tion by Professor Langley of his Bolometer, which is an instrument for detecting and measuring small quantities of radiant heat much more sensitive than the thermopile. It depends upon the fact that the electrical resistance of a metal is increased as it rises in temperature. Suppose, now, that two circuits conveying equal and opposite currents meet in a galvanometer, the needle will of course remain at rest. If, however, a portion of one of these two circuits be heated, its resistance will be increased, and the current passing through it will thus be diminished. The two opposing currents will now no longer balance each other, and in consequence the galvanometer needle will be deflected.

In the bolometer the two circuits each contain a sheet of extremely thin platinum foil, so that a very small quantity of radiant heat falling upon these may produce a considerable result. These sheets may be compared to the two faces of the pile, and if the one be heated we shall have a current in the one direction, while if the other be heated we shall have a current in the opposite direction. By this instrument Professor Langley has determined with much precision the exact distribution of energy in the solar spectrum. But he has done more than this: he has carried his instrument up to the top of Mount Whitney, in America, and has thus procured us much information regarding the absorbent effect of the various constituents of the earth's atmosphere.

The following diagram (Fig. 10) exhibits the result of his researches. In it the lower band represents the solar spectrum as obtained by a perfect method. The shaded curve above the spectrum represents the observations made by Professor Langley with his Bolometer at the foot of the mountain. We have next a dotted curve derived from observations at the top of the mountain, and, finally, another representing the probable curve of solar energy above the limits of the atmosphere. It follows from these curves that if we could view the sun beyond the limits of the atmosphere the light would be decidedly blue.

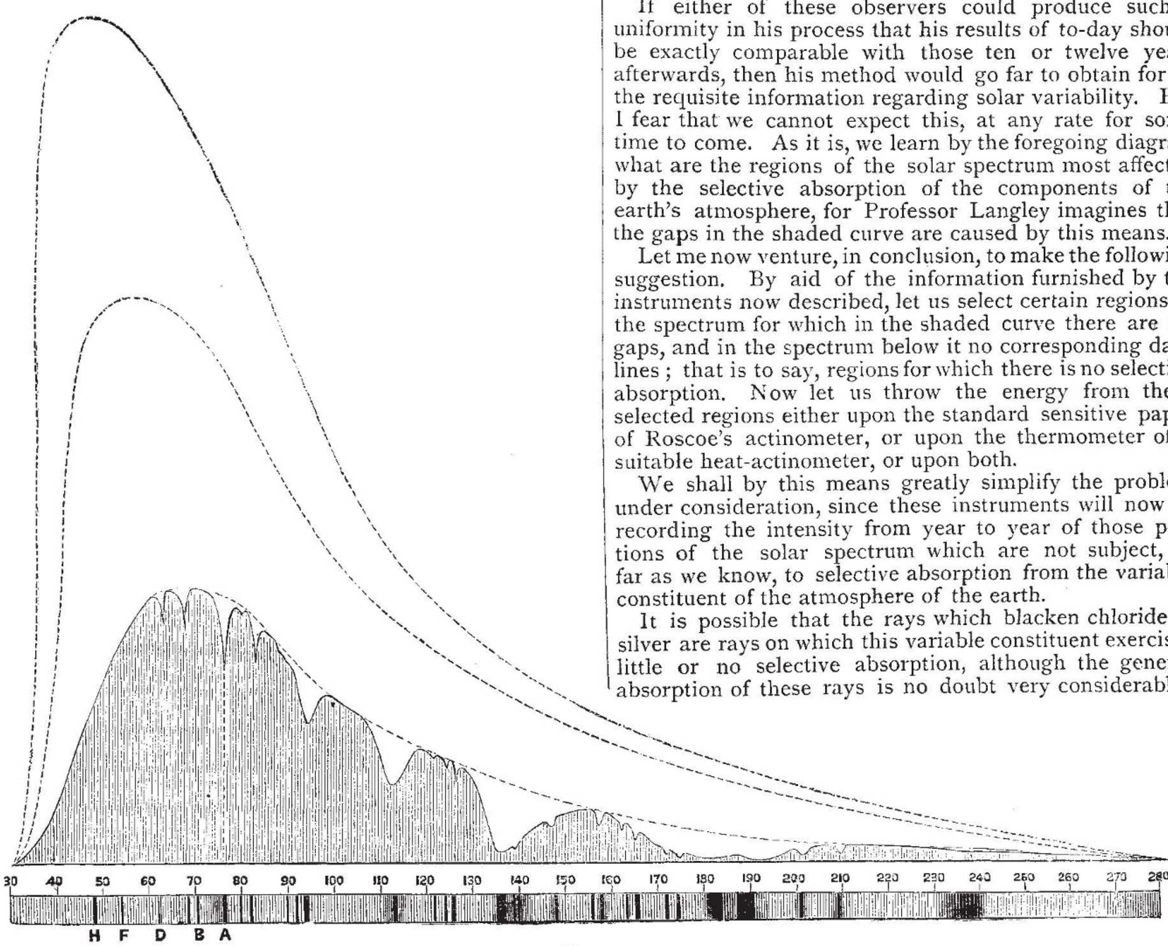

Fig. 10.

There can be no doubt that the improved process of photography devised by Captain Abney, and the Bolometer of Professor Langley, furnish us with excellent differential instruments by which we may compare at any place and moment the relative distribution of solar energy over the various parts of the spectrum.

If either of these observers could produce such a uniformity in his process that his results of to-day should be exactly comparable with those ten or twelve years afterwards, then his method would go far to obtain for us the requisite information regarding solar variability. But I fear that we cannot expect this, at any rate for some time to come. As it is, we learn by the foregoing diagram what are the regions of the solar spectrum most affected by the selective absorption of the components of the earth's atmosphere, for Professor Langley imagines that the gaps in the shaded curve are caused by this means.

Let me now venture, in conclusion, to make the following suggestion. By aid of the information furnished by the instruments now described, let us select certain regions of the spectrum for which in the shaded curve there are no gaps, and in the spectrum below it no corresponding dark lines; that is to say, regions for which there is no selective absorption. Now let us throw the energy from these selected regions either upon the standard sensitive paper of Roscoe's actinometer, or upon the thermometer of a suitable heat-actinometer, or upon both.

We shall by this means greatly simplify the problem under consideration, since these instruments will now be recording the intensity from year to year of those portions of the solar spectrum which are not subject, as far as we know, to selective absorption from the variable constituent of the atmosphere of the earth.

It is possible that the rays which blacken chloride of silver are rays on which this variable constituent exercises little or no selective absorption, although the general absorption of these rays is no doubt very considerable: in this case no special adaptation to the chemical actinometer would be necessary.

To conclude, I think we may entertain a well-grounded hope that by patience and persistence in these or similar means, we shall ultimately arrive at a definite solution of this very interesting and important problem.

BALFOUR STEWART

(*To be continued.*)

NOTES

THE Geological Congress met last week at Berlin. England was represented by Messrs. Geikie, Hughes, Bauermann, Hinde, Marr, Topley, White, Woodall, Lieut.-Col. Tabuteau, and

Capt. Shelley. Altogether there were 248 members, representing Germany, Austria, Belgium, Spain, the United States of America, France, India (Mr. Blanford), Italy, Japan, Norway, Holland, Portugal, Roumania, Russia, Sweden, and Switzerland.

MR. W. H. WHITE, who has succeeded Sir N. Barnaby as Director of Naval Construction, has entered upon his duties at the Admiralty.

WE regret to learn of the death of Walter Weldon, F.R.S., the eminent technical chemist, in his fifty-third year. Mr. Weldon's name is well known in connection with the Weldon process for the regeneration of the manganese peroxide used in the generation of chlorine, and with the consequent revolution in the production of bleaching-lime, affecting favourably such important industries as the cotton and paper trades.

THE Annual Exhibition of the Photographic Society was opened on Monday; the exhibits are up to the average of recent years.

SIR JOHN LUBBOCK unveiled on Thursday last, at Birmingham, a marble statue of the late Sir Josiah Mason, which has been placed in the square between the Science College and the Town Hall. Referring to the Mason College, Sir John said that such an institution was all the more needed on account of the extraordinary manner in which science is still neglected in our public schools. There were, indeed, according to the Technical Commission, only three schools in Great Britain in which science is fully and adequately taught. The majority of schools devoted to it less than three hours out of forty. Scientific men claimed for it six hours, which, with the same number for mathematics, ten for modern languages, and two for geography, would still leave no less than sixteen for classics. He advocated the general teaching of science, because it would add to the interest and brightness of life, would purify and ennoble the character, and because, with our rapidly-increasing population, it was almost a necessity, if our people were to be maintained in comfort. As regards the first point, it was quite a mistake to regard science as dry and uninteresting. Sometimes it might destroy a poetical idea, such as the ancient Hindoo theory of rivers—that Indra "dug out their beds with his thunderbolts and sent them forth by long continuous paths." But the real causes of natural phenomena were far more striking, and contained more real poetry than any that had occurred to the untrained imagination of mankind. Not our happiness only, but in many cases our very life itself depended on our knowledge of science. Huxley had well asked, "Whether, if it were perfectly certain that the life and fortune of every one of us would one day depend on our winning a game of chess we should not all learn something of the game. Yet it is a very plain truth that the life and fortune of every one of us depend on our knowing something of the rules of a game infinitely more difficult. It is a game which has been played for untold ages, every man and woman of us being one of the two players. The chessboard is the world, the pieces are the phenomena of the universe, the rules of the game are what we call the laws of nature. The player on the other side is hidden from us. We know that his play is always fair, just, and patient. But also we know, to our cost, that he never overlooks a mistake, or makes the smallest allowance for ignorance. To the man who plays well the highest stakes are paid with overflowing generosity, but one who plays ill is checkmated—without haste, but without remorse." The national necessity for science was most imperative. Even now we required to purchase food to the amount of 150,000,000*l*. a year. A century hence our coal would be approaching exhaustion, our population would be trebled, and we should require, to speak moderately, 400,000,000*l*. to pay for food. Nothing but the development of scientific training and appliances would enable us, under these circumstances, to maintain our population in happiness and comfort. We had, in fact, the choice between science and suffering.

MR. H. H. JOHNSTON appeals in the *Times* for subscriptions to make good the loss which Mr. H. O. Forbes has sustained while embarking at Batavia for his exploring journey in New Guinea. The boat which was carrying all his baggage on board ship suddenly capsized, and the unfortunate explorer in a few seconds lost all his equipment, a loss which it would probably take about 1000*l*. to replace. Mr. Forbes, it may be remembered, was subsidised by the Royal, the Scottish, and the Australian Geographical Societies, while the British Association at Aberdeen has made a grant of 150*l*. to help to replace his loss. What excellent work Mr. Forbes is capable of doing for science is shown in his recently-published work on the Malay Archipelago. He lost no time in getting to Brisbane, and has doubtless there obtained on credit such articles as will enable him to go on with his work, as according to the latest news he is again on his way to New Guinea. Subscriptions may be sent to the Secretary, Royal Geographical Society, Savile Row, W.

IN a few days the rock in the Hell Gate entrance to New York harbour, from Long Island Sound, is to be blown up by a party under the command of General Newton, United States Engineer. For nine years the work of excavation has been in progress. The rock has been honeycombed with chambers, the surface being still supported by columns of rock, into which dynamite cartridges have been fitted. Some 45,000 of these cartridges cased with copper have been laid. The work of distributing the cartridges began in July, 1884, and has just been completed, 275,000 lbs. of dynamite having been used. The explosion is to be brought about by means of an automatic detonator, placed upon Flood Rock, an electric connection with the land being established. It is expected that the explosion will pulverise the whole of the rock, without making much commotion in the water, or doing harm beyond a distance of 1000 feet. The *débris* will afterwards be removed, so as to make a channel 26 feet deep at low water. Flood Rock and the adjacent reefs under water which will be destroyed cover a space of nine acres.

THE Rev. M. F. Billington, of Chalbury Rectory, Wimborne, Dorset, writes to the *Times* under date September 29:—"This afternoon, at 5 o'clock precisely, we witnessed from this hill, of 360 feet altitude, a most perfect reflection in the clouds of a ship in full sail. The Purbeck Hills, situate about thirteen or fourteen miles to our south-west, shut out our direct view of the sea in that direction, and in all our long experience of many beautiful views of the coast line we have never before observed this curious phenomenon. It lasted for about three minutes, and then slowly faded out of sight."

ON September 29, between 8 and 9 p.m., a mirage somewhat similar to that described last week (p. 541) was again observed by many persons at Valla in Sweden. The entire lower part of the north-western horizon shone with a lurid glare, above which was a cloud-bank assuming the most remarkable forms. From time to time animals, trees, and shrubs were seen. Soon a bear changed into an elephant, and soon a dog into a horse. Later on groups of dancers were seen, men being distinguished from women. Further north the cloud formed an oak forest, in front of which was a valley, and nearer still a park with sanded paths. At about 9.30 the cloud sank into a mass, and the phenomenon disappeared.

THE Royal Microscopical Society will meet at King's College, W.C., on Wednesday, the 14th inst., at eight o'clock, when the following papers will be read:—Dr. Maddox: On the Feeding of Insects with Bacilli. Mr. T. B. Rossiter: On the Gizzard of the Larvæ of *Corethra plumicornis*.

ARRANGEMENTS are being made for the establishment of a Zoological Garden in Christiania.

DURING last week a series of experiments were carried out upon North Sea trawling vessels with a view to lighting them by electricity. The attempt was on the whole satisfactory. The introduction of electric light into fishing-boats would prove invaluable, but the heavy expenditure involved in such a scheme would exclude its general usage.

THE United States Fish Commission report a great decrease in the halibut and cod fisheries of America. The cause for this is attributed either to low temperatures of water or the destruction of fry by reckless fishing. A general falling off of flat-fish is reported from Germany this year, and a diminution in the herring fishery is recorded from Belgium. The increased number of fishermen off Holland and the destruction of immature fish has produced a bad effect upon the fishery of that place.

THE National Fish Culture Association have made arrangements to import a large consignment of carp from Germany for the purpose of acclimatising them to the waters of the United Kingdom. Numerous applications have been made from all parts for supplies of these fish, which are far superior to our own species. In Germany, China, France, and America carp farming is extensively prosecuted with highly satisfactory and remunerative results.

WE have received the report for the summer session of 1885 of the Queenwood College Mutual Improvement Society. It describes in detail the various excursions of the session, and would make an admirable guide for the parts of Hampshire and the Isle of Wight visited.

WE have received from the author a pamphlet containing a geological sketch of the Island of Antigua, by Mr. Purves, which was originally contributed to the *Bulletin* of the Royal Museum of Natural History of Belgium. Prior to this paper the only information on the subject was contained in a paper by Dr. Nugent, published in 1819, and by Prof. Hovay, published in the *American Journal of Science* in 1839. The pamphlet is illustrated by a geological sketch map.

THE Queen has been pleased to grant to Prof. W. Chandler Roberts, F.R.S., of the Royal Mint, authority to use after his paternal name the name of his uncle, the late Major N. L. Austen, J.P., of Haffenden and Combourne, in the county of Kent.

THE additions to the Zoological Society's Gardens during the past week include a Toque Monkey (*Macacus pileatus* ♂) from Ceylon, presented by Mr. Septimus Smith; a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mr. S. T. K. D. Potter, F.R.G.S.; six Indian Fruit Bats (*Pteropus medius*) from India, presented by Mr. W. Jamrach; two Canadian Skunks (*Mephitis mephitica*) from North America, presented by Dr. C. Hart Merriam, C.M.Z.S.; a Common Badger (*Meles taxus*), British, presented by Lord Egerton of Tatton, F.Z.S.; a Ring-necked Parrakeet (*Palæornis torquata*) from India, presented by Mrs. Douglas; a Common Barn Owl (*Strix flammea*), British, presented by Miss Linda Raven; two Common Guinea-Fowls (*Numida cristata*), British, presented by Mr. C. H. Hopwood, M.P.; a Loggerhead Turtle (*Thalassochelys caouana*) from the Atlantic Ocean, presented by Mr. A. Duncan Fraser; four Hog-nosed Snakes (*Heterodon platyrhinos*), a Say's Snake (*Coronella sayi*), two —— Snakes (*Coluber alleghaniensis*), an American Black Snake (*Coluber constrictor*) from Indiana, North America, presented by Mr. F. J. Thompson; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, a Great Bird of Paradise (*Paradisea apoda*) from the Aroo Islands, a Common Cormorant (*Phalacrocorax carbo*), British, an Emu (*Dromæus novæ-hollandiæ*) from Australia, a Gigantic Salamander (*Megalobatrachus maximus*) from Japan, deposited.

OUR ASTRONOMICAL COLUMN

THE SATELLITES OF URANUS AND NEPTUNE.—In Appendices I. and II. of the Washington Observations for 1881, Prof. Asaph Hall has published the results of his investigation of the orbits of the outer satellites of Uranus, *Oberon* and *Titania*, and the satellite of Neptune. The satellites of Uranus were amongst the first objects observed with the 26-inch refractor of the Naval Observatory, after it was mounted in November, 1873. The first series during the oppositions of 1874 and 1875 were discussed by Prof. Newcomb, with the view to the determination of the mass of the planet, and the formation of tables of the motions of the satellites, which were published in the Washington Observations for 1873. Remarking that as the earth would be nearly in the plane of the orbits in the year 1882, and observations made about that year would probably afford a good determination of the position of this plane, Prof. Hall commenced a new series in March, 1881, which were continued through the four oppositions until the end of May, 1884; these observations were made with magnifiers of 606 and 888; in fair conditions of the atmosphere the outer satellites are stated to be easily observable with the Washington instrument. A comparison of the measures with Prof. Newcomb's tables showed that those tables required but small corrections, which were found by equations of condition in the usual manner. It should be mentioned that the tables were founded mainly upon Prof. Newcomb's own measures; those by Prof. Hall in the years 1875 and 1876 are included in his recent discussion.

For the position of the nodes and inclination of the orbits of the satellites, Prof. Hall finds—

$$N = 165^\circ{\cdot}81 + 0^\circ{\cdot}0142t$$
$$I = 75^\circ{\cdot}30 - 0^\circ{\cdot}0014t$$

t being the number of years from 1883·0.

The mean value of the mass of Uranus by the observations of *Oberon* is $\frac{1}{22603}$, and by those of *Titania*, $\frac{1}{22833}$, or, combining the values with their respective weights, the final result is $\frac{1}{22682}$. This value, though somewhat smaller than those previously obtained, Prof. Hall thinks is as good as he could obtain with the filar-micrometer of the large refractor, and he does not consider that there would be much gained by a continuation of the measures. He mentions that during the oppositions of the planet from 1881 to 1884, which were especially favourable for the search after new satellites, he made careful examination on several good nights along the orbit plane of the known satellites, without finding any new ones.

The orbits of *Oberon* and *Titania* appear to be sensibly circular.

Prof. Hall's discussion of the elements of the orbit of the satellite of Neptune is founded upon his own observations during the oppositions of 1875 and 1876, and those of 1881—84; in addition, he has made use of Prof. Holden's measures in the interval 1874 December—1878 November, and has also discussed those of Lassell and Marth taken at Malta in 1863 and 1864. Prof. Newcomb's elements are corrected by the formation of equations of condition and their solution, as in the case of the satellites of Uranus. The following are the principal results:—

$$N = 184^\circ{\cdot}32 + 0^\circ{\cdot}0095t$$
$$I = 120^\circ{\cdot}05 + 0^\circ{\cdot}0005t$$

t being counted from 1883·0.

Comparing the observations of 1881—84 with those of Lassell and Marth, the periodic time is found to be 5·876839 mean solar days; that deduced by Mr. Hind, which was adopted by Prof. Newcomb in his tables, is 5·8769 days; the small difference would produce a change of about 5° in the true position of the satellite in its orbit at the beginning of next century, and Prof. Hall leaves it to future observations to decide whether his correction is required.