satisfactory progress. He has now accomplished the Talamanca survey, and will probably extend his researches into other parts of the country, particularly that bordering upon the Pacific coast, his previous explorations having been confined to the Atlantic slope. With only four assistants besides Indian labourers, Prof. Gabb has surveyed the entire tract, of about 3,000 square miles, from the borders of civilisation on the north to the borders of Panama, and from the Atlantic to the crest of the Cordilleras; and this he has mapped out more accurately than any other equal area of Costa Rica has been surveyed, not excepting the section where the towns are situated. He also gives reliable information and statistics about an agricultural country sufficiently large, fertile, and healthful to support the entire population of Costa Rica, but which as yet contains only 1,226 Indians and twelve foreigners, of whom only one is white. It is watered by one river, which is navigable throughout the year, and which reaches within thirty miles of the most remote portion of a country valuable for agricultural purposes. In addition to the survey proper, as referred to, information has been gathered in regard to the mineral resources of the region and its animal and vegetable life, immense collections of both, as previously stated, having been sent to the Smithsonian Institution for identification. Among the number are one hundred specimens of monkeys alone, while the other mammals, birds, &c., are in due proportion. The exhaustive inquiries prosecuted into the ethnology of the country have resulted in very rich collections, which have likewise been forwarded to Washington. Numerous vocabularies, with several dialects, have also been obtained, which offer much of promise to the philologist. It is greatly to be hoped that Prof. Gabb's inquiries may be continued, with Costa Rica as a base, until they include the whole of the unknown portions of Central America.

THE *Kölnische Zeitung* of Feb. 10 gives an account of Prof. Böhm's (Dorpat) researches on revival after cases of poisoning. He succeeded in reviving cats which had been poisoned by injection of potash salts into their veins, after forty minutes' duration of a state which was in no way different from actual death, the action of the heart and respiration having completely ceased. He obtained these results by artificial respiration and simultaneous compression of the breast in the vicinity of the heart. The professor points out the importance of the latter point, which he deems as essential as the action of the lungs. In any case his researches are of high interest for the relation they bear upon the revival of poisoned persons.

THE *Bohemia* reports extremely heavy snowstorms which took place in a part of Moravia and Bohemia on Feb. 5, and caused great damage to railways, several trains being thrown off the lines, luckily without much injury to passengers. At Znaim (Moravia) the storm was so violent at noon that it was impossible to see more than three yards ahead.

THE *Oberschlesische Volkszeitung* of Feb. 1 reports the discovery of some colossal remains of the Mammoth (*Elephas primigenius*) near Ober Glogau (Silesia).

THE *Neue Freie Presse* announces that Herr R. Falb, of Vienna, discovered a new variable star, near ι Orionis, on the night of Jan. 31. The discovery was confirmed on the same night by Prof. Oppolzer at his private observatory, and on subsequent nights by the astronomers at the Imperial Observatory of Vienna. The star is visible with the naked eye.

PROF. ASA GRAY, in a paper in the February number of *Silliman's Journal*, on the question, "Do Varieties wear out, or tend to wear out?" comes to the conclusion that from the scientific point of view, sexually propagated varieties, or races, although liable to disappear through change, need not be expected to wear out, and there is no proof that they do; but non-sexually propagated varieties, though not liable to change, may theoretically be expected to wear out, but to be a very long time about it.

WE are glad to see that the Watford Natural History Society is now completely organised and fairly set a-going. At a recent meeting officers were elected, and a *conversazione* was afterwards held. The president chosen is Mr. John Evans, F.R.S., and Mr. J. Gwyn Jeffreys, F.R.S., is one of the vice-presidents. The first regular meeting is to be held on March 11, when Mr. J. L. Lobley, F.G.S., one of the members of the Council, will read a paper on "The Cretaceous Rocks of England."

ON the 10th inst., at six o'clock in the evening, a large aërolite was observed at Paris, in the department of the Marne, at Orleans, and at Belleisle en Mer. No noise was heard, but the display of light was magnificent. The track was visible for a time varying from a quarter to half an hour.

SEVERAL large landslips are reported as having taken place on the Danish island of Möen, on a chalky rock named "Möensklint;" from another one, called "Jetterbrinken," a piece of several million cubic yards has fallen down. These occurrences are ascribed to enormous changes in the temperature which have lately taken place in that locality.

THE Royal Geological Society of Ireland have just published Part I. vol. iv., new series, of their journal. It contains: On a new genus of fossil fish of the order Dipnoi, by Dr. Traquair; On the microscopic structure of Irish granites and of the Lambay porphyrite, by Prof. Hull; On a bed of fossiliferous "kunkur," by J. E. Gore; On the Leinster coal-field, by J. McC. Meadows; On a raised estuarine beach at Tramore Bay, by E. Hardman; On the elevated shell-bearing gravels near Dublin, by the Rev. Maxwell Close; and Remarks on the genera Palæchinus and Archæocidaris, by W. H. Baily.

THE Forty-third Annual Report of the Royal Zoological Society of Ireland has just been published. The number of visitors to the gardens of the Society during 1874 was 109,923, and the receipts from the same, 1,442*l.* 14*s.* 4*d.* The number of visitors would appear to have been the smallest during the last ten years, but owing to an increase of the admission fees the income is scarcely below that of the best of the ten years. The Council propose to construct "an Elephant Compound on the plan of those so well known in the London Gardens," the total cost of which will amount to 150*l.*

THE additions to the Zoological Society's Gardens during the last week include two Feline Douracoulis (*Nyctipithecus felinus*) and two Squirrel Monkeys (*Saimaris sciurea*) from Brazil; a Saffron Cock of the Rock (*Rupicola crocea*) from Demerara; a Grey Mullet (*Mugil capito*), twelve Cottus (*Cottus bubalis*), and eighteen Basse (*Labrax lupus*), all British, deposited and purchased.

PRELIMINARY INQUIRY INTO THE EXISTENCE OF ELEMENTS IN THE SUN NOT PREVIOUSLY TRACED *

IN a paper communicated to the Royal Society on December 12, 1872 (Phil. Trans. 1873, p. 253), I have shown that the test formerly relied on to decide the presence or absence of a metal in the sun, namely, the presence or absence of the brightest and strongest lines of the metal in question in the average solar spectrum, was not a final one, and that the true test was the presence or absence of the longest lines of the metal: this longest line being that which remains longest in the spectrum when the pressure of the vapour is reduced.

Of the test in question I have said in the paper already mentioned, "It is one, doubtless, which will shortly enable us to

* Extract from a memoir presented to the Royal Society in November 1873, which has just been printed in the "Philosophical Transactions."

determine the presence of new materials in the solar atmosphere, and it is seen at once that to the last published table of solar elements—that of Thalén—must be added zinc, aluminium, and possibly strontium, as a result of the new method."

In order to pursue the inquiry under the best conditions, complete maps of the long and short lines of all the elements are necessary. It is, however, not absolutely necessary for the purposes of a preliminary inquiry to wait for such a complete set of maps, for the lists of lines given by the various observers may be made to serve as a means of differentiating between the longest and shortest lines, because I have also shown that the lines given at a low temperature, by a feeble percentage composition, or by a chemical combination of the vapour to be observed, are precisely those lines which appear longest when the complete spectrum of the pure dense vapour is studied.

Now with regard to the various lists and maps published by various observers, it is known (1) that very different temperatures were employed to produce the spectra, some investigators using the electric arc with great battery power, others the induction spark with and without the jar; (2) that some observers employed in certain cases the chlorides of the metals the spectra of which they were investigating, others used specimens of the metals themselves.

It is obvious, then, that these differences of method could not fail to produce differences of result; and accordingly, in referring to various maps and tables of spectra, we find that some include large numbers of lines omitted by others. A reference to these tables in connection with the methods employed shows at once that the large lists are those of observers using great battery power or metallic electrodes, the small ones those of observers using small battery power, or the chlorides. If the lists of the latter class of observers be taken, we shall have only the longest lines, while those omitted by them and given by the former class will be the shortest lines.

In cases therefore in which I had not mapped the spectrum by the new method of observation referred to in my paper, I have taken the longest lines as thus approximately determined; for it seemed desirable, in view of the very large number of unnamed lines, to search at once for the longest elemental lines in the solar spectrum without waiting for a complete set of maps.

A preliminary search having been determined on, I endeavoured to get some guidance by seeing if there was any quality which differentiated the elements already traced in the sun from those not traced; and to this end I requested my assistant, Mr. R. J. Friswell, to prepare two lists showing broadly the chief chemical characteristics of the elements traced and not traced. This was done by taking a number of the best known compounds of each element (such, for instance, as those formed with oxygen, sulphur, chlorine, bromine, or hydrogen), stating after each whether the compounds in question were unstable or stable. Where any compound was known not to exist, that fact was indicated.

Two tables were thus prepared, one containing the solar, the other the more important non-solar elements (according to our knowledge at the time).

These tables gave me, as the differentiation sought, the fact that in the main the known solar elements formed stable oxygen-compounds.

I have said in the main, because the differentiation was not absolute, but it was sufficiently strong to make me commence operations by searching for the outstanding strong oxide-forming elements in the sun.

The result up to the present time has been that *strontium*, *cadmium*, *lead*, *copper*, *cerium*, and *uranium*,* in addition to those elements in Thalens' last list, would seem with considerable probability to exist in the solar reversing layer. Should the presence of *cerium* and *uranium* be subsequently confirmed, most of the iron group of metals will thus have been found in the sun.

As another test, certain of those elements which form unstable compounds with oxygen were also sought for, gold, silver, mercury being examples. None of these were found.

The same result occurred when the lines due to the jar-spark taken in chlorine, bromine, iodine, and those of some of the other non-metals were sought, these being distinguishable as a group by formation of compounds with hydrogen.

Now other researches, not yet completely ready for publication, have led me to the following conclusions:—

I. The absorption of some elementary and compound gases is limited to the most refrangible part of the spectrum when the gases are rare, and creeps gradually into the visible violet part, and finally to the red end of the spectrum, as the pressure is increased.

II. Both the general and selective absorption of the photospheric light are greater (and therefore the temperature of the photosphere of the sun is higher) than has been supposed.

III. The lines of compounds of a metal and iodine, bromine, &c., are observed generally in the red end of the spectrum, and this holds good for absorption in the case of aqueous vapour.

Such spectra, like those of the metalloids, are separated spectroscopically from those of the metallic elements by their columnar or banded structure.

IV. There are in all probability no compounds ordinarily present in the sun's reversing layer.

V. When a metallic compound vapour, such as is referred to in III., is dissociated by the spark, the band spectrum dies out, and the elemental lines come in, according to the degree of temperature employed.

Again, although our knowledge of the spectra of stars is lamentably incomplete, I gather the following facts from the work already accomplished with marvellous skill and industry by Secchi of Rome.

VI. The sun, so far as the spectrum goes, may be regarded as a representative of class (β) intermediate between stars (α) with much simpler spectra of the same kind, and stars (γ) with much more complex spectra of a different kind.

VII. Sirius, as a type of α, is (1) the brightest (and therefore hottest?) star in our northern sky; (2) the blue end of its spectrum is open; it is only certainly known to contain hydrogen, the other metallic lines being exceedingly thin, thus indicating a small proportion of metallic vapours; while (3) *the hydrogen lines in this star are enormously distended*, showing that the chromosphere is largely composed of that element.

There are other bright stars of this class.

VIII. As types of γ the red stars may be quoted, the spectra of which are composed of channelled spaces and bands. Hence the reversing layers of these stars probably contain metalloids, or compounds, or both, in great quantity; and in their spectra not only is hydrogen absent, but the metallic lines are reduced in thickness and intensity, which in the light of V., *ante*, may indicate that the metallic vapours are being *associated*. It is fair to assume that these stars are of a lower temperature than our sun.

I have asked myself whether all the above facts cannot be grouped together in a working hypothesis which assumes that in the reversing layers of the sun and stars various degrees of "celestial dissociation" are at work, which dissociation prevents the coming together of the atoms which, at the temperature of the earth and at all artificial temperatures yet attained here, compose the metals, the metalloids, and compounds.

On this working hypothesis, the so-called elements not present in the reversing layer of a star will be in course of formation in the coronal atmosphere and in course of destruction as their vapour-densities carry them down; and their absorption will not only be small in consequence of the reduced pressure of that region, but what absorption there is will probably be limited wholly or in great part to the invisible violet end of the spectrum in the case of such bodies as the pure gases and their combinations, and chlorine. (See I. *ante*.)

The spectroscopic evidence as to what may be called the plasticity of the molecules of the metalloids, including of course oxygen and nitrogen, but excluding hydrogen, is so overwhelming, that even the absorption of iodine, although generally it is transparent to violet light, may (as I have found in a repetition of Dr. Andrews' experiments on the dichroism of iodine, in which I observed the spectrum) in part be driven into the violet end of the spectrum, for iodine in a solution in water or alcohol at once gives up its ordinary absorption properties, and stops violet light.*

A preliminary comparison of the ordinary absorption spectrum of a stratum of 6 ft. of chlorine renders it not improbable that chlorine at a low temperature is the cause of some of the Fraunhofer lines in the violet, although, as said before, I have not yet obtained certain evidence as to the reversal of the bright lines of chlorine seen in the jar-spark.

There is also an apparent coincidence between some of the faint Frauenhofer lines and some of the lines of the low temperature absorption-spectrum of iodine.

Should subsequent researches strengthen the probability of this

* Potassium has since been added.

* I have since obtained the same result by observing the absorption of vapour in a white-hot tube.

working hypothesis, it seems possible that iron meteorites will be associated with the metallic stars and stony meteorites with metalloidal and compound stars. Of the iron group of metals in the sun, iron and nickel are those which exist in greatest quantity, as I have determined from the number of lines reversed. Other striking facts, such as the presence of hydrogen in meteorites, might also be referred to.

An interesting physical speculation connected with this working hypothesis is the effect on the period of duration of a star's heat which would be brought about by assuming that the original atoms of which a star is composed are possessed with the increased potential energy of combination which this hypothesis endows them with. From the earliest phase of a star's life the dissipation of energy would, as it were, bring into play a new supply of heat, and so prolong the star's light.

May it not also be that if chemists take up this question which has arisen from the spectroscopic evidence of what I have before termed the plasticity of the molecules of the metalloids taken as a whole, much of the power of variation which is at present accorded to metals may be traced home to the metalloids? I need only refer to the fact that, so far as I can learn, all so-called changes of atomicity take place when metalloids are involved, and not when metals alone are in question.

As instances of these, I may refer to the triatomic combinations formed with chlorine, oxygen, sulphur, &c. in the case of tetrad or hexad metals.

May we not from these ideas be justified in defining a metal, provisionally, as a substance, the absorption-spectrum of which is generally the same as the radiation-spectrum, while the metalloids are substances the absorption-spectrum of which, generally, is not the same? In other words, in passing from a cold to a comparatively hot state, the plasticity of these latter comes into play, and we get a new molecular arrangement. Hence are we not justified in asking whether the change from oxygen to ozone is but a type of what takes place in all metalloids?

My best thanks are due to Mr. R. J. Friswell for the valuable aid he has afforded me in these investigations.

J. NORMAN LOCKYER

SCIENTIFIC SERIALS

Poggendorff's Annalen der Physik und Chemie, 1874, No. 12.—This number completes vol. 153 of the series, and contains the following papers:—On the capacity of liquids for conducting heat, by A. Winkelman; account of experiments based upon the same method which Stefan employed successfully for determining the heat-conducting capacity of air, and results tabulated for water, alcohol, bisulphide of carbon, glycerine, and solutions of chlorides of potassium and sodium.—On the elastic after-effects in torsion motions, by F. Neesen.—Experimental researches on the behaviour of non-conducting bodies under the influence of electric forces, by Ludwig Boltzmann. The author starts from the correct supposition that, according to the theories of Clausius, Maxwell, and Helmholtz on the behaviour of dielectric non-conductors in the electric field, the remarkable yet obvious consequence results (which seems to have been overlooked hitherto), that electric forces must necessarily exercise perceptible attraction upon non-conductors simply on account of their dielectric polarisation. The results he obtained were quite in correspondence with the theories his experiments were based upon.—On the action of electrophora, by P. Riess.—Critical remarks on electro-dynamics, by H. Helmholtz.—On the power of conducting electric currents in metallic sulphides, by Ferdinand Braun. This paper is a supplement to another one by Herr Herwig (vol. 153, No 9, of these *Annals*), on the behaviour of iron and steel rods in galvanic currents.—On the reflection of light from the two surfaces of a lens, by Dr. Krebs. It is a well-known fact, that when light passes through a lens and we neglect the absorption in the interior of the lens itself, a certain quantity of light is reflected by the surfaces of the lens. Dr. Krebs for the first time gives a mathematical account of this phenomenon.—On the apparent place of a luminous point situated in a denser transparent medium, or that observed through a so-called plane-parallel plate, by K. L. Bauer. The author arrives at the conclusion that in most works on physics, and especially on optics, misrepresentations of the point in question are contained, and quotes as examples the works of Mousson, Wüllner, Crüger, Müller, Riedel, Schabus, Krebs, Frick, Bänitz, Weinhold, and Jochmann; the only praiseworthy exception he found was Harting's xcellent work on the microscope.—On some new sulphur salts, by R. Schneider (tenth paper). The new salts mentioned in this paper are a compound of the formula—

$$Na_2S,Tl_2S_3 + Tl_2S,Tl_2S_3$$

and another one of the formula Tl_6S_7.—On a new eye-piece, by Dr. H. Krüss. The author points out that the latest improvements in optical instruments generally applied to object-glasses, and that the eye-pieces remained where Huyghens and Ramsden left them; he therefore directed his attention to the improvement of eye-pieces, which he describes. Whether these improvements will answer their purpose, practical experiments only can show.—A note, by G. Wiedemann, on the dissociation of salts containing water. Mr. Wiedemann claims priority with regard to the investigations of M. Debray (*Comptes Rendus*, t. 66, p. 194, 1868).—A note on the theory of electricity, by E. Edlund.—A note by F. Lippich, on an electro-dynamic experiment of F. Zoellner, described in these *Annals*, vol. 153, p. 138.—A note by O. E. Meyer, on a paper by Dr. G. Baumgartner, on the influence of temperature upon the velocity of effluence of water flowing from tubes (these *Annals*, vol. 153, p. 44).—A note by H. Baumhauer, on a paper of Dr. F. Exner, on the solution-figures upon the surfaces of crystals (these *Annals*, vol. 153, p. 53). Mr. Baumhauer points out that these figures are quite independent of the crystallographic construction of the substances undergoing solution.—On the rays of light which decompose the xanthophyll of plants, by J. Wiesner. Finally, A. Gawalovski describes a self-acting mercury valve for shutting off gases, and preventing their passage in any but the desired direction.

THE *Journal of the Chemical Society* for January contains the following papers:—Action of bromine in presence of water on bromo-pyrogallol and on bromo-pyrocatechin, by Dr. J. Stenhouse. The action of bromine on pyrogallol gives rise to the formation of a yellow crystalline body of the formula $C_{18}H_4Br_{14}O_6$ in accordance with the equation—

$$4C_6H_3Br_3O_3 + 11Br_2 + 6H_2O = C_{18}H_4Br_{14}O_6 + 6CO_2 + 20HBr.$$

The author has not been able to determine the constitution of this body, but proposes to name it provisionally *xanthogallol*. Alkalies act upon xanthogallol in presence of ether in the following manner:—

$$C_{18}H_4Br_{14}O_6 + 3NaHO = C_{18}H_7Br_{11}O_9 + 3NaBr.$$

The excess of alkali at the same time reacts with the substance and forms an alkaline salt. The action of bromine and water on bromo-pyrocatechin gives rise to a crimson crystalline compound of the formula $C_{18}H_2Br_{10}O$, which the author has named provisionally *erythro-pyrocatechin*. This body is formed as follows:—

$$4C_6H_2Br_4O_2 + 5Br_2 + 5H_2O'' = C_{18}H_2Br_{10}O + 6CO_2 + 16HBr.$$

The next paper is by the same author, on the action of bromine on protocatechuic acid, gallic acid, and tannin. When protocatechuic acid is heated with excess of bromine in sealed tubes at 100° tetrabromopyrocatechin is produced, in accordance with the reaction—

$$C_7H_6O_4 + 4Br_2 = C_6H_2Br_4O_2 + CO_2 + 4HBr.$$

The protocatechuic acid used was prepared from East Indian kino. Gallic acid heated with bromine to 100° gives rise to the formation of tribromopyrogallol, $C_6H_3Br_3O_3$. The reaction in the case of tannin is different according as the substance is perfectly dry or contains water. The action of chlorine on protocatechuic acid and on pyrogallol has likewise been studied.—On propionic coumarin and some of its derivatives, by W. H. Perkin. The author prepares this body by the action of propionic aldehyde on sodium-salicyl hydride. β-bromopropionic coumarin has been prepared by substituting sodium-bromosalicyl hydryde for sodium-salicyl hydride in the preparation of propionic coumarin. The same body is produced by the action of bromine in excess on propionic coumarin. By the further action of bromine (dissolved in CS_2) in a sealed tube heated to 150°, β-dibromopropionic coumarin is produced. Fuming sulphuric acid dissolves propionic coumarin with the formation of a sulpho-acid of the formula $C_{20}H_{16}O_4S_2O_6$.—Action of the organic acids and their anhydrides on the natural alkaloids, Part II.: Butyryl and benzoyl derivatives of morphine and codeine, by G. H. Beckett and Dr. C. R. A. Wright. The action of butyric acid on codeine gives rise to the formation of dibutyryl-codeine, $C_{36}H_{40}(C_4H_7O)_2N_2O_6$. Butyric aldehyde yields the same body when heated with codeine. When morphine is substituted for codeine, an analogous compound,