Fe : Ni = 3·4 : 4·2 : 2·4.

IN continuing his investigation of the action of hydrogen peroxide on aromatic compounds (NATURE, vol. xxiv. p. 111) Dr. A. R. Leeds shows that in some of these compounds the peroxide acts only as an oxidiser, in other cases it replaces hydrogen by (OH), and sometimes both actions occur together (*Berliner Berichte*).

THE same chemist has repeated (*Amer. Chem. Journ.*) many of these experiments, wherein ozone is said to be produced by the action of heat on metallic and non-metallic oxides; he finds that in every case the supposed ozone reaction, obtained by bringing the evolved oxygen into contact with potassium iodide and starch, is due to traces of impurities, generally to traces of chlorine.

ACCORDING to M. Chappuis (*Bull. Soc. Chim.*) the phosphorescence of phosphorus in oxygen or air is an accompaniment of the combustion of phosphorus vapour by ozone. Phosphorus is not luminous in pure oxygen at 15°, and at the ordinary pressure, introduction of a trace of ozone causes luminosity; those substances which hinder the luminosity of phosphorus, *e.g.* turpentine oil, are substances which destroy ozone. If a little turpentine oil is brought along with phosphorus into a tube containing pure oxygen, and a small quantity of ozone is then passed in, the phosphorus exhibits luminosity for a few moments only; M. Chappuis supposes that this is due to the combustion of phosphorus vapour by the ozone, and that the transiency of the phenomenon is explained by the rapid removal of the ozone by the turpentine oil.

EXPERIMENTS on the action of heat on oxides of manganese, by S. V. Pickering, are detailed in *Chem. News*. According to this chemist some specimens of manganese oxides undergo a slow molecular change when kept. Thus a sample containing, when freshly prepared, 85·149 per cent. MnO_2, 9·356 per cent. MnO, and 5·490 per cent. H_2O, *lost* 1·065 per cent. oxygen when heated to 100°, but after eighty days the same sample *gained* 0·24 per cent. oxygen when heated to 100°, and 1·114 per cent. at 195°.

HERR E. RAMANN concludes from his experiments (*Berliner Berichte*) that the passivity of iron is always caused by the formation of a layer of magnetic oxide (Fe_3O_4) on the surface of the iron. In addition to nitric acid, the following liquids induce passivity in iron, viz. ammoniacal silver nitrate solution, solutions of nitrate of silver, ammonium, aluminium, nickel, cobalt, or iron.

THE same author describes an amalgam of iron, nearly of the composition expressed by the formula Hg_3Fe_2, prepared by the action of sodium-amalgam on finely-divided iron in presence of water. Dry sodium-amalgam has no action on iron.

HERREN V. MERZ AND W. WEITH have investigated the action of heat on various amalgams with the view of determining whether these bodies lose mercury regularly as temperature increases, or whether they exhibit the properties of definite compounds. The results, which are detailed in the *Berliner Berichte*, seem to show that many amalgams, *e.g.* of gold, silver, copper, bismuth, lead, cadmium, &c., although very easily decomposed by heat, nevertheless contain their component elements in definite proportions by weight; such amalgams are probably to be classed as molecular compounds. Amalgams of the alkali metals exhibit the properties of definite compounds in a greater degree than amalgams of the other metals.

IN the *Berichte* Herr V. Meyer publishes a note on the densities of the vapours of the halogens, in which he states that he means to relinquish the further working out of these problems to M. Crafts. He states that he has obtained numbers for the densities of phosphorus and arsenic which stand midway between those required by the formulæ P_4 and As_4, and P_2 and As_2.

VARIOUS papers on new nitrogen derivatives of carbon compounds are published in the same *Berichte*, by Prof. V. Meyer and his students; these papers promise results of much interest. Hitherto "azo-compounds" have only been known in the aromatic series; nitroso-substitution compounds of what is apparently azo-ethane are described by Prof. Meyer, especially $NO-C_2H_4-N_2-C_2H_4-NO$. A new series of organic bases called "*ketines*" is also described. The starting-point of this series is *ketine* or nitrosoacetene, $CH_3-CO-CH_2(NO)$.

HERR STRECKER (*Annalen Phys. Chem.*), from determinations of the velocity of sound in chlorine, bromine, and iodine gases, has obtained the following numbers for the specific heats of the e gases:—

	Chlorine.	Bromine.	Iodine.
At constant pressure ...	0·115	0·05504	0·03489
At constant volume ...	0·08373	0·04257	0·02697
Ratio of values of the two specific heats ...	1·323	1·293	1·294

From these results it is concluded that the action and reaction between the atoms in the molecules of these gases is different in kind from that which subsists in other diatomic molecules, *e.g.* oxygen or carbon monoxide.

REMSEN has again investigated the action of finely-divided iron in inducing the formation of cyanide when nitrogen is passed over a hot mixture of carbon, iron, and an alkaline metal; he finds (*American Chem. Journ.*) that freshly reduced iron induces a large formation of cyanide, but that iron after keeping for some time loses this power.

FROM experiments on the decomposition of barium carbonate by ammonium chloride solution, Tommasi (abstract in *Berliner Berichte*) concludes that an aqueous solution of sal-ammoniac contains free ammonia and free hydrochloric acid.

REFERENCE was recently made in these Notes to the experiments of Jones on gaseous boron hydride; Reinitzer describes experiments (*Wien. Akad. Ber.*) which appear to show that when dilute hydrochloric acid acts on potassium boride the solid green-brown amorphous powder which is formed is a boride of hydrogen approximately of the formula $B_{3\cdot32}H$.

CONSIDERABLE doubt has been expressed whether calomel is or is not liable to decomposition in the human system, with production of corrosive sublimate. According to experiments described by P. Hoglan (*Chem. News*) calomel is slowly changed

by the action of water at the temperature of the body with formation of corrosive sublimate; and this change is accelerated by the presence of citric acid, sodium chloride, or sugar.

FROM analyses and examination of the distillation vessels used in zinc furnaces, Herren Schulze and Steiner (*Jahrb. für Mineral.*) have found that these vessels contain well-formed crystals of *zinc-spinell* (or zinc aluminate) along with crystals of tridymite. The authors discuss the bearing of their results on the natural formation of minerals of the spinell group in limestones; they point out that the generally accepted hypothesis that such limestones must have been in a fused state for some time, is not necessary, but that the minerals may have been formed by the action of vapour penetrating the solid hot limestone. The action of gases on a softened rock mass may give rise to molecular changes resulting in the production of various minerals.

PHYSICAL NOTES

A CONTINUOUS registering thermometer for recording the temperature of the body has just been described by its inventor, M. Marey. It consists of a brass tube communicating with a Bourdon manometer, containing oil, and closed. Any change of temperature, by altering the internal pressure, makes the curved manometer tube curl more or less, and to it is fixed an index which registers the movements by inscribing them on a recording cylinder. The thermometric bulb may be at some distance from the inscribing apparatus, being connected by a flexible tube of annealed copper. Two such bulbs may be applied to different parts of the body, even to the interior. It is possible therefore to note the relations between the temperatures of the interior and exterior of the body. If we remember rightly, an analogous but more portable instrument was suggested some time ago by Mr. Donald Macalister, but we are not aware whether his instrument is yet before the public.

PROF. E. LOMMEL describes in *Wied. Ann.* a new polarising apparatus in which two plates of platinocyanide of magnesium, cut perpendicularly to the optic axis, are used as polariser and analyser, just as in the tourmaline pincette. Such a section of this crystal transmits a blue light, which, when the angle of incidence exceeds 2°, is found to be perfectly polarised in the plane of incidence, and it therefore can be used, if tilted to that extent out of perpendicularity to the axis, as a polariser for a pencil of parallel blue rays. One curious point in respect to the behaviour of a thin film thus prepared is the following:—Let ordinary non-polarised light be looked at through the crystal while the latter is normal to the line of sight. A white central spot, perfectly circular in form, and non-polarised, is observed in the middle of a blue field, which is polarised at every point radially. The only other crystals which can be used for polarising pincettes are the tourmaline and herapathite (iodo-sulphate of quinine): the point of difference between these and the platinocyanide of magnesium is that while the two former (which are negative crystals) absorb the ordinary ray, and must therefore be cut parallel to the optic axis, the latter absorbs the extraordinary ray, and must therefore be cut at right-angles to the optic axis.

THE galvanic properties of carbon have been closely examined by Dr. Hanichi Muraoka, a Japanese student at Strassburg. He determined the specific resistance and the change of resistance with increase of temperature of all kinds of hard carbon, including Siberian graphite, gas-retort carbon, the artificial carbons used for electric lighting by several well-known firms, and even the graphitic compound used in Faber's lead-pencils. The specific resistance (at 0° C.) of the last was 952·0, while that of the first was 12·2. The artificially-prepared carbons ranged from 36·86 to 55·15. In all however the resistance *decreased* with a rise of temperature, the coefficient of decrease being greatest for the Siberian graphite, least for a carbon pencil prepared from coke by Heilmann of Mühlhausen. This result entirely confirms the recent researches of Siemens and Beetz. The thermo-electric powers of the various samples of carbon were also determined, with respect to that of graphite; their thermo-electromotive force was in every case + to graphite, and varied from 423 microvolts for the Faber pencil carbon to 9·26 microvolts for the gas-retort carbon (of Parisian manufacture) used for battery plates.

HERR P. VOLKMANN observes that in the determination of the specific gravity of heavy liquids, such as quicksilver, by means of the specific gravity bottle or pyknometer, the change of volume of the vessel caused by the internal pressure may introduce a source of error, especially as the glass vessel may suffer a sub-permanent strain from which its recovery is not immediate. He gives an example of this error in the case of a pyknometer provided with a capillary tube marked in equal divisions. This pyknometer was filled with mercury *while standing in mercury* until the top of the column stood at 68·1 divisions. On taking it out of the mercurial bath the column fell to 65·4, and on dipping it it again rose to 68·5. The necessary precautions to avoid this error having been taken, a redetermination was made of the specific gravity of distilled mercury at 0° C., the density of water at 0° C. being assumed (at Pierre's value) as 0·999881. The new value for the density of mercury comes out as 13·5953 ± ·0001, which is a little less than the lowest of the values given by Regnault.

PROF. S. P. LANGLEY has made the following calculation:—A sunbeam one square centimetere in section is found in the clear sky of the Alleghany Mountains to bring to the earth in one minute enough heat to warm one gramme of water by 1° C. It would therefore, if concentrated upon a film of water 1-500th of a millimetre thick, one millimetre wide, and ten millimetres long, raise it 83⅓° in one second, provided all the heat could be maintained. And since the specific heat of platinum is only 0·0032, a strip of platinum of the same dimensions would, on a similar supposition, be warmed *in one second* to 2603° C.—a temperature sufficient to melt it!

THE alteration of the zero of thermometers after undergoing sudden changes of temperature is a well-known phenomenon, as is also the gradual rise in the zero in thermometers during the first few months after they have been made. M. Pernet has lately examined the question whether the distance between the "boiling point" and the "freezing point" of a thermometer is constant at all different stages of secular alteration in volume of the bulbs, and finds that this is so, provided the freezing point be determined immediately *after* the boiling point. On the other hand, if the boiling point be determined and a long interval elapse before the zero is determined, there is considerable error. Suppose a thermometer to be (owing to recent heating or to long rest) in any particular molecular state. In this state its reading will probably be in error: but this amount (so far as due to the above cause) may be ascertained by immediately plunging the thermometer into ice, and observing the error of the zero reading. In order that a thermometer should read rightly at any particular temperature it should be exposed for a considerable time to the temperature for which exact measure is desired, or else for a few minutes to a slightly *higher* temperature.

THE transparency of ebonite to heat rays may be shown by the following pretty and simple experiment. A radiometer is set revolving by the light and heat radiated from an argand gas-flame or the flame of a paraffin lamp. When a thin sheet of ebonite is interposed the rotations continue though with slightly diminished energy. But the thinnest sheet of note-paper interposed suffices to check the revolution of the vanes.

PROF. GRAHAM BELL has sought to prove whether the diaphragms subjected to intermittent radiation in one of the forms of the radiophone did or did not execute mechanical vibrations. The experiment of Mr. W. H. Preece of attaching a Hughes' microphone to the disk had led to negative results. But Prof. Bell has shown that the central region of the disk (on which the rays fall) is set into mechanical vibration; and he has proved the point by employing a modification of the mechanical microphone of Wheatstone. A stiff metallic wire is fixed to the centre of a thin metallic disk mounted at the extremity of a flexible hearing tube. When the end of the wire is pressed against any vibrating body its sounds are heard, and the vibrations at different points of the disk of a radiophone can be successively explored. The vibrations are found to be almost entirely confined to the illuminated area at the centre of the disk. A Hughes' microphone attached to the edges of the disk would therefore not easily give any indications. With this simple apparatus one very curious effect was obtained. An intermitted beam of rays was focussed upon a brass kilogramme weight, and the surface was explored with the point of the metallic microphone. Over all the illuminated area and for a very short distance outside it a feeble but distinct sound was detected, but not over other parts.

MR. EDISON has devised a new meter for voltaic currents even more ingenious than the "Weber-meter" which he proposed a year ago to fix in houses supplied with electric lamps. In the

new instrument two copper plates are suspended in an electrolytic cell containing sulphate of copper in solution, and placed in a branch circuit through which a known fraction of the main current is shunted. The copper plates are hung upon a lever arm so adjusted that when by electrolysis one has grown a certain amount heavier (by deposition of copper) and the other grown an equal amount lighter, the lever tips up and reverses the current through the cell, and at the same time moves a registering dial-apparatus through one tooth. The action goes on again until the tilting lever is again overbalanced, and tipped back, when the current is again reversed, and another registration effected. Each "tip" clearly corresponds to the passing of an exact quantity of electricity through the cell, and the registered indications are therefore proportional to the total consumption. *But will it work?*

HERR ED. DORN has investigated the relation between the absolute diameters of molecules of gases and their dielectric capacity on the lines of a suggestion due to Mossotti, that the properties of dielectrics might be explained by supposing them to consist of non-conducting material, in which innumerable minute particles of conducting matter are imbedded.

EVERYONE knows that the very feeblest currents produce audible sounds in the telephone, which is more sensitive than any galvanometer to feeble currents. M. Pellat lately declared that the heat necessary to warm a kilogramme of water one degree would, if converted properly into the energy of electric currents, suffice to produce in a telephone an audible sound for ten thousand years continuously.

GEOGRAPHICAL NOTES

THE preparations for the International Geographical Congress, to be held in September next at Venice, together with a Geographical Exhibition, are advancing rapidly. The *Bolletino* of the Italian Geographical Society announces in its last number that the saloons for the Exhibition are already distributed among the exhibitors, and that the nations which will occupy the most space will be Italy, France, Germany, Austria and Hungary, Russia, and Switzerland. The saloons allowed for the Exhibition in the royal palace being insufficient, it was agreed immediately to proceed to the construction of provisional buildings. The Italian railway companies have granted a reduction of 30 per cent. on the prices of tickets, and of 50 per cent. on goods for members of the Congress. The Austrian Lloyd and the Navigation Company, "Rubattino e Florio," grant a reduction of 50 per cent. on passengers' fares. As to the questions to be discussed at the Congress, the Commission has already published in the *Bolletino* its reports on most of them. Among the questions are:—On the Present State of Telegraphic Determinations of Longitude, by G. Lorenzoni.—On the Determination of the Temperature of Sea-water at Different Depths; on the Measurement of Depths; on the State of the Surveys of Coasts, &c., by G. B. Magnaghi; on the Extinction of Aboriginal Races, by L. Hugues; and on the Teaching of Geography in Schools, by L. Schiaparelli. We do not hear of any great activity in the collection of British exhibits for the annexed exhibition of geographical apparatus, &c. In England, indeed, no great interest is felt in these congresses. In Russia, on the contrary, a collection of apparatus has for some time been in preparation. M. Grigorieff is to represent the Russian Government and the Imperial Geographical Society at Venice.

THE Swedish Government has decided to send a scientific expedition to Mossel Bay in the course of next year, for the purpose of collecting meteorological information. The expedition will be directed by Capt. Malmberg, and will have to remain during the summer of 1882 and the winter of 1883, in order to obtain the observations of an entire year. Mossel Bay is situated to the north of Spitzbergen, lat. 79°54, long. 16°15. The locality is well known to the Swedes. Prof. Nordenskjöld stayed there in the winter of 1872-73 with three ships. A Swedish man-of-war will take the expedition to Mossel Bay, under the command of Capt. Palander, who, after having fixed the special meteorological station of Capt. Malmberg, will return to Sweden.

WE find in the last number of the *Bolletino della Società Geografica Italiana* a paper on the journey of the late Signor G. M. Giulietti from Zeila on the Gulf of Aden to Harar. This journey was accomplished in 1879, and the narrative was intended to form part of the complete description of all Signor Giulietti's travels, but after his death M. Guido Cora published this small fragment with a map of the country. We notice also in the same publication a paper by Prof. G. Pennesi on the Italian missionaries who travelled in Lower Guinea during the second half of the seventeenth century; also accompanied with a small map of the country. The author speaks at some length of the two most interesting journeys of P. Dionigi Carli from Piacenza, and of P. Gio. Antonio Cavazzi from Montecuccolo.

COUNT WALDBURG-ZEIL, the well-known scientific explorer, started from Bremerhafen on board the steamer *Luise* for the River Yenisei on the 22nd of last month. The journey is undertaken solely for scientific purposes, Count Waldburg-Zeil intending to make collections illustrating the fauna of the Siberian coast and the sea in that district.

IN a letter just received from the Gaboon Père Delorme reports the foundation of a mission station on the Ogowé River, which the French are making peculiarly their own. The station is placed at the east end of a large island in the river, called by the natives Ozangé-Nengé, *i.e.* Island of Light, which is conveniently situated for communicating with the tribes on the banks of the Ogowé and the Ngunié, one of its principal affluents. Immediately round the station are the Galois; next to them, on the right bank of the Ogowé, come the Eningas, while further south, on the left bank, or rather on the banks of a branch of the Ogowé, which goes to form Lake Ajingo, are found the Adyombas. Père Delorme expresses a decided opinion that these three tribes are really one people; they all speak the same language and have the same laws. All of them are very vain and voluptuous. The Galois despise agriculture, and are a trading people. They go up beyond the rapids of the Ogowé in search of india-rubber, ivory, and ebony. The slaves, or in default of them the women, are left to attend to the cultivation of manioc, banana trees, ground-nuts, and sugar-cane.

THE statement that an instalment of the Geographical Society's large map of Eastern Equatorial Africa will be issued this month is, we learn, unauthorised; and though, probably owing to the long delay which has already occurred, the propriety of issuing the map in parts has been discussed, the question is still left open. When ready, the map will be published by Mr. Stanford.

THE fourteenth Congress of the Italian Alpine Club will meet at Milan on August 29 to September 2 next. An Alpine exhibition will also be held, and three excursions will be made: the first to Erba in the Brianza and the grotto of Pinto, the second *viâ* Como to Varenna on the Lake of Como, and the third to Etico, coupled with an ascent of Monte Grigna.

THE death is announced of the well-known African traveller Herr J. M. Hildebrandt. He died on May 29 last at Tananarivo (Madagascar).

DR. O. FINSCH, the Polynesian traveller, safely arrived at Sydney from New Britain at the beginning of May. He stayed over eight months in New Britain, and has thence sent forty-five cases containing natural history collections to Berlin *viâ* Hamburg. These collections consist of no less than 12,000 zoological specimens, a large number of anthropological objects, besides a series of ethnographical specimens, surpassing in number and completeness any collections yet made in this field. Dr. Finsch intends staying only a short time at Sydney, and then proceeds to New Zealand in order to become acquainted with real Maoris, for the sake of comparison with the Polynesian and Mikronesian races he has studied so minutely. Afterwards the traveller, in continuation of his Melanesian researches, intends to visit North Australia to see and study the so-called Australian negroes. For the same purpose he will try to stay upon New Guinea for some time, as he considers the minute study of real Papuans of great importance.

NEWS has been received from Commander van Boekhuyzen, the leader of the Dutch North Polar Expedition. He writes from Vardö to say that the *Willem Barents* could not reach Spitzbergen. The ice extended in a compact mass from 68° 30′ N. lat. and 6° W. long. to 73° 30′ N. lat. and 14° E. long., some twelve geographical miles to the north of Vardö. There was ice also some thirty geographical miles south of Bear Island. Commander van Boekhuyzen will make another attempt to get northwards in 72° N. lat., and then return home after a month, as he is convinced that Novaya Zemlya is completely inclosed in a barrier of ice.

LETTERS from Dr. W. Kobelt have just been received by the Rüppell Institution at Frankfort, who are the promoters of the expedition. The letters are dated from Oran. Dr. Kobelt's

travels were much impeded by a revolution among the natives and the prolonged drought. Nevertheless four cases, containing collections of seeds, plants, reptiles, insects, and mollusks, have arrived at Frankfort, and Dr. Kobelt has obtained valuable results concerning the geographical distribution of mollusks. With regard to the revolution among the Arabs it appears that they are of opinion that the fifty years during which the Prophet has permitted the French to hold Algiers are now over. Dr. Kobelt has left for Spain, where he will continue his researches.

We are informed that Mr. J. M. Schuver, the adventurous Dutch traveller, who not long ago started on his formidable journey from Cairo to the Cape, is not at Famaka, on the southern frontier of Fazokl, as has been stated, but has established his head-quarters for the present a considerable distance to the south, and actually in the Galla country. A quantity of stores have lately been sent from London to Fazokl for him by way of Suakim, and it is Mr. Schuver's intention to return to Fazokl for them in November next, before proceeding on his southward journey. In the meantime he has established a dromedary post between his camp in the Galla country and Khartum.

In the July number of *Petermann's Mittheilungen* Lieut. Kreitner describes at considerable length the observation made by him while in company with Count Szechenyi, journeying from Sayang in Yunnan to Bhamo in Burmah; a useful map accompanies the paper. Dr. Junker continues his letters describing his travels in the Niam-Niam country, concluding with some important observations on a visit he paid to some of the Monbuttu tribes. Dr. Radde concludes the narrative of his journey to Talysh, Aderbéjan, and Savulan.

We have received from Perthes of Gotha parts 23 to 26 of the new edition of Stieler's Hand-Atlas. This edition has continued to appear with praiseworthy regularity, and will be completed in other six parts.

Among the papers in No. 20 of the *Bulletin* of the Lyons Geographical Society are the following:—The Economic Unity of the Globe, by Prof. C. Stewart Merritt; the South Pole, by M. E. Chanbeyrin; the Slave Coast, by Dr. Chappet; South Africa, a lecture by the Rev. M. Coillaird, the missionary who succeeded Serpa Pinto; Lake Fucino, by M. Math. Desgrands.

The U.S. steamer *Alliance*, in search of the *Jeanette* expedition, arrived at Hammerfest on its way to the Siberian Arctic Seas on the 24th inst.

The Egyptian Geographical Society does not often issue a *Bulletin*, but when it does the number usually contains some good matter, often drawn from the archives of the General Staff, the chief of which is President of the Society. The number just published contains, among other matter, a paper on Cape Guardafui by Col. J. Graves of the Staff, and another on the country between the coast and the lofty plateau of Abyssinia by Gen. Stone Pasha.

Commandant Titre, who was formerly at the head of the Survey Department in Algiers, has lately published a large map of Algeria, which embodies all the most recent topographical information.

SOLAR PHYSICS—THE CHEMISTRY OF THE SUN[1]

We have next to consider another method, which enables us to determine the motions of the solar gases. It has been already noticed that it is easy to see the prominences rushing with extreme velocity upwards in radial lines from the photosphere, and that while they are thus being carried up by some violent motion of ejection from below, they are twisted out of the radial line, now to the right, and now to the left, by what we are justified in describing as winds in the atmosphere of the sun. Those were the mere visual phenomena which were incidentally observable the moment a method was obtained of viewing the forms of prominences as well as the bright lines produced by the vapours of which they were built up, and they afforded us an opportunity of getting an insight into solar meteorology.

It was soon however perfectly clear that there was another method, in some respects a much better method, of doing this work. When we consider how it happens that we get any phenomena visible in our universe at all, we are driven to the conclusion that it depends on the fact that bodies in a state of agitation reflect, so to speak, their own state of agitation on the ether, and that the ether carries those vibrations, those agitations to our eyes. So that if we can assume, as we must assume, that the sun with its gases, consisting of hydrogen, magnesium, &c., was communicating its vibrations to the ether, and the ether was communicating in its turn its vibrations to us, it was obvious we had there an opportunity of testing a view which had been put forward by Doppler a good many years ago, to the effect that the light from a moving light source is not the same in all its qualities as light from a fixed one.

The colours which we see in the spectrum are exactly analogous to the notes which we hear in a piano when we go from one end of the scale to the other. Doppler imagined the equivalent of a piano going away from or coming towards the listener with considerable velocity — a velocity comparable, in fact, to the velocity of sound through the air. It is perfectly clear that under these circumstances we should no longer get true concert pitch, for the reason that the note which gives us a certain tone, because it produces in the air so many waves per second, will change its tone if the source of the note is coming to us. Take, for instance, a tuning-fork giving concert C, and imagine it rapidly coming to us: the waves of sound will be crushed together, we shall have more waves in a second falling on the ear, and we shall get a higher note. If we imagine, on the other hand, the tuning-fork is going away from us, the notes will be paid out at longer intervals, so to speak, and we shall get a lower note. In neither case shall we continue to have concert C. A very familiar instance where we do get this change of pitch due to change of motion, is produced in these days of very rapid railway travelling. Any of us who have been at a country railway station when the express is coming by will know that as the train approaches us the note of its whistle is at one pitch, and as it goes from us after passing it changes and gets lower, according to the velocity of the train. A familiar experimental illustration of this principle is to attach a whistle to the end of a long india-rubber tube. If then a person sounds the whistle by blowing through the open end of the tube, and while still blowing whirls it round rapidly in a vertical plane in which an observer is standing, that observer will note that when the whistle is approaching him in one part of the curve, and the waves are therefore being crushed together, the note will appear higher than when it is receding from him in the opposite part of the curve, where the waves are being, as it were, pulled asunder. Now apply that to the light of the sun. The long notes of light are red, and the short notes are blue, and if we sharpen or shorten any light note in any part of the spectrum we shall give that light a tendency to go towards the blue, and if we lengthen or flatten it we shall give it a tendency to go towards the red, so that, for instance, if a mass of magnesium gas giving the line or note in the green indicated by "*b*" is approaching us with a velocity comparable to the velocity of light, the line will change its position in the spectrum towards the blue; and if we are careful to note the exact amount of change of refrangibility as it is called, we shall have then an absolute method of determining the rate of motion of that mass of gas. This will help us in more ways than one. Suppose we observe the gas at the limb of the sun, we shall then, if we get any change of refrangibility, be justified in calling it a solar wind, because the motion thus indicated would be very nearly parallel to the surface of the sun; but if on the disk of the sun itself—take a spot, for instance, in the very middle of the disk—we get any change of wave-length such as I have referred to, it is perfectly clear that we shall no longer be dealing with what we can justly call a wind, it will really be an upward or downward current. So that this principle enables us at the limb of the sun to determine the velocity of solar winds, and at the centre of the sun to determine the velocity of those up-rushes or down-rushes, in fact, those convection currents to which Prof. Stokes has already directed attention.

The accompanying drawings (Fig. 16) were made when the sun was in a considerable state of agitation in the year 1872. They give us one of the lines of hydrogen, and indicate, I think, amply this kind of phenomenon. We have in the first figure on a large scale the "F" line of hydrogen, the line in the green at the edge of the sun. The slit—the perfectly straight slit—has been worked round the limb in search of a prominence, and it has found one. But the slit is no longer shown us as a perfectly straight line, it is in fact a very irregular one; and further than this it branches

[1] Lectures in the Course on Solar Physics at South Kensington (see p. 150). Revised from shorthand notes. Continued from p. 274.

at a certain height. The line of hydrogen has really divided into two lines of hydrogen, so that there we get, according to the principle just laid down, an indication of the fact that the hydrogen up to a certain height was very nearly at rest, and that beyond part of it was torn away, the line being deflected towards the blue, indicating that it is approaching us. Now the other Fraunhofer lines in the diagram may be looked upon as so many milestones which enable us to measure by the deflection the number of miles traversed by the gas in one second; for these deflections are nothing more or less than alterations of wave-length, and, thanks to Ångström's map, we can measure distances along the spectrum in $\frac{1}{10000000}$ mm., and we know that an alteration of $\frac{1}{10000000}$ mm. in the wave-length of the F line towards the violet means a velocity of thirty-eight miles a second towards the eye; and that a similar alteration towards the red means a similar velocity from the eye; so that carrying the part

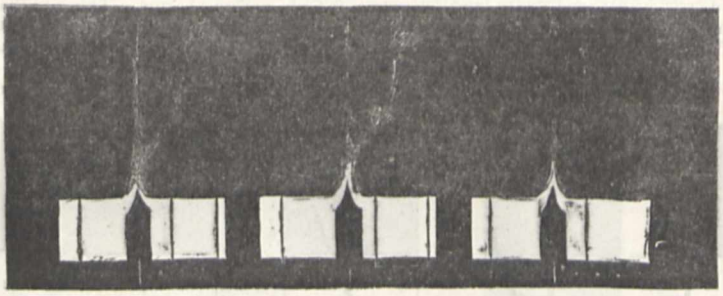


FIG. 16.—Alterations of wave-length in prominences. The dots show $\frac{1}{10000000}$ mm.

of the line which has the greatest deflection from the normal down to the dots, we find that the velocity of the solar wind under observation at that time was something like 114 miles per second.

In the second figure this same prominence is seen a short time afterwards. The tremendous rush of hydrogen has descended somewhat nearer the sun, and bringing that in the same way down to our milestones, we can give that velocity at something like fifty miles per second. The wind velocities measured in this way have amounted to 140 miles a second. The phenomena of convection currents give us velocities which very often amount to forty or sixty miles a second.

This method enables us to determine a matter which a few years ago we could not have determined in any other way. I refer to the fact that the motions of the solar winds are to a very large extent cyclonic. These various effects have been produced by varying the position of the slit a very little indeed over a small prominence.

In the first of the accompanying diagrams it will be seen that the hydrogen line indicates by its change of refrangibility that the gas is receding from us, that the waves are being lengthened out, and that they therefore have approached towards the less refrangible end of the spectrum. In the third diagram we see that in that part of the prominence the rays were being deflected towards the violet; that is to say, they were approaching us. In the middle of the prominence we get indications that they were both receding and approaching, as shown in the second diagram. Now if anybody in the moon had as good a method as this of measuring an earthly cyclone, he would see exactly this sort of thing—the part of the cyclone receding from him would give a deflection in one direction, the centre of the cyclone would give him both deflections, because he would get currents going in both directions, and on the other side of the cyclone he would get a deflection in the other direction.

So obvious and so very definite did these observations at last become that a new word had to be coined to separate the forms of

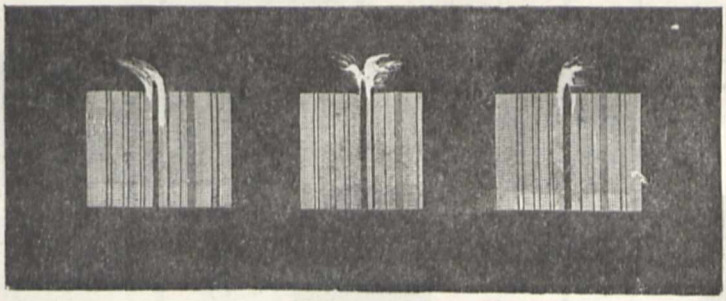


FIG. 17.—Solar cyclone. Left-hand diagram, retreating side of cyclone on slit; centre diagram, both sides on slit; right-hand diagram, advancing side on slit. The right-hand side of each diagram is the most refrangible.

the prominences as seen with a widened slit from the forms which were assumed by the prominences depending on their rate of motion.

Fig. 18 is a diagram of what have for this reason been called "motion forms," because such forms are really not the forms of the prominences at all—have nothing whatever to do with the shape of the prominences, but are simply produced by the various changes in the refrangibility of the light brought about by the varying motions in different parts. It is a very remarkable fact, noticed at the time, that some prominences seem to be shot up like so many smoke rings—little cyclones. And many of the strangest motion-forms are due to this cause. The velocities in the same prominence vary very much from the time it leaves the photosphere until it arrives at its greatest elevation in the sun's atmosphere, indeed the variations in any one prominence are almost as great as the variations observed between any two prominences.

There is another important fact connected with this: when the phenomena are observed close to the limb it is very often seen that the dark line on the surface of the sun is broken; in fact we got a doubling of the dark "F" line in exactly the same way as we got this doubling of the line in the prominence itself. That taught us that not only were these motions enormous in the case of vapours ejected from the sun, but that the subjacent parts of the sun itself—of the photosphere rather—felt that same influence.

The next point observed was (and this was an observation very difficult indeed to make near the limb) that whenever we got any very considerable velocity we got a new order of phenomena altogether, indicated in these two diagrams (Figs. 19 and 20).

It was found that the absorption of the hydrogen, or of the magnesium, or of the sodium, as the case might be, was enormously reduced; that for that part of the sun there was practically no absorption; but instead of absorption an excessive brilliance

in that part of the spectrum where the dark line would otherwise be. In the brighter portion between the two small spots (Fig. 19) the absorption is replaced by an exceedingly brilliant radiation, so brilliant indeed that it is quite impossible to draw a diagram so as to give any idea of the intense brilliancy of some of these little spots of light which one sees in the spectroscope; they fatigue the eye enormously, although they cover such a very small portion of the field of view.

Accompanying this intense radiation there is a gradual fading away of the absorption line; it wanes, and fades, and becomes almost invisible; while, on the other hand, on the other side or in other places, instead of getting a brilliant patch of light of the same width as the "F" line, we get one many times broader. We have also the absorption deflected to the left, or red end of the spectrum, and on this side it is gradually fined or eased off, so that it is very difficult to determine exactly where this broadened, deflected "F" line actually ceased to give us absorption; whereas at the other side, where it changed its refrangibility towards the blue end of the spectrum, we have an enormous patch of light. Now the explanation of that is perfectly simple: we have at one part of the spot an enormous up-rush, an ejection of hydrogen so intensely hot that it declines naturally to absorb the light from anything behind it, because it finds nothing hotter. This gradually replaces the absorbing hydrogen which was driven down again with considerable velocity, and so changed its refrangibility towards the the red.

Enough has been said already to show that this method of studying solar phenomena *in situ* has really helped us enormously

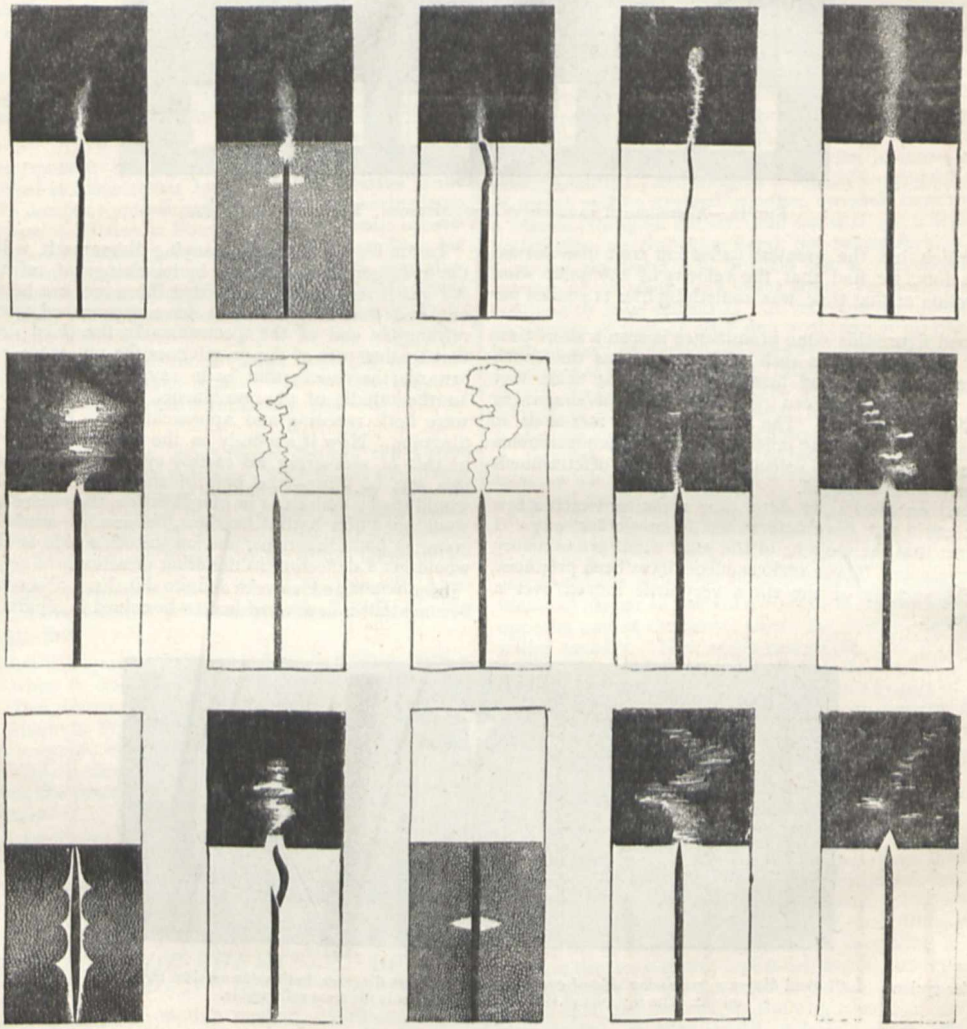


FIG. 18.—Motion-forms.

with regard to the chemical nature of the sun. We can allocate the absorption of the hydrogen, magnesium, and so on; we can see *where* they are absorbing, and in the phenomena just referred to, where they cease to absorb, we get bright lines.

What, then, was the totality of the knowledge which had been acquired a few years ago with regard to the chemical nature of the sun's atmosphere taken as a whole—the sun's atmosphere from the upper reaches of the coronal atmosphere down to the region where, doubtless, the spot phenomena are located?

I have two little glass vessels here which ought to point what I wish to say. I have here hydrogen arranged so that I can make it luminous with a minimum of agitation. If we examined it with the spectroscope, we should find it would give the F line alone, there is nothing red about it. Now there is a region around the sun which gives us something very like that in colour, and something absolutely like it, so far as the result of spectroscopic observation is concerned. Now we have in this other little tube hydrogen in a condition to be considerably agitated, because instead of allowing it to occupy a globe, it is arranged so that the electric current has to pass through a fine capillary space in which the gas is inclosed. That is a condition which is supposed to give us the effect of high temperature. This really does give us something like what we see in the next lower solar region. This is exactly the same gas as we have in the globe, but it is treated differently, and the effect is widely different. As we pass from few encounters of molecules to many it is very much more luminous, and it is red. The level which gives such a spectrum as is got from the capillary tube is considerably lower than the one which gives us the F line alone (Fig. 21).

Is this all? By no means; going further down, as was pointed out at an early stage of the work, we get some lines seen in the spectrum of magnesium all round the sun at certain periods of the solar activity. Underneath this again we get a layer in which lines seen in the case of sodium are almost as constantly seen. Still a lower depth—practically there is no end of them—in which we get the lines of iron and other substances. There are many lower variable layers depending upon local disturbance. Tacchini, an eminent Italian observer, has studied these very carefully. We have by these observations a means of determining the fact that the solar atmosphere consists of what may be very conveniently and justly called a very considerable number of layers; and what happens with these layers is this. If the sun is quiet, or if we observe any particular part of the sun at any particular time at which it is not agitated, the layers

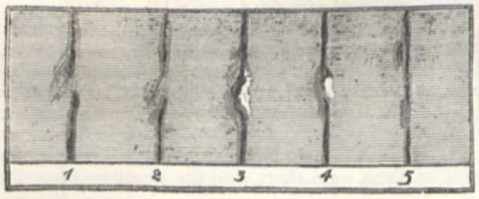


FIG. 19.—Contortions of F line on disk. 1 and 2, rapid downrush and increasing temperature; 3 and 4, uprush of bright hydrogen and downrush of cool hydrogen; 5, local downrushes associated with hydrogen at rest.

visible at that time, few in number, are nearly concentric (Fig. 21), but the moment there is any agitation in any part of the sun the lower layer shoots up into the next layer above it; the next shoots up into the one next above that; and so on (Fig. 22). How far into the very confines of the solar atmosphere this sort of action goes we do not know, because it wants more time to observe than is afforded by an eclipse, but it is certainly known that from the very lowest layer to the upper hydrogen one the layers are made to obey this same sort of rhythmic movement, and extend over like so many shells, so many domes on every part of the sun, which is being most violently agitated at the time.

So far then we have so many shells, so to speak, so many thinnings out.

Tacchini's work shows well that observers have gone into considerable detail. I give one of his drawings (Fig. 23).

The figure shows two separate portions of the chromosphere, and below each portion is shown the height above the photosphere

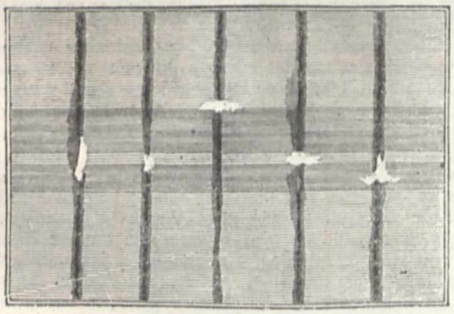


FIG. 20.—Contortions of F line on disk, in connection with spots and uprushes of bright hydrogen.

to which the various substances indicated by the lines given extend. Thus it will be seen that the magnesium stratum reaches the greatest elevation, next the so-called 1474 stuff, then an undetermined substance giving a line at wave-length 4923, another giving a line at 5017, then sodium, then a substance giving a line between B and C, another with a line between B and A, and finally one with a line at 5369. The two last layers were not observed in the second portion shown. It will be observed that most of the lines seen in these small prominences belong to substances with which we are totally unacquainted on this earth.

So much for the first results obtained in localising the solar chemistry. We pass from a general theory, saying that the absorption is above the sun, and that the sun consists of such and such chemical substances; we go to a very much more complete picture, in which we say that the solar absorption is built up by vapours of so and so, and so and so, corresponding to different heights, changing their forms, changing their shapes, changing their quantities at different times, some of them being more particularly visible in the bright ejections from the interior called prominences, and others again being brought to our ken in those down-currents called spots.

Attention must next be drawn to another method of observation, or rather to the same method extended to a different line of work.

Kirchhoff, when he examined the sun as a whole, compared it with the light of a light source as a whole. So far we

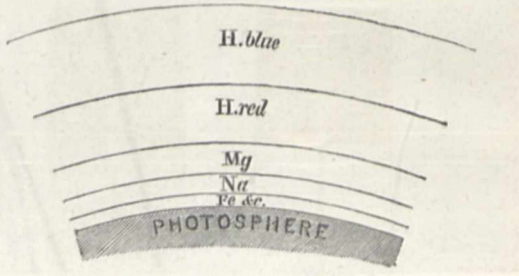


FIG. 21.—Stratification of the solar atmosphere.

have seen the difference in the results obtained when we pass from the question of observing the sun as a whole to that other more detailed question of observing every little bit of the sun that we can get at.

Now is it worth while to do this with the light source?—that is the question. Take the case of the volatilisation of iron in an electric arc. It is obvious that light from every part of a light source placed in front of a slit must enter every part of it; and if there are any differences between the light proceeding from the upper pole or the lower pole, or from the globule of iron which is being melted, and exists in a liquid form, or from the vapours of iron which surround that liquid globule—if there are any differences in these, those differences must be absolutely lost, for the reason that light from all these parts of

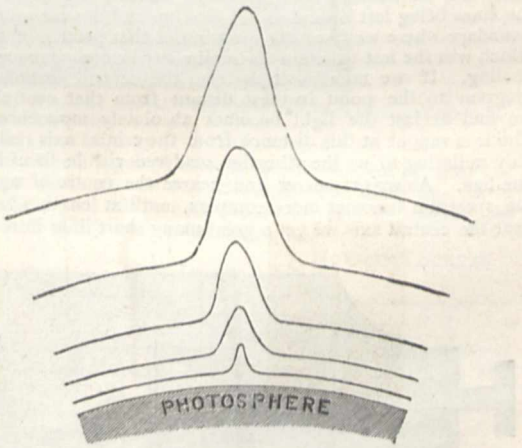


FIG. 22.—Stratification of solar atmosphere, showing the upheaval of a prominence.

the very compound phenomenon we are observing will pass to every part of the slit. But if we introduce a lens between the light source and the slit of the spectroscope, if as we throw an image of the sun on the slit, so we throw an image of the light source on the slit, we ought really to bring about a very considerable difference. For instance, we ought to be able to focus the light on the slit in such a way, that if there are any differences we should see them. It is difficult for us on a small scale to see whether there are any such differences, but if in an electric lamp we so volatilise a piece of iron, and throw the image on a screen, we readily see that there are very considerable optical differences in the various parts of the image of the light

source. We have the upper and lower pole, the globule of iron volatilising, and the vapour, both in the arc, properly so-called, and the accompanying flame. It is obvious that if we throw the image of the arc on the slit we can examine the vapour without getting any light from the pole. It is also obvious that if we arrange the slit horizontally while the current is passing in a vertical direction from one pole to the other, we shall be able,

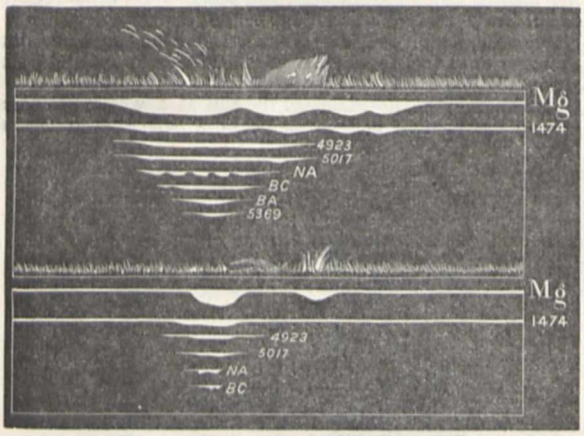


FIG. 23.—Chromosphere with jets (Tacchini).

by moving the slit upwards, to see if there are any differences observable in the vapour, first in the region where we have intense boiling and volatilisation going on, and in the necessarily cooler region where the arc is in contact with the outer air. Photographs taken in this manner show what is really observed in the case of iron under these circumstances. Whether we use the artifice of a horizontal arc with a vertical slit, or a vertical arc with a horizontal slit, does not matter, provided we keep the slit immersed in the light of the arc, and thus reflect the light from the poles, and at the same time arrange the slit so that we can compare the light in the interior portion of the light source with the light nearer its boundaries—if we take all these precautions we shall then get in the case of every substance such a result as here exhibited (Fig. 25). We have in the centre a complete spectrum, its intensity being gradually toned down, and some of the lines being left behind as we look up and down towards the boundary where we have the spectrum of that portion of the arc which was the last to retain its luminosity in consequence of its cooling. If we take horizons from the central portion of the diagram to the point furthest distant from that central axis, we find at last the light becomes absolutely monochromatic. The iron vapour at this distance from the central axis really was only radiating to us the vibration rendered visible to us by that one line. As we get nearer and nearer the centre of agitation the spectrum becomes more complex, until at length when very near the central axis we get a great many short lines introduced,

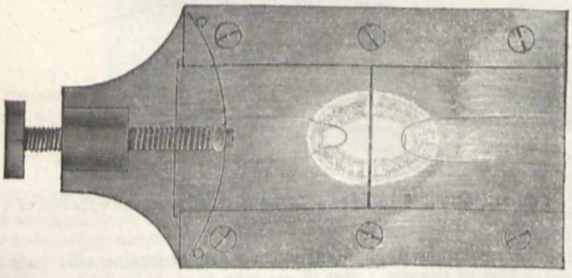


FIG. 24.—Arrangement for obtaining long and short lines. Image of the horizontal arc on slit plate of spectroscope.

so that the spectrum at that point is most complex. This I am anxious to draw attention to with some insistence, because we shall understand at once the terms long and short lines from this diagram, and about those long and short lines there will be a great deal in the sequel.

The figure shows the much more simple spectrum of sodium.

In all cases under the conditions mentioned it is quite easy to obtain photographs of longs and shorts; the longest line in the middle is D, that to the left the line is the green, and we find that one line excels all the others, and reaches a greater distance from the central axis of the photograph.

An electric lamp can be arranged to show the long and short lines of sodium on a screen; the arrangement is rather a delicate one, but the point is that we have not, as in the case of the other electric lamps, vertical poles, but horizontal ones, and we have a vertical slit close to the horizontal poles in the very middle of the lamp, so that if the experiment is carried far enough we can then prove the accuracy of the statement that the line is an image of the slit, because the slit generally melts, and we see the shape of the lines varying on the screen as the melting goes on. The lines are of different lengths: the yellow is longer than the green, the green longer than the red, and so on.

Results obtained by this method have a very important bearing upon every question connected with solar spectroscopy. When these spectra were observed—the spectra of the longs and shorts, of course we had a perfectly new set of phenomena to deal with. In all preceding spectra all the lines had been practically shown of the same length, or else the lengths had represented their intensities. But here we had, in the case of each chemical substance, to deal with the remarkable fact that when that chemical substance was examined in this way, some of the lines were long and some of them were short, and the question naturally arose,

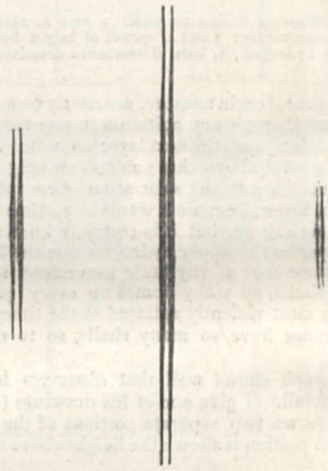


FIG. 25.—Spectrum of sodium, showing the long and short lines.

how is it that some of the lines are long and some of them short? That question was an exceedingly difficult one to answer: I do not know that it has been thoroughly answered yet; but while researches were being made for the answer to this question certain general statements became possible which are of very considerable importance to us in our inquiry. Such a general statement as this, for instance, that if we take, say, some iron, observe its spectrum, and then mix some manganese with it, and observe the spectrum of the mixture: if the quantity of manganese is very small, we shall only get the longest line of manganese; if the quantity of manganese is increased, the next longest line will come in; and so on. So that if the spectrum of any specimen of iron was photographed, it was at once easy to see whether there was an impurity of manganese in that iron. If you make the admission that the spectra of iron and manganese, and so on, were the spectra of bodies not decomposable at the temperature which you were employing—if, for instance, there was a great quantity of manganese existing as impurity in the iron—you got a great many lines, and of course with the quantity of admixture the number of lines would go on increasing until you had 50 per cent. of each, when you would have the greatest number of lines of iron and the greatest number of lines of manganese you could ever get together, but in no case then would you get *all* the lines of iron, or *all* the lines of manganese.

The great importance of this result was, that it enabled any spectroscopist, or any chemist who chose to take the trouble and devote the time to it, to examine as to the existence of impurities in different substances: not to determine the absolute amount of impurity, but enabling him to say that in specimen A

there is a greater impurity of X than there is in specimen B, or there is a greater impurity in specimen Y of article A than there is in specimen Z, and so on. The statements were not absolute, but they were relative, and being relative they were certainly a very great advance on anything which had been done before, because until this question of longs and shorts was introduced it was almost impossible to see how to eliminate impurities.

There was another matter: it was easy to determine the behaviour of compound bodies under the action of heat by such a method. For instance, if we took the salts of calcium, or of strontium, salts which have as perfect and as complete spectra of their own as iron itself—if we heated them properly, that is to say, if we did not employ too high a temperature, and did not give them a chance of oxidising, it was exceedingly easy to see how these would behave when the heat was gradually increased, and it was then found that the longest line of the metal was always the one which showed itself first. In fact the metal always behaved as an impurity, and brought out this longest line first, in exactly the way that the smallest quantity of impurity would do. Those are small examples of the work which was done, in the one case by working at a constant temperature, and in the other case by working at varying temperatures; and you see it was possible in this way to prepare maps in which all the various impurities of one substance in another may be eliminated. A diagram will explain the way in which this new knowledge could be utilised. We have, for instance, a great number of photographs of iron, cerium, vanadium, and a great number of other chemical elements. We have compared the spectrum of each of the chemical elements with all the others, compared the lines of iron with cerium, titanium, and so on. The question now is, Given these photographs bristling with impurities—for if there were no impurities present in these photographs we should not know that our photograph was a good one—how are we to produce a map which shall be absolutely purified, in which none of these impurities shall have any effect? This diagram (Fig. 26) will show the process which was rendered possible by this long and short series of observations. We have there mapped three spectra, with their long and short lines. We have compared A with B, and we find that in the photograph which gives us A compared with B we have so many lines of the two substances. Now we say if B exists in A as an impurity, the longest line of B will be there. We look for the longest line of B, and we find it, and we put a minus sign over that line in A to show it is most probably due to an impurity of B. We then ask if there is any more B in A, and we naturally look for the next longest line of B; we find that, and we put a minus sign over that, and then we look for the next longest line, and mark that; then we look for the next one—it is not there—then there is no more of B in A. In that way, if we knew everything, we should years ago have been able to determine a spectrum of a substance A, from which all traces of the spectroscopic effects due to the presence of a substance B, had been eliminated, and we might go on with substance C, and so on, and in that way eliminate the effects of C as well as B from the substance A.

I am the more anxious to insist on this work because I shall

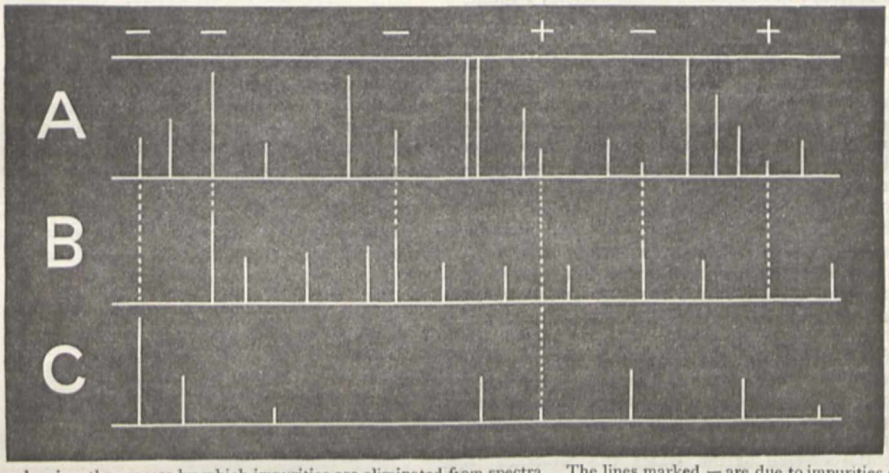


FIG. 26.—Diagram showing the process by which impurities are eliminated from spectra. The lines marked — are due to impurities of one substance in another; those marked + are common or basic lines.

have to show subsequently that it took a very long time to execute it; that the work is of a very rigid nature; and that, so far as I know, no other suggestion has been made with regard to obtaining pure spectra; and of course, if we wish to study the physics of the sun—especially the chemical physics of the sun—the first desideratum, as Kirchhoff saw, and as Ångström saw, and as we all see now, is to have a series of maps absolutely and completely beyond all suspicion.

There is one other question to be referred to. Was the way perfectly clear, taking the work as it stood, four or five years ago? Did our chemical theories then explain all the facts which had been gathered by many men in many lands touching this localisation of the solar chemistry? The localisation had depended on using existing maps, whether tainted with impurities or not, observing the lines in all prominences and spots. Was everything, I say, quite clear, let us say, five years ago? I shall have to show that things were by no means at all clear; that any one who took the trouble to bring together all the results which had been obtained up to that time would have found not only that there was a rift in the lute, but that there was a very big one, and that the discord which grew upon one as one went into detail either with regard to the spectrum of the spots or with regard to the spectrum of the prominences, or with regard to the general localisation of the solar layers, was really very much more remarkable than the accord, and that although, of course, an immense deal had been done towards elaborating a view of solar chemistry a great part of which would stand, still there was a great deal which required a considerable amount of attention and a great deal more which suggested that there was still a higher light to be got before we could really face the magnificent problem with which we are attempting to grapple.

J. NORMAN LOCKYER

(*To be continued.*)

ANCHOR ICE

IN an address recently delivered at the Annual Convention of the American Society of Civil Engineers in Montreal, Mr. James B. Francis, the President, gave, *inter alia*, the results of his observations, during forty years, of anchor ice. The following is the passage in question:—

A frequent inconvenience in the use of water-power in cold climates is that peculiar form of ice called anchor or ground ice. It adheres to stones, gravel, wood, and other substances forming the beds of streams, the channels of conduits, and orifices through which water is drawn; sometimes raising the level of water-courses many feet by its accumulation on the bed, and entirely closing small orifices through which water is drawn for industrial purposes. I have been for many years in a position to observe its effects and the conditions under which it is formed.

The essential conditions are, that the temperature of the water is at its freezing-point, and that of the air below that point; the surface of the water must be exposed to the air, and there must be a current in the water.

The ice is formed in small needles on the surface, which

would remain there and form a sheet if the surface were not too much agitated, except for a current or movement in the body of water sufficient to maintain it in a constant state of intermixture. Even when flowing in a regular channel there is a continued interchange of position of the different parts of a stream, the retardation of the bed caused variations in the velocity which produce whirls and eddies and a general instability in the movement of the water in different parts of the section. The result being that the water at the bottom soon finds its way to the surface, and the reverse. I found by experiments on straight canals in earth and masonry that coloured water discharged at the bottom reached the surface at distances varying from ten to thirty times the depth.[1]

In natural watercourses, in which the beds are always more or less irregular, the disturbance would be much greater. The result is that the water at the surface of a running stream does not remain there, and when it leaves the surface it carries with it the needles of ice, the specific gravity of which differs but little from that of the water, which combined with their small size, allows them to be carried by the currents of water in any direction. The converse effect takes place in muddy streams. The mud is apparently held in suspension, but is only prevented from subsiding by the constant intermixture of the different parts of the stream; when the current ceases the mud sinks to the bottom; the earthy particles composing it, being heavier than water, would sink in still water in times inversely proportional to their size and specific gravity. This, I think, is a satisfactory explanation of the manner in which the ice formed at the surface finds its way to the bottom; its adherence to the bottom, I think, is explained by the phenomenon of *regelation* first observed by Faraday; he found that when the wetted surfaces of two pieces of ice were pressed together they froze together, and that this took place under water even when above the freezing point. Prof. James D. Forbes found that the same thing occurred by mere contact without pressure, and that ice would become attached to other substances in a similar manner. Regelation was observed by these philosophers in carefully arranged experiments with prepared surfaces fitting together accurately and kept in contact sufficiently long to allow the freezing together to take place. In nature these favourable conditions would seldom occur in the masses of ice commonly observed; but we must admit, on the evidence of the recorded experiments, that under particular circumstances pieces of ice will freeze together or adhere to other substances in situations where there can be no abstraction of heat.

When a piece of ice of considerable size comes in contact under water with ice or other substance it would usually touch in an area very small in proportion to its mass, and other forces acting upon it and tending to move it would usually exceed the freezing force, and regelation would not take place. In the minute needles formed at the surface of the water the tendency to adhere would be much the same as in larger masses touching at points only, while the external forces acting upon them would be extremely small in proportion, and regelation would often occur, and of the immense number of the needles of ice formed at the surface enough would adhere to produce the effect which we observe and call anchor-ice. The adherence of the ice to the bed of the stream or other objects is always down stream from the place where they are formed; in large streams it is frequently many miles below; a large part of them do not become fixed, but as they come in contact with each other, regelate and form spongy masses, often of considerable size, which drift along with the current and are often troublesome impediments to the use of water-power.

Water-powers supplied directly from ponds or rivers or canals frozen over for a long distance immediately above the places from which the water is drawn, are not usually troubled with anchor-ice, which, as I have stated, requires open water up stream for its formation.

UPON A MODIFICATION OF WHEATSTONE'S MICROPHONE AND ITS APPLICABILITY TO RADIOPHONIC RESEARCHES[2]

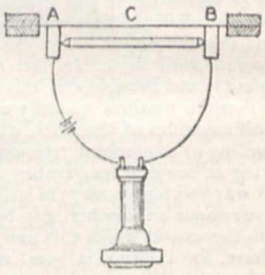
IN August, 1880, I directed attention to the fact that thin disks or diaphragms of various materials become sonorous when exposed to the action of an intermittent beam of sunlight,

[1] Paper clx. in the *Transactions* of the Society, 1878. Vol. vii., pages 109, 168.

[2] A paper read before the Philosophical Society of Washington, D.C., June 11, 1881, by Prof. Alex. Graham Bell.

and I stated my belief that the sounds were due to molecular disturbances produced in the substance composing the diaphragm (Amer. Assoc. for Advancement of Science, August 27, 1880). Shortly afterwards Lord Rayleigh undertook a mathematical investigation of the subject, and came to the conclusion that the audible effects were caused by the bending of the plates under unequal heating (NATURE, vol. xxiii. p. 274). This explanation has recently been called in question by Mr. Preece (Royal Society, March 10, 1881), who has expressed the opinion that although

Fig 1.

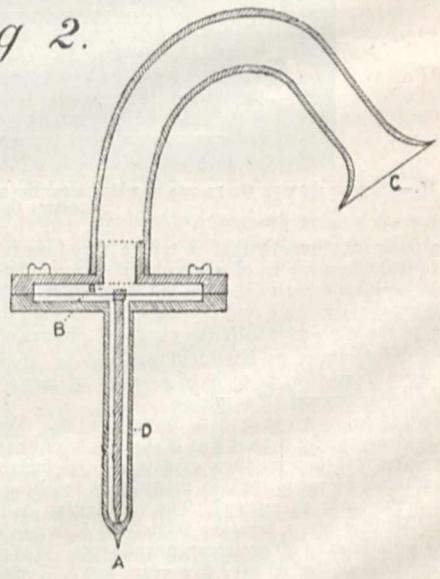


A B, Carbon supports; C, Diaphragm.

vibrations may be produced in the disks by the action of the intermittent beam, such vibrations are not the cause of the sonorous effects observed. According to him the aërial disturbances that produce the sound arise spontaneously in the air itself by sudden expansion due to heat communicated from the diaphragm, every increase of heat giving rise to a fresh pulse of air. Mr. Preece was led to discard the theoretical explanation of Lord Rayleigh on account of the failure of experiments undertaken to test the theory.

He was thus forced—by the supposed insufficiency of the explanation—to seek in some other direction the cause of the

Fig 2.



A, Stiff wire; B, Diaphragm; C, Hearing tube; D, Perforated handle.

phenomenon observed, and as a consequence he adopted the ingenious hypothesis alluded to above. But the experiments which had proved unsuccessful in the hands of Mr. Preece were perfectly successful when repeated in America under better conditions of experiment, and the supposed necessity for another hypothesis at once vanished. I have shown in a recent paper read before the National Academy of Science, April 21, 1881, that audible sounds result from the expansion and contraction of the material exposed to the beam, and that a real to-and-fro

vibration of the diaphragm occurs capable of producing sonorous effects. It has occurred to me that Mr. Preece's failure to detect with a delicate microphone the sonorous vibrations that were so easily observed in our experiments might be explained upon the supposition that he had employed the ordinary form of Hughes' microphone shown in Fig. 1, and that the vibrating area was confined to the central portion of the disk. Under such circumstances it might easily happen that both the supports (A B) of the microphone might touch portions of the diaphragm which were practically at rest. It would of course be interesting to ascertain whether any such localisation of the vibration as that supposed really occurred, and I have great pleasure in showing to you to-night the apparatus by means of which this point has been investigated (see Fig. 2).

The instrument is a modification of the form of microphone devised in 1827 by the late Sir Charles Wheatstone, and it consists essentially of a stiff wire (A), one end of which is rigidly attached to the centre of a metallic diaphragm (B). In Wheatstone's original arrangement the diaphragm was placed directly against the ear, and the free extremity of the wire was rested against some sounding body, like a watch. In the present arrangement the diaphragm is clamped at the circumference like a telephone-diaphragm, and the sounds are conveyed to the ear through a rubber hearing-tube (C). The wire passes through the perforated handle (D), and is exposed only at the extremity. When the point (A) was rested against the centre of a diaphragm upon which was focussed an intermittent beam of sunlight, a clear musical tone was perceived by applying the ear to the hearing-tube (C). The surface of the diaphragm was then explored with the point of the microphone, and sounds were obtained in all parts of the illuminated area and in the corresponding area on the other side of the diaphragm. Outside of this area, on both sides of the diaphragm, the sounds became weaker and weaker, until at a certain distance from the centre they could no longer be perceived.

At the points where one would naturally place the supports of a Hughes microphone (see Fig. 1) no sound was observed. We were also unable to detect any audible effects when the point of the microphone was rested against the support to which the diaphragm was attached. The negative results obtained in Europe by Mr. Preece may therefore be reconciled with the positive results obtained in America by Mr. Painter and myself. A still more curious demonstration of localisation of vibration occurred in the case of a large metallic mass. An intermittent beam of sunlight was focussed upon a brass weight (1 kilogram.) and the surface of the weight was then explored with the microphone shown in Fig. 2. A feeble but distinct sound was heard upon touching the surface within the illuminated area and for a short distance outside, but not in other parts.

In this experiment, as in the case of the thin diaphragm, absolute contact between the point of the microphone and the surface explored was necessary in order to obtain audible effects. Now I do not mean to deny that sound-waves may be originated in the manner suggested by Mr. Preece, but I think that our experiments have demonstrated that the kind of action described by Lord Rayleigh actually occurs, and that it is sufficient to account for the audible effects observed.

EXPERIMENTAL DETERMINATION OF THE VELOCITY OF WHITE AND COLOURED LIGHT[1]

THE method employed in this research to measure the velocity of light resembled the method of M. Fizeau, subsequently employed by M. Cornu. A revolving toothed wheel is employed in the same way to alter the intensity of the light reflected from a distance. In the present method, however, there are two distant reflectors instead of only one. They are separated by a distance of a quarter of a mile. The observing telescope and the two reflectors are almost in the same line. The observer sees two stars of light, which go through their phases with different periods as the toothed wheel is revolved at increasing speeds. One star is increasing, while the other is diminishing, in intensity, with increase of speed of the toothed wheel. The speed required to produce equality of the light is determined by means of a chronograph.

By choosing such a speed as gives a maximum of one star at the same speed as a minimum of the other, a pair of observations eliminates all cause of doubt arising from varying brightness in the stars, and ratio of the width of a tooth to the width of a space. The distances were observed by triangulation with the Ordnance Survey 18-inch theodolite, using as a base line a side of one of the Ordnance Survey triangles. The source of light was an electric lamp. The velocities (uncorrected for rate of clock, and reduction to a vacuum) measured are as follows :—

187,707
188,405
187,676
186,457
185,788
186,495
187,003
186,190
186,830
187,266
188,110
188,079
Mean ... ... 187,167 miles a second.

The correction to vacuum is + 54 miles a second. The correction for rate of clock to a mean solar time is + 52 miles a second.

The final results for the velocity of the light from an electric lamp *in vacuo* is 187,273 miles a second, or 301,382 kilometres a second.

Using Struve's constant of aberration 20·445", we obtain for the solar parallax the value 8·77", and for the mean distance of the sun 93,223,000 miles.

On February 11, 1881, the reflected stars were seen to be coloured, one reddish, the other bluish. The particular colour of a particular star depended upon the speed of rotation of the toothed wheel. That star which was increasing with increase of speed of the toothed wheel was reddish, that one that was diminishing with increase of speed was bluish. This seems to be caused by the fact that blue rays travel quicker than red rays.

A number of tests were made to judge of the accuracy of this conclusion, and they confirmed it. In the final arrangements, the electric light was acted upon by a bisulphide of carbon prism, and part of a pure spectrum was used. Differential measurements were then made to find the difference in velocity of rotation of the toothed wheel, required to produce equality of red and of blue lights. The most convenient method was to use a driving weight slightly in excess of that required to produce equality of the light, then to fix to the pulley carrying the weights one end of a piece of stout india-rubber tubing, the other end being fixed to a point above. This gradually diminished the effective driving weight. The equality of red lights was first noted, the colour of the light was changed, and the interval of time until the blue lights were equal was measured. The rate at which the india-rubber diminished the speed was afterwards measured by the aid of the chronograph, and thus the difference of speed determined. The mean of thirty-seven determinations in this and other ways gave the result that the difference in velocity between red and blue lights is about 1·8 per cent. of the whole velocity, blue travelling most rapidly.

The general conclusion seems to be supported by a comparison of the velocity of light measured by M. Cornu and Mr. Michelson, where the source of light usually employed is taken into consideration. These are the only accurate measurements of the velocity of light hitherto published. They give us the following results :—

	Usual Source of Light.	Velocity in kilos. a Second.
Michelson's research ...	The sun near horizon ...	299,940
Cornu's ,, ...	Lime light	300,400
The present ,, ...	Electric light...	301,382

Classifying the sources of light used by Cornu, we get the following approximate relative velocities :—

Source of Light.	No. of Observations.	Approximate Relative Velocity.
Petroleum	20	298,776 kilos.
Sun near horizon ...	77	300,242 ,,
Lime light...	449	300,290 ,,

All these results seem to support the view that the more refrangible the source of light, the greater is the velocity. Bu the evidence of the present observations, indicating an excess of

[1] Abstract of a paper by Dr. J. Young, F.R.S., and Prof. G. Forbes, read before the Royal Society, March 19.

velocity for blue over red light, seeming to exceed 1 per cent. of the whole, must rest upon the merit of the present observations themselves.

SCIENTIFIC SERIALS

Journal of the Royal Microscopical Society, June, 1881, contains: On the diatoms of the London Clay, by W. H. Shrubsole, with a list of species and remarks by F. Kitton (Plate V. Fig. 1).—On the estimation of aperture in the microscope, by Prof. E. Abbe (woodcuts).—On a new species of Hydrosera (Wallich), by Dr. H. Stolterforth (*H. tricornata*), Plate V. Figs. 2, 3.—Summary of current researches relating to zoology and botany (principally Invertebrata and Cryptogamia), microscopy, &c., including original communications from Fellows and others.—Proceedings of the Society.

The Scottish Naturalist, July, 1881, contains under Phytology—Dr. Stirton, on the genus Usnea and a new genus allied to it.—Rev. J. Stevenson, Mycologia Scotica (continued).—J. Cameron, the Gaelic names of plants (continued).—Dr. F. B. White, preliminary list of the flowering plants and ferns of Perthshire.

SOCIETIES AND ACADEMIES

VIENNA

Imperial Academy of Sciences, July 7.—L. T. Fitzinger in the chair.—Dr. T. Holetschek and T. v. Hepperger, determination of the elements and ephemeris of the comet of 1881*b*.—E. Rathay, on the spermagonia of the *Aecidio mycetes*.—F. Exner, on galvanic couples consisting only of chemical elements, and on the electromotive force of bromine and iodine.—C. Block, a sealed packet.—A. Brezina, on new and little-known meteors (third report).—A. Schlosser and Z. H. Skraup, synthetical experiments on the chinolin series.—R. Brix, on the constituents of copahu (Maracaïbo) and on commercial copaïbic and metacopaïbic acid.—H. Weidel, on dichinolins.—A. Spina, inquiry into the mechanics of intestinal and cutaneous resorption.—Th. Opeuchowsky, on the pressure of the pulmonary circulation.

July 14.—L. Fitzinger in the chair.—T. Glax and R. Klemensiewicz, contributions to the theory of inflammation (1st part).—E. Scherks, on the action of metals on α-bromopropionic ethyl ether.—H. Leitgeb, on *Completoria complens*, Lohde, a fungus-parasite on fern-prothallia.—N. v. Lorenz, on the action of lead-metal on aqueous solutions of nitrate of lead.—A. Adamkiewicz, preliminary note on the microscopical vessels of human cord.—A. W. Meisels, studies on the zoöid and oekoid of different vertebrates.—C. Etti, contributions to the knowledge of catechin.—T. Kachler, on the action of nitric acid on some fatty bodies made by ustion.—S. Exner, to the knowledge of the cortical motor area.

PARIS

Academy of Sciences, July 18.—M. Wurtz in the chair.—With regard to a telegram from Gabès about a recent earthquake there, and detonations preceding the shocks, M. Boussingault remembered having heard detonations at intervals during an earthquake in South America in 1827.—Observations of comet *b* 1881 at Paris Observatory, by MM. Tisserand and Bigourdan.—Theory of the plane flexion of solids, &c. (continued), by M. Villarceau.—On the reduction of quadratic forms, by M. Jordan.—Researches on glycolic ether, and on oxides of ethylene, by M. Berthelot.—On the trajectory of cyclones, and on the announcements transmitted by telegraphic cables, by M. Faye. Commandant Bridet has lately shown that if Mauritius and Réunion (Bourbon) were connected by means of a cable, the latter might be informed eighteen or twenty four hours in advance of the arrival and direction of storms. M. Bridet is trying to get this project realised.—On the integration of a linear differential equation of the second order on which evection depends, by M. Gyldén.—Effects produced by sulphide of carbon on vines of Beaujolais, by M. Henneguy.—Ephemerides of the planet (103) Hera for the opposition of 1881, by M. Callandreau.—On the tails of comets, by M. Flammarion. He replies to M. Faye, and supports M. Berthelot's theory of electric illumination.—On the vision of stars through comets, by M. André. The enlargement of the image is probably a simple effect of diffraction indicating the presence of solid or liquid nuclei in the mass of matter.—On a function similar to modular functions, by M. Poincaré.—Distribution of energy in the normal spectrum, by Prof. Langley. He gives two curves obtained from observations with his new instrument for a diffraction spectrum after and before zenithal absorption by our atmosphere. The curve of light coincides almost exactly with that of heat. There is enormous absorption by the atmosphere in the blue.—On a method enabling us to amplify the displacements of the plane of polarisation of light, by M. H. Becquerel. When monochromatic luminous rays, polarised rectilinearly, traverse a half-wave crystalline plate, the emergent rays are polarised rectilinearly in a plane which, relatively to the axis of the plate, is symmetrical with the plane of polarisation of the incident waves. This known property is utilised for the purpose indicated.—On the velocities of propagation of the inflammation in explosive gaseous mixtures, by MM. Mallard and Le Chatelier. In one form of apparatus each end of the tube has a lateral orifice communicating through a caoutchouc tube with a small chamber closed with an elastic membrane, which, being pressed outwards at the moment of explosion, affects an inscribing style. The propagation in the larger tube in not of normal velocity, unless the part not yet inflamed remains as rest during the whole phenomenon. In a tube closed at one end the velocity is much greater if the gas be fired from the closed end. Even in the other case violent movements often occur in the unburnt mass, and there are various irregularities.—On the decomposition and enlargement of bands of the rainbow, by M. Ritter. Near the observer (to a distance of about 1·50m.) the two systems of cones, with parallel axes from the eyes, by which the rainbow is defined, are quite separate; thus if the drops are within that distance one should see two distinct arcs or rings. Illustrations of this deduction and others are given.—On the extraordinary temperature of July, 1881, by M. Renou. The temperature of 37°·8 in the Park of Saint-Maux, on July 15, is undoubtedly the highest ever experienced in Paris or the environs.—On hydrosulphurous acid, by M. Schutzenberger.—Action of sulphur on various metallic solutions by MM. Filhol and Senderens. It decomposes them (in heat), producing more or less complex reactions.—Separation and determination of alumina and oxides of iron and chromium, by M. Carnot.—Industry of magnesia, by M. Schloesing. This is preliminary to an account of new ways of extracting magnesia from the water of salt marshes, and even from sea-water.—On injury done in Greece by anthracnose and *Peronospora viticola*, by M. Gennadius.—On the origin of trunks of fossil trees perpendicular to the strata of the coal formation, by M. Fayol.—On some points relative to anthracic immunity, by M. Toussaint.—On a new malady of domestic geese observed in the Commune of Viviers-les-Montagnes (Tarn), by M. Caravin-Cachin.—Experiments on yellow-fever patients with phenic acid, phenate of ammonia, &c., by M. de Lacaille.—On the Cretaceous system of the Northern Sahara, by M. Rolland.

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