highest temperature that I can get on the earth either by the long heat-waves or by means of electricity, I find that there is absolutely no difference whatever in the molecular arrangement of that sodium vapour at the extreme points. Spectroscopically it is absolutely the same.

Then if I take, not sodium but another element, such as iron, I find it excessively difficult, by means of the heat-waves, to shake asunder the molecules of iron and the diatomic or polyatomic molecules of iron vapour at all. But we know that by electricity non-atomic iron vapour can be got; and then we may say, at all events so far as the lines in the spectrum are concerned (I do not mean their position, but their general nature), that we get a spectrum from the vapour of iron, similar in character to that of the vapour of sodium; but the spectrum has become more complicated as we pass from the monad metal to one with a higher atomicity.

Suppose that, instead of taking a monad metal like a sodium, with its few-lined spectrum, or a metal like iron, with its high atomicity and its many-lined spectrum, we take a *metalloid*; then we find that those conditions no longer hold good. It is not too much to say that in the case of the metalloids every change of even low temperature brings about a change in the spectrum. It is perfectly true, as I have said before, that by means of electricity we can get a line-spectrum from most of the metalloids. But from the ordinary temperature to the electric spark in the case of a metalloid, instead of getting the perfect similarity that we did in the case of sodium vapour, we get an equally perfect and equally beautiful dissimilarity; so that whilst we say that in the case of sodium we only know of but one spectrum, in the case of sulphur, to take one case, we certainly know of four.

You must let me again remind you that when we employ electricity the spectra of the metalloids present exactly the same appearance as the spectra of the metallic elements, such as iron and sodium, and that it is only when we employ heat-waves that those other changes to which I have referred take place.

One word more, too, on the fundamental difference between the spectrum of a metalloid and the spectrum of a metal on the one hand, and the spectrum of a compound on the other. The metalloid has a spectrum of channelled spaces or bands, sometimes to be found in the central part, that is to say, in the green part, or thereabouts, of the spectrum, whereas in the case of the vapour of metals such as iron, and so on, we get bright lines only, not bands; and these lines increase in number generally toward the violet, while in the case of the compound molecules, such as iodide of strontium, to which I referred, we get a something which is half channelled spaces and bands, and half lines, but in all the cases I have examined, excluding oxides, they are limited to the red end of the spectrum.

Let me attempt briefly to summarise what I have stated. With electricity in the case of all elements we obtain line spectra; as we are here dealing with the most complete simplification of matter that we can attain, let us call this the *atomic spectrum*.

With heat we can obtain a continuous spectrum, from solids, liquids, and some vapours; with electricity we can even obtain a similar spectrum from dense gases. Let us call this the *molecular spectrum*.

In the case of many of the metalloids we get, between these extremes, a channelled space spectrum. Let us term this the *sub-atomic spectrum*.

In the case of some compound molecules, we get by heat in some cases, and by electricity in others, a spectrum which is dissimilar from all these. Let us call this the *compound atomic spectrum*.

J. NORMAN LOCKYER

(*To be continued.*)

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 19.—Preliminary Notice of Experiments concerning the Chemical Constitution of Saline Solutions, by Walter Noel Hartley, F.C.S., Demonstrator of Chemistry, King's College, London.

The author has been engaged in investigating the above subject during the last eighteen months, and his experiments being still in progress, he thinks it desirable to place the following observations on record:—

In the examination of the absorption-spectra, as seen in wedge-shaped cells, of the principal salts of cerium, cobalt, copper, chromium, didymium, nickel, palladium, and uranium, to the number of sixty different solutions, it was noticed that the tinctorial properties of the substances could be ascertained by noticing the absorption-curves and bands, so that, provided water be without chemical action, it could be foreseen what change would occur on dilution of a saturated solution.

The Effect of Heat on Absorption-spectra

When saturated solutions of coloured salts are heated to 100° C. there are (1) few cases in which no change is noticed; (2) generally the amount of light transmitted is diminished to a small extent by some of the more refrangible (the less refrangible), or both kinds of rays being obstructed; (3) there is frequently a complete difference in the nature of the transmitted light. Anhydrous salts not decomposed, hydrated compounds not dehydrated at 100° C., and salts which do not change colour on dehydration, give little or no alteration in their spectra when heated.

Solutions of hydrated salts, and most notably those of haloid compounds, do change; and the alteration is, if not identical, similar to that produced by dehydration and the action of dehydrating liquids, such as alcohol, acids, and glycerine, on the salts in crystals or solution.

A particular instance of the action of heat on an aqueous solution is that of cobalt chloride, which gives a different series of dark bands in the red part of the spectrum at different temperatures, ranging between 23° C. and 73° C. Band after band of shadow intercepts the red rays as the temperature rises, till finally nothing but the blue are transmitted. Drawings of six different spectra of this remarkable nature have been made. The changes are most marked between 33° and 53°, when the temperature may be told almost to a degree by noting the appearance of the spectrum. Though to the unaided eye cobalt bromide appears to undergo the same change, yet, as seen with the spectroscope, it is not of so curious a character, the bands being not so numerous.

With cobalt iodide a band of red light is transmitted at low temperatures; this moves towards the opposite end of the spectrum with rise of temperature until it is transferred to such a position that it consists of green rays only. In this instance the change to the eye is more striking when seen without the spectroscope, because the mixtures of red, yellow, and green rays, which are formed during the transition, give rise to very beautiful shades of brown and olive green. Thus a saturated solution at 16° C. was of a brown colour, at −10° C. it became of a fiery red and crystals separated, at +10° reddish brown, at 20° the same, at 35° Vandyke brown, 45° a cold brown tint with a tinge of yellowish green, at 55° a decidedly yellowish green in thin layers and yellow brown in thick, 65° greenish brown, thin layers green, 75° olive-green. An examination of this cobalt salt has shown that there are two distinct crystalline hydrates; the one formed at high temperatures has the formula $CoCl_2.2H_2O$, and is of a dark green colour; the other, which contains a much larger proportion of crystalline water, is produced at a low temperature, and its colour is generally brown, in cold weather inclining to red.

The action of heat on solutions of didymium is characterised by a broadening of the black lines seen in the spectrum, more especially of the important band in the yellow; and in the case of potassio-didymium nitrate, this is accompanied by the formation of a new line. In the case of didymium acetate, which decomposes with separation of a basic salt, the lines thickened on heating.

Thermo-chemical experiments

Regnault (Institut, 1864; "Jahresbericht," 1864, p. 99) has shown that on diluting a saturated solution of a salt, as a rule there is an absorption of heat, but in one or two cases he noticed that heat was evolved. The change in colour that takes place on the dilution of saturated solutions of cobalt iodide, cupric chloride, bromide and acetate is very remarkable. There is every likelihood that this phenomenon is due in each case to the formation of a liquid hydrate. It is impossible of belief that accompanying such a circumstance there should be no measurable development of heat; and the author's experiments have proved that in the above cases, at any rate, the heat disengaged is very considerable, amounting, for instance, on the part of cupric chloride, at least to 2,565 "units when 1 gram molecule of the crystalline salt is displaced in its minimum of water at 16° C. and brought into contact with sufficient to make the addition of 40 Aq." These numbers only roughly approximate the truth. On diluting a solution of cobalt iodide till the red colour appears, the thermal effect must be much greater, as not only does it register several degrees on an ordinary thermometer, but it may be perceived by the hand.

The conclusions indicated by these results are obvious, but it is beyond the scope of this paper to refer to them. The writer hopes before long to complete his experiments with the view of having them communicated to the Royal Society.

Spectroscopic Observations of the Sun, by J. Norman Lockyer, F.R.S., and G. M. Seabroke, F.R.A.S.

Note on the Intracellular Development of Blood-corpuscles in Mammalia, by Edward Albert Schafer.

Linnean Society, March 19.—Dr. G. J. Allmann, F.R.S., in the chair.—The following papers were read:—Observations on Bees and Wasps, by Sir John Lubbock, Bart., F.R.S. (for an abstract of which see another column), followed by an interesting discussion in which the president, Mr. Robert Warren, Major-General Strachey, Mr. A. W. Bennett, Prof. Newton, Prof. Thiselton Dyer, Mr. D. Hanbury, Mr. Elliot of New York, and others, took part.—On *Oniscigaster wakefieldi*, a singular insect from New Zealand, belonging to the family Ephemeridæ, with notes on its aquatic conditions, by R. M'Lachlan.

Zoological Society, March 12.—Prof. Newton, F.R.S., in the chair.—The Secretary called the attention of the meeting to an important addition that had been made to the Society's collection on the 7th inst., by the acquisition of a young male Javan rhinoceros (*Rhinoceros sondaicus*) from Batavia, believed to be the first example of this rhinoceros that had ever been brought alive to Europe.—A letter was read from the Rev. S. J. Whitmee, resident at Samoa, stating that he had forwarded, through Dr. G. Bennett, of Sydney, a *Didunculus* and two curlews for the Society's collection, and giving interesting particulars concerning the habits of this bird, and another peculiar Samoan species, *Pareudiastes pacificus*.—An extract was read from a letter addressed to the Secretary by Dr. George Bennett respecting a *Didunculus*, and other birds, he had received from the Rev. Mr. Whitmee, of Samoa, intended for the Society's collection.—Dr. Günther, F.R.S., gave some details concerning the recent introduction into this country, by Lord Arthur Russell, of the Ide (*Leuciscus melanotus*, var. *orfus*).—Prof. Huxley read a memoir upon the structure of the skull and of the heart of *Menobranchus lateralis*, describing the structure of the bony skull in the osteo-cranium, and giving a full account of the primordial skull or chondrocranium, which has not hitherto been noticed. The chondrocranium was compared with that of *Proteus*, and that of larval frogs and tritons, and its essentially embryonic character was indicated. The chondrocranium was further shown to be formed by the coalescence of three distinct classes of elements which were termed *parachordal*, *pleural*, and *paraneural*. The heart was described, and the septum of the auricles was shown to be an open network allowing of free communication between the right and left auricular chambers. The structure of the *Truncus arteriosus* was compared with that observed in other amphibians.—Mr. R. B. Sharpe communicated the descriptions of two new species of birds recently procured by Mr. H. T. Ansell, of Gaboon; these were proposed to be called *Centropus anselli*, and *Dryoscopus coronatus*.

Chemical Society, March 19.—Prof. Odling, F.R.S., president, in the chair.—On Dissociation, by Prof. Dewar. The lecturer premised that as he had but little that was new to tell, he must content himself with condensing and epitomising the results of others. After briefly referring to the theories of Priestly and Hutton, he described the famous experiments of Sir James Hall, who obtained a substance identical with marble by fusing carbonate of lime under pressure. He next noticed Grove's discovery that water was decomposed at a temperature lower than that produced by the union of oxygen and hydrogen, and then explained the masterly researches of Deville on the effect of heat in causing the dissociation of carbonic anhydride, carbonic oxide, water, &c. After this the lecturer showed that in dissociation the tension of the vapour evolved is constant for a given temperature and independent of the mass, illustrating it by Debray's experiments on the decomposition of carbonate of lime at a regulated heat, and the evolution of water from certain hydrated salts. The lecture, which was illustrated with diagrams of various curves of tension, concluded with some remarks on the dissociation of the compound of hydrogen and palladium, and with a description of an apparatus devised by the speaker for ascertaining the temperature produced by the explosion of a mixture of oxygen and hydrogen under various pressures.

Meteorological Society, March 18.—Dr. R. J. Mann, president, in the chair.—Mr. R. H. Scott, F.R.S., read a paper On an attempt to establish a Relation between the Velocity of the Wind and its Force (Beaufort scale), with some remarks on anemometrical observations in general. The author stated that he considered that the existing scales of wind force were unsatisfactory. The highest pressure corresponding to force 6 of the land scale was 36 lbs. per square foot, whereas pressures of above 40 lbs. had frequently been registered. He further brought forward proofs of the irregularity in the distribution of such high pressures. He then spoke of the Beaufort scale, and pointed out some of its defects, but stated that speaking generally it might be considered to be a rough classification of the wind force, exact enough for practical purposes, and proceeding by nearly equal degrees. He had recently made experiments at Holyhead and at Yarmouth to test the velocity recorded by the anemometer at each station at the hours when the several figures of the Beaufort scale were reported. The result was a scale which agreed very closely with that given by Schott, as a deduction from theory in his discussion of the observations made by Sir F. Leopold M'Clintock in the *Fox*, and published by the Smithsonian Institution. Inasmuch as the accordance of practice with theory was very great, he proposed this scale for general adoption—

Force.	Miles per hour.	Force.	Miles per hour.
0	2·5	7	40·5
1	8	8	48·5
2	13	9	56·5
3	18	10	65
4	23	11	75
5	28	12	90
6	33·5		

The paper then went on to point out from experience gained at Holyhead, Yarmouth, and Falmouth, the very serious discrepancies which had been proved to exist in the records of velocity for the various points of the compass, especially at Yarmouth, and which showed that the influence of local situation, not only as to the contour of the country, but even the very shape and height of the observatory and the adjacent buildings, exercised a most serious influence on the correctness of the data afforded by the instruments. It therefore seemed very dangerous to reason as to the mean motion of the air over the British Isles from the anemometrical records of one or two stations, as has been done by Dove.—The next paper read was by Mr. G. J. Symons, On the Sensitiveness of Thermometers, in which he gave the results of a series of comparisons of the speed with which thermometers with bulbs of various sizes took up the true temperature to which they were exposed. Three series of thermometers were used, a set with spherical bulbs filled with mercury, and varying in diameter from a quarter to three-quarters of an inch. The result was that the small bulb took up the true temperature in about three minutes, while the large bulb took three times as long; a second set were similar in form, but filled with spirit; they were more sluggish, but the small spirit ones were more prompt than large mercurial ones. Lastly, the new patterns of spirit minimum thermometers introduced by Mr. Casella and Mr. Hicks were tested and found as sensitive as ordinary mercurial thermometers. The instruments were all examined by the Fellows at the close of the meeting.—The last paper was by Mr. R. Strachan, On the Weather of Thirteen Autumns.

Royal Astronomical Society, March 13.—Prof. Adams, F.R.S., president, in the chair.—On an occultation of Neptune observed at Walthamstow on April 24, by Mr. Talmage. The planet was seen to skirt along the moon's limb, and was only occulted for a few seconds. The occultation was also watched for at Greenwich by Mr. Criswick, and although the difference of latitude only amounts to a few miles, the planet was never lost sight of.—On a remarkable structure visible upon the photographs of the solar eclipse of December 12, 1871, by Mr. Ranyard. In viewing the photographs by transmitted light a minute partially transparent spot can be traced at a height of about 9′ from the eastern limb on all the negatives of Lord Lindsay's series, and on four out of the six negatives of Col. Tennant's series. It appears to occupy identically the same place with regard to the dark details of the corona in all the photographs, and cannot therefore be due to any reflection within the camera, for the position of the corona is shifted upon the different plates. On first making the discovery, he had been inclined to think that it must be due to a star seen through the corona, but on further reflection he had been obliged to abandon that idea, for a star would have been represented by a dark or opaque point, whereas this must be due to an object darker than the corona, apparently hiding or cutting out some of its light. On a closer examination of the negatives, with suitable lights, three partially transparent circular arcs concentric with the bright point were detected above it. Such forms are totally different from the corona structure visible on other parts of the plate, and there seemed no alternative but to suppose that they were due to some partially opaque body situated between us and the sun, cutting out or partially intercepting the light of the corona. The structure is similar to that which has often been observed in the nuclei and concentric comæ of comets, and Mr. Ranyard thought that it did not seem unreasonable to suppose that this was really a photograph of a faint though large comet near to perihelion. Mr. Christie said that he had examined the negatives and he did not think there could be any doubt about the existence of the structure. It was distinctly to be traced on Lord Lindsay's series, and also on those taken 120 miles away at Ootacamund by Col. Tennant.

Entomological Society, March 16.—Sir Sidney Smith Saunders, president, in the chair.—Mr. Champion exhibited specimens of *Euryporus picipes* taken near Chatham.—Mr. Edward Saunders exhibited a box of *Buprestidæ* collected by Prof. Semper in the Philippine Islands; and read some notes and descriptions of the new species.—A paper was communicated by Prof. Westwood on several additional species of *Lucanidæ* in the collection of Major F. J. Sidney Parry.

Geologists' Association, March 6.—Prof. Morris, F.G.S., vice-president, in the chair.—On the geology of the Nottingham district, by the Rev. A. Irving, F.G.S. The district under consideration comprises coal-measures, Permian, Bunter, Keuper, and Lias rocks—a border-land between the Palæozoic and Mesozoic epochs. No apparent unconformability exists between the Permian and Triassic series here; while that between the Permian and coal-measures is enormous. (1) *Coal Measures.* There are seven seams of coal at present workable in this field, with many more of inferior quality. The enormous unconformability between the coal-measures and the Permian is shown by the fact that at the Shire Oak Colliery near Worksop, 1,300 ft. of coal-measures are passed through before the "top-hard" is reached, whilst at Stretley, twenty miles to the south, the magnesian limestone rests directly (according to Mr. G. Fowler, C.E.) upon the "top-hard" seam. (2) *The Permian.*—The great unconformability between the Permian rocks and the coal-measures is rendered more significant by the absence of the Lower Red Sandstone (Rothliegende), whilst there are clear proofs of continuous deposition of the Permian and Lower Bunter. In this area stratigraphical evidence points to the Permian and Bunter as but portions of one great unbroken sequence of rocks deposited upon highly disturbed and denuded coal-measures. (3) The *Bunter.*—The Lower Mottled Sandstone is nowhere more than 100ft. thick. The Himlack stone exhibits the junction of the Lower and Middle Bunter. It is marked by unconformability. A bed of calcareous grit and breccia forms the basement of the pebble beds, or Middle Bunter. This is evidently a shore formation. The author concluded, from its composition and from the general prevalence of current bedding, that it occupied an area of deposition subject to shifting currents, but protected from the open ocean. (4) *Keuper.*—Two sections were given where the "water-stones," consisting of alternating beds of sandstone and marls, are seen resting upon the eroded surface of the bunter. In each case the junction is marked by a bed of highly calcareous breccia; and there is unconformability between the two formations. Footprints of *Cheirotherium* have been observed at Castle Donnington, and recently by the author at Colwick, near Nottingham. Ripple marks, &c., are also commonly met with. (5) The *Rhætic beds.*—The black paper shales were discovered by Mr. Etheridge a short time ago at Elton; there also the author has found a portion of the bone-bed. (6) The *Lias* may be observed capping the hills on the south side of the Trent Valley. Belvoir Castle crowns an escarpement of the Middle Lias (marlstone), abounding in *Rhync. tetrahedra* and *Ter. punctata.* (7) *Drift and Alluvium.*—The greater part of the former appears to have been long since carried down into the valley of the Trent, where extensive gravel-pits are worked, as *e.g.* at Saveley and Beeston.

PARIS

Academy of Sciences, March 16.—M. Bertrand in the chair. The following communications were read:—Note on the employment of flexible laminæ for the tracing of arcs with curvature of large diameter, by M. Resal.—Researches on symmetrical isomerism and on the four tartaric acids, by MM. Berthelot and Jungfleisch. The authors have determined the heat of solution of dextro-tartaric acid, lævo-tartaric acid, racemic acid, and inactive tartaric acid. The authors think it probable from their researches that water decomposes the inactive acid into its two active constituents during the act of solution.—On the crystalline hydrates of sulphuric acid, by M. Berthelot; also a thermo-chemical communication.—Experimental researches leading to a determination of the sun's temperature: a letter from P. Secchi to the perpetual secretary. The author has compared the solar radiation with that of the electric arc from a battery of 50 Bunsen's elements, using for this purpose his "thermo-heliometer." After making necessary corrections for atmospheric absorption the result obtained is 133780°, but the author considers this number only an approximation, and considers it possible that it may have to be raised to 169680°.—Report of the geodesic work relating to the new determination of the French meridian, by M. Elie de Beaumont.—Memoir on the swim-bladder from the point of view of station and locomotion, by M. A. Moreau.—On an application of the theory of substitutions to linear differential equations, by M. C. Jordan.—On the heat of combustion of different varieties of red phosphorus; a note by MM. Troost and Hautefeuille.—On the conditions which determine the movements of chlorophyll granules in the cells of *Elodea canadensis*; note by M. E. Prillieux. By a microscopical examination the author has sought to distinguish clearly in the example chosen the movements which are affected by light from those produced by lesion of the tissues during the act of preparation for microscopic examination.—The blocks and rolled flints in the Red Sandstone of the drift of Saint-Brieuc; note by M. T. Héna. These flints appear to have been brought from Erquy, 24 kilometres to the north-east of Saint-Brieuc by means of floating ice.—On the laws of the plane distribution of pressures in the interior of the isotropic bodies in the state of limited equilibrium; note by M. J. Bossinesq.—On the friction of glaciers and the erosion of valleys, by M. C. Grad. The author expresses his belief that neither the Alpine valleys, the Italian and Swiss lakes, nor the fjords of Norway and Greenland owe their origin to glacial erosion.—Chemical nature of the sulphide of iron (troïlite) contained in meteoric irons, by M. S. Meunier. A reiteration of the view, formerly expressed by the author, that this substance is a variety of pyrrhotine (Fe_7S_8) and not simply a ferrous sulphide (FeS).—On a phosphate of cerium containing fluorine, by M. F. Radominski. This mineral contains cerium, lanthanum and didymium, calcium, magnesium, iron, fluorine, phosphoric acid and traces of water. It was found near Fahlun in Sweden. During the meeting M. Gosselin was elected into the section of medicine and surgery to supply the vacancy caused by the death of M. Nelaton.

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