latter augments and the line disappears, the ultra-violet flutings gradually die out altogether.

It is philosophical to infer from these observations that not only are the line and flutings in question produced by carbon, but that the blue line (4266), since it is visible at the highest temperature, corresponds to the most simple molecular groupings we have reached in the experiments, and the flutings to others more complex.

The result to which attention is most to be directed in this place is that touching the two sets of flutings, and should future research justify the double conclusion (1) that these flutings are truly due to carbon, a result I accept, though it is denied by Angström and Thalèn; and (2) that the different flutings really represent the vibrations of different molecular groupings; a great step, and one in the direction of simplification, will have been gained.

Indeed it is much to be hoped that this ground will be at once worked over again by men of science who are both honest and competent: that the truth is sure to gain by such work is a truism.

I have so often taken occasion to refer with admiration to the work of Angström and Thalèn that I shall not be misunderstood when I say that their conclusions, to which such prominence is given, and on which such great stress is laid by Messrs. Liveing and Dewar, rest more upon theory and analogy than upon experiment.

Their work, undertaken at a time when the existence of so-called "double spectra" was not established upon the firm basis that it has now, and when there was no idea that the spectrum recorded for us the results of successive dissociations, gave, as I have previously taken occasion to state, the benefit of the doubt in favor of flutings being due to compounds, and it was thought less improbable that cyanogen or acetylene should have two spectra than that carbon or hydrogen should possess them.

Indeed, later researches have thrown doubt upon the view that the fluted spectra of aluminium and magnesium are entirely due to the oxides of those metals instead of to the metals themselves—and this is the very basis of the analogy which Angström and Thalèn employed.

The importance of the observations to which I have referred is all the greater because of the general conclusions touching other spectra which may be drawn from them. Thus from what I have shown it will be clear that if my view is correct, the conclusions drawn[1] by Messrs. Liveing and Dewar from the assumed hydrogen-carbon bands touching both the spectrum of magnesium and the spectra of comets, are entirely invalid. These conclusions are best given in their own words:—

"The similarity in the character of the magnesium-hydrogen spectrum, which we have described, to the green bands of the hydrocarbons is very striking. We have similar bright maxima of light, succeeded by long drawn-out series of fine lines, decreasing in intensity towards the more refrangible side. This peculiarity, common to both, impels the belief that it is a consequence of a similarity of constitution in the two cases, and that magnesium forms with hydrogen a compound analogous to acetylene. In this connection the very simple relation (2 : 1) between the atomic weights of magnesium and carbon is worthy of note, as well as the power which magnesium has, in common with carbon as it now appears, of combining directly with nitrogen. We may with some reason expect to find a magnesium-nitrogen spectrum. . . .

"The interest attaching to the question of the constitution of comets, especially since the discovery by Huggins that the spectra of various comets are all identical with the hydrocarbon spectrum, naturally leads to some speculation in connection with conclusions to which our experiments point. Provided we admit that materials of the comet contain ready-formed hydrocarbons, and that oxidation may take place, then the acetylene spectrum might be produced at comparatively low temperatures without any trace of the cyanogen spectrum or of metallic lines. If, on the other hand, we assume only the presence of uncombined carbon and hydrogen, we know that the acetylene spectrum can only be produced at a very high temperature, and if nitrogen were also present that we should have the cyanogen spectrum as well. Either, then, the first supposition is the true one, not disproving the presence of nitrogen, or else the atmosphere which the comet meets is hydrogen only, and contains no nitrogen."

The importance of the question here treated of comes out very well from these two extracts. We find the same spectral phenomenon at once called into court, and very properly called in, both to suggest the existence of chemical substances of which the chemist has never dreamt, and to explain the chemical nature of a large group of celestial bodies.[1]

There is little doubt that when a complete consensus of opinion is arrived at among the workers, other suggestions more far reaching still will be derived from the prosecution of these inquiries. For the present, however, the chief point to bear in point is that both in line-spectra and in fluted spectra we have indications which I think favor the view that in each case the origin is compound rather than simple.—*Nature*.

J. NORMAN LOCKYER.

OBAN, *July* 20.

[1] Paper read February 12, 1880.

PHYSICAL NOTES.

FROM the above article we see that as far back as 1878, Mr. Lockyer communicated to the Royal Society a paper in which the conclusion was drawn that vapor of carbon was present in the solar atmosphere. This inference was founded upon experiments similar to those of Attfield and Watts, who showed that flutings are always present in different compounds of carbon exposed to the action of heat and electricity. This observation of Lockyer has been called in question by Liveling and Dewar, as they have found it an almost impossible problem to eliminate hydrogen from masses of carbon. This latter view has been long held by Edison, who, in a great number of experiments, some of which were participated in by Prof. Young, has found at the enormous heat developed by igniting a fine carbon thread $\frac{8}{1000}$ of an inch diameter, of high resistance, in air vacuum, until a light of 80 candles is reached, that only a carbon spectrum is given, until just a few seconds before the rupture of the loop, *when a sharply defined hydrogen spectrum is observed.* On the other hand, in an observation of the purified spectrum of carbon tetrachloride, Mr. Lockyer (*Nature*, August 5th) found only carbon appeared at high temperatures. It is an excellent index of the spirit of unbiased investigation in the author of (*Nature*, December, 1878) The Hypothesis that the so-called Elements are Compound Bodies, and still later, of the Universal Hydrogen Hypothesis, to learn from Mr. Lockyer that, both in line and fluted spectra, he thinks we have indications which favor the view that in each case the origin is compound rather than simple.

IN a communication from William Huggins, F.R.S., received June 16th, 1880, and published in the *American Journal of Science* for August, are embodied some observations on the nature of the spectrum of water, which may give rise to a question of priority. It appears that Dr. Huggins made a photograph of the flame of hydrogen burning in air, December 27, 1879, but did not publish the fact.

On June last, Messrs. Liveing and Dewar state, in a paper read before the Royal Society, that they have obtained a photograph of the ultra violet part of the spectrum of coal gas burning in oxygen, and in a note dated June 8th, they add that they have reason to believe that this remarkable spectrum is not due to any carbon compound, but to water. Professor Stokes (whose well-known monograph in *Phil. Trans.*, 1852, has furnished so much suggestive material for others to work upon in this very line), authorizes the statement that Dr. Huggins, in a let-

[1] With special reference to this last question, that of cometary spectra, one of acknowledged difficulty, I may perhaps be permitted to add here by way of note that the view I put forward some years ago touching the relation to this spectrum to that of the nebulæ has been lately strengthened by the observation that at a low temperature one of the brightest lines in the spectrum of iron is that coincident with the chief line in the nebula-spectrum.

ter bearing date 30th January, 1880, spoke of "a novel and interesting result," referring, probably, to the above-mentioned photograph. Since then, Dr. Huggins has taken a large number of photographs of the spectra of different flames, but only presents one (that of hydrogen) to the Royal Society. We regret this, both because of the loss to our general stock of science, in this unnecessary detention of the spectrum of carbon and its compounds, and because of the imminent probability of a repetition of these disagreeable questions of priority, as, on this side of the water (to the writer's knowledge), this particular subject is being eagerly studied under unique conditions.

The experiment of Dr. Huggins consists of first burning hydrogen *per se* in atmospheric oxygen, and then a mixture of oxygen with hydrogen in air. He finds the two spectra identical. For purposes of comparison, he very ingeniously photographs them on the same plate, in rapid succession, using the upper half of his spectroscope slit for the first, and the lower half for the second impression. As all the lines of both spectra fit each other exactly, without excess, it is evident that either represents the spectrum of water. The article referred to contains a partial spectrum, giving the characte ristic lines of wate.

PROF. J. TROWBRIDGE has recently studied the earth as a conductor of electricity and details some interesting experiments, and advances some bold speculations and prophecies in the *American Journal of Science* for August. In all the telephone circuits between Boston and Cambridge for a distance of about four miles, the ticking of the Observatory clock could be heard when transmitting time signals. This was attributed to the proximity of the telephone circuit wires to the time wires of the Observatory. Mathematical considerations, however, (Maxwell's Electricity and Magnetism, Vol. II., p. 209), will convince one that with telephones of the resistance usually employed, no inductive effect will be perceived between wires which run parallel to each other a foot apart for the distance of thirty or forty feet, even if ten-quart Bunsen cells be used. The transmission of these time signals is evidently not due to induction, but to tapping the earth, so to speak, at points which are not in the same potential. Running a wire five or six hundred feet long to ground at both ends, and putting a telephone in circuit, the ticking was distinctly heard when an exploration was made in an open field an eighth of a mile from the Observatory; yet the same wire, under similar conditions, gave no sound when one mile away from the central line between the Observatory and the Boston office. With the boldness of a Gallileo, Professor Trowbridge deduces thence the theoretical possibility of telegraphing across the Atlantic without a cable. He says: "Powerful dynamo-electric machines could be placed at some point in Nova Scotia, having one end of their circuit grounded near them and the other end grounded in Florida, the conducting wire consisting of a wire of great conductivity and carefully insulated from the earth, except at the two grounds. By exploring the coast of France, two points on two surface lines not at the same potential could be found; and by means of a telephone of low resistance, the Morse signals sent from Nova Scotia to Florida could be heard in France. Theoretically this is possible, but practically, with the light of our present knowledge, the expenditure of energy on the dynamo-electric engine would seem to be enormous."

A VERY curious observation has been made by M. J. Janssen of a remarkable inversion in a photographic image by exposure during different times. It passed from negative to positive with an intermediary neutral, invisible period. After a first exposure of $\frac{1}{1800}$ of a second a negative can be developed, a little longer exposure would dull the sharpness of the image; then there soon arrives a point where the negative disappears entirely. By a still longer exposure a new phase occurs, a positive image starts out from the plate, with lights and shadows just the reverse of the first and as sharply defined. By allowing further action of the light a second neutral condition occurs. M. Janssen does not say by what state this is followed.—*Moniteur Sci.*

M. SCHEURER-KESTNER in a note to the Académic des Sciences, qualifies a previous statement that sulphuric acid attacks platinum, by new experiments. Absolutely pure sulphuric acid does not attack platinum, but if there be ever so small a content of nitrous acid, a very appreciable quantity of the vessel is dissolved, $\frac{1}{10000}$ being enough for the purpose. In one of his experiments, on 60 grams of sulphuric acid, two milligrams of platinum were dissolved. This fact should be verified by manufacturers of concencentrated sulphuric acid.

Mr. Albert Levy finds considerable variation in the ammoniacal contents of rain waters collected in the different quarters of Paris, but the annual means are identical. The per centages diminish from one month to the next, in passing from the cold to the hot season. The minimum at all stations was for the month of July, when there was present .93 of a milligram of nitrogen, against 1.35 in January. The potable waters of Paris are affected in exactly the same way. The reverse, however, is the case with the ammonia of the air which is most abundant in the hot season.—*Moniteur Scientifique*, Aug.

THE organisms described by Pasteur as the origin of epidemics and contagious disease, are so minute and few compared with the multiplying swarms of bacteria, etc., pervading all generating solutions, that it becomes necessary to provide a means of eliminating the masses of infusoria from solutions to be studied under the microscope. These microzoa haunt even the clearest drinking water at times, and it becomes highly important to easily determine their presence. M. Certes (Proceedings Acad. des Sciences), suggests the use of osmic acid as a sure means of killing them without destroying their tissues. He dips a glass rod into the solution to be examined and then into a 1½ per cent. solution of the acid; washing this in a narrow test tube of distilled water, it is easy to collect what is necessary for examination. There are certain precautions to be taken as to cleanliness and time of immersion. By the use of a mixture of Paris violet in diluted glycerine, he finds it possible by uniform difference of tint, to easily distinguish cellulose, amylaceous matter and the vibrating cilia.

M. DE LESSEPS, as an argument against the quarantine system, read a letter to the French Academy of Science, from the engineer in charge of the preparatory work of the interoceanic canal, informing him that a number of persons had disembarked at the isthmus while sick of yellow fever, without having propagated the disease among the workmen. Following this communication of M. De Lesseps, M. Bouley said he could not allow the inference from such remarks to pass unchallenged. Admitting that what M. De Lesseps said was true, that quarantines are a constant inconvenience to commercial and maritime relations, yet this injury is in the highest degree compensated for by the guarantees given to the public health. Since the international sanitary police has been watching over Egypt, and preserving it from the invasion of cholera by strict quarantine, this disease had come to be less feared in Europe. It is by quarantine alone we shelter ourselves from those diseases which vessels so easily carry with them, particularly the yellow fever to which M. De Lesseps refers. The atmospheric conditions which he says render quarantines nugatory, cannot contribute to the propagation of epidemics, unless those who are attacked are allowed to land from the vessels which contain the germs. But these germs are not intangible exhalations, subtile vapors, effluvia which have a property of fatal expansion, against which we can do nothing. Quite the contrary is true. Thanks to the researches of experimental science, the principle of contagion is no longer unknown; it has taken body and can be studied and followed in its manifestations. But even before this accession to our knowledge, practice, inspired by observation, had proved that strict surveillance of men and things coming from suspected countries would prevent the spreading of the germs. This is the province of the quarantine and by it alone can it be done. It is, then, necessary to maintain it in spite of the convenience to commercial and maritime relations.

OTTO A. MOSES.