Taken, then, on the whole, this aurora of February 4th was one of the most brilliant, most interesting, and most widely visible which has been witnessed for many years past, and is probably one that will cause renewed attention to be paid to the still unsolved problem of their causes.

J. P. EARWAKER

[We have also received the following from J. W. Spengel of Berlin:—"At Berlin, the sky being covered by clouds, no one could see anything. But a young astronomer of our observatory told me that he had recognised the existence of a mighty aurora by means of the spectroscope. The magnets were also vehemently disturbed, and all the telegraphs failed for several hours. The following appears in the *Leipziger Allgemeine Zeitung* for Feb. 8:—'Freiberg, Feb. 6. The aurora observed by many on the evening of Sunday caused here a complete interruption of communication through the telegraph wires for some time. The intensity between 5·40 and 6·45 overcame the strength of the battery at this station, so that it was not possible to change the oscillations of the magnetic needle caused by the earth-stream. After the northern light had become fully developed the oscillations became stronger, and followed one another at short intervals until the phenomena entirely disappeared about 7 P.M.' At Warmbrunn in the Riesengebirge, the aurora was seen magnificently from 6 to 8·30. Towards 10 it had almost disappeared. The thermometer indicated 0° C., with a violent storm from the south-west. About 11 the storm suddenly subsided; the thermometer fell to − 1·5°, and the aurora appeared for the second time in the same manner and with the same uninterrupted play of colours as at 6. After 11·30 the storm recommenced, and the aurora disappeared soon after 12. The play of the aurora on the snow-covered mountains is described as one of the most magnificent sights that can be conceived."—ED.]

REFERENCE SPECTRUM FOR THE CHIEF AURORA LINE

WHILE Nature herself seems to delight in surrounding some questions with triple difficulties and mysteries almost inscrutable, there are other questions which she has made the easiest of the easy if men will only use the means which she has prepared. And amongst such easy questions, no more signal example can be quoted than the exact spectrum place, within very narrow limits indeed, of Angström's yellow-green aurora line, whenever any aurora at all appears.

This chief aurora line coinciding precisely (as I believe I may say from my own observations, though by means of the roughest of home-made apparatus) with the second line, at W.L. 5579, of the citron band of the blue base of flame, from any and every material used for artificial illumination by man, and having immediately on one side the 1st line, of the same strength with itself, at W.L. 5630, and on the other side the fainter 3rd line, at W.L. 5535, of the same citron band; the smallest variation of spectrum place in the aurora line can be instantly perceived by the eye on this chemical scale, without the aid of any mensuration apparatus.

And yet in your last impression a respectable spectroscopist, after much labour, informs the Academy of Sciences in Paris, on Feb. 5, that Angström's yellow-green aurora line is somewhere close to Fraunhofer's solar line E, *i.e.* W.L. 5269; and in your previous impression a returning Indian observer considers the same Angström line to be somewhere near F, or W.L. 4860. Now, not only are these statements in error to the extent of from 30 to 70 times what they need be, but they cruelly drag us backwards in what should be the always onward course of science, and cause men to flounder once again in that slough of confusion they were immersed in a couple of years ago, when the chief solar corona line, at W.L. 5316, and Angström's grand aurora line, at W.L. 5579, were stated to be one and the same line, in the same place.

Excuse may, indeed, be proffered for these two observers, that they did not know of such a convenient night reference-spectrum as that which I have now alluded to; and then comes the question as to whose fault was that.

A full description of the method (after extensive trial for several months) was sent by me to the Royal Astronomical Society on May 30, 1871, with the particular request that the paper might be read at their June meeting and printed in the June Monthly Notice. This was mainly with the hope of supplying some possibly useful hints to the intending eclipse-corona-observers of December. The paper, however, though taken in, was neither read at the June meeting (if I am rightly informed) nor did it appear in the June Monthly Notice; but was handed over to secret referees, who simply sat upon it during six long months—or until the eclipse was safely past, and then they began to hint about possible objections being likely to be taken against some parts of the paper.

Of course I could not allow so admirable a society to run any risks of which they were afraid on my account; so I withdrew the paper thereupon, and am now engaged in publishing it myself, sustained in so doing by the hope that, although the eclipse for which it was mainly intended is irretrievably gone, its pages may yet be useful to some spectroscopists of aurora; and, in fact, that through their influence certain of both French and English observers will cease to attempt comparing the faint aurora's chief line with a bright solar spectrum, which they can never see in combination therewith (and if they could it has no coincident lines), but with a cheaply-procured chemical spectrum, which only comes well into view under the darkness of night, and is gifted by Nature in the spectroscope with an easily recognisable line in apparently absolute coincidence with the cosmical line of Angström.

C. PIAZZI SMYTH

15, Royal Terrace, Edinburgh, Feb. 16

*AMERICAN DEEP-SEA SOUNDINGS**

UNDER the title at foot a pamphlet of thirty-three pages, accompanied by a large chart, and illustrated by several diagrams and tables, has been issued. The school-ship *Mercury* is a vessel belonging to the commissioners having in charge the hospitals and prisons of New York city, and is employed for the purpose of training boys, committed by the magistrates for vagrancy and slight misdemeanours, to become thorough seamen. Instead of growing up to be a curse to the community, such boys are made into valuable men. The adventurous life has a special charm for them.

An essential feature of the discipline on this ship is to make long cruises, by which the boys are fitted quickly to enter into the service of the navy or mercantile marine. Of 258 boys carried out on this voyage, 100 were on the return of the ship, in the opinion of the captain, capable of discharging the duties of ordinary seamen.

The commissioners, in addition to the above object, desiring to advance the interests of science as far as lay in their power, instructed the captain, P. Giraud, to obtain a series of soundings on the line of or near the equator, from the coast of Africa to the mouth of the Amazon, to observe the set of the surface currents and the temperature of the water at various depths. He was also directed to bring home specimens of water and of the sea bottom.

The ship sailed on December 20, 1870, and arrived at Sierra Leone on February 14. On February 21 she left

* Cruise of the school-ship *Mercury* in the Tropical Atlantic, with a Report to the Commissioners of Public Charities and Correction of the City of New York on the chemical and physical facts collected from the deep-sea researches made during the voyage of the nautical school-ship *Mercury*, undertaken by their order in the Tropical Atlantic and Caribbean Sea, 1870–71. By Henry Draper, M.D., Professor of Analytical Chemistry and Physiology in the University of New York.

Sierra Leone, and the soundings and other observations were continued till she reached Havanah, April 13, 1871.

The papers, together with the various specimens, were placed in the hands of Professor Henry Draper, of the New York University, for examination. His report commences by stating "that much attention has recently been given to deep-sea researches in consequence of the investigations made by the United States government on its coast, and by Dr. Carpenter. Mr. Gwyn Jeffreys, and Prof. Wyville Thomson, in the North Atlantic and Mediterranean Sea. Not only have many of the facts so ascertained been corroborated by this voyage of the *Mercury*, but the commissioners, by authorising it, have added much that is new and interesting to our knowledge of the physical condition of the deep sea."

Then follows a discussion of the barometric variations, in which it is show that they were very small in crossing the ocean, the minimum being only $\frac{18}{100}$ below, and the maximum $\frac{8}{100}$ above the mean. In a general manner the pressure increased on nearing the American coast.

The currents varied from south near the African coast by south-west to west near the American coast, and their velocity was on an average above half a knot.

Some general remarks on the sounding apparatus (Brook's detaching apparatus) and water-collecting cylinder are next made, attention being more particularly directed to the incorrect conclusions that the latter is apt to lead to. "The constitution of the water as it exists at great depths is not correctly represented by the sample thus obtained. A considerable portion of the gases dissolved therein may escape under the relief of pressure as the cylinder is drawn to the surface, and hence examinations of such samples as regards their gaseous ingredients are liable to be deceptive. Even the saline ingredients will suffer disturbance when they are held in solution by gases that will thus escape; for instance, this is the case with carbonate of lime." Table iv. shows the specific gravities of the samples of sea water from the surface and at various depths to 420 fathoms; Table v., the air temperature between Sierra Leone and the Florida capes; Table vi., the temperature of the air, sea surface, and of the water at various depths. The thermometer was of Six's form, without index error when compared with a standard Kew instrument, but not protected on the Miller-Casella plan.

A diagram of the bed of the Atlantic Ocean at the twelfth parallel of latitude is introduced, based on fifteen soundings. It shows that "parting from the African coast the bed of the ocean sinks very rapidly. A couple of degrees west of the longitude of Cape Verde the soundings are 2,900 fathoms. From this point the mean depth across the ocean may be estimated at about 2,400 fathoms, but from this there are two striking departures—first a depression, the depth of which is 3,100 fathoms, and second, an elevation at which the soundings are only 1,900,—the general result of this being a wide and deep trough on the African side, and a narrower and shallower trough on the American. It may be that this peculiarity is a result of the river distribution on the two continents respectively, there being, with the exception of the Senegal and Gambia, no important streams on the African side, whilst on the American there are many, and among them pre-eminently the Orinoco and the Amazon, these vast rivers carrying their detritus far out to sea and helping to produce the configuration of the ocean bottom in question. However this may be, it is doubtless through these deep troughs that much of the cold water of the north polar current finds its way."

"In accordance with this we perceive, on examining the temperature of the water after the African verge of the greater or eastern sea trough is reached, that there is a difference in temperature between the surface and that at a depth of not more than 200 fathoms exceeding 25° in many cases. This decline of temperature increases as the depth increases, one observation giving an additional fall of 4° at an additional depth of 200 fathoms. It is not, however, intended to affirm that the mass of cold water is restricted to these deep troughs, since even in the West India seas at similar depths low temperatures are observed, and this though the heat of the surface water had become very much higher. In those seas while the surface temperature was 84° the thermometer at depths of 400 and 500 fathoms marked 48°; and these it must be remembered were the indications of an uncompensated instrument which was bearing a pressure of at least half a ton on each square inch of its surface, and hence registering degrees that were higher than the truth. This accords with the observation of Mr. Barrett that in the deepest parts of the sea near Jamaica there exists a temperature not far above that of the freezing point of fresh water." Accompanying these remarks is a diagram showing the curves representing the temperature of the air, surface of the water, and deep water during the voyage, and that is followed by a diagram of the specific gravity of surface and deep water.

"The general conclusion which may be drawn from these results as to temperature and specific gravities is that there exists all over the bottom of the tropical Atlantic and Caribbean Sea a stratum of cold water—cold since its temperature is below 50°. This is the conclusion to which Dr. Carpenter has come as respects the Atlantic in higher north latitudes; and in this important particular the cruise of the *Mercury* must be considered as offering confirmatory proof of the correctness of the deductions drawn from the cruises of the *Lightning* and *Porcupine*."

"There are reasons for supposing that, so far from this water being stagnant, its whole mass has a motion towards the Equator, whilst the surface waters in their turn have a general movement in the opposite direction."

An analysis of the gaseous ingredients was not attempted, because the specimens had been kept too long and for other reasons that are specified; but in relation to organic matter it is stated: "I made some examinations of the organic matter contained in these waters both by incinerating the solid residue and by the permanganate test. . . . . It needed no especial proof that organic matter was present in every one of these samples, for the clearest of them contained shreddy and flocculent material, some of them quantities of sea-weed in various stages of decomposition. With these vegetable substances were the remains of minute marine animals. As bearing on this subject I found on incinerating the solid residue of a sample of water taken from 200 fathoms, that the organic and volatile material was not less than 11 per cent. of the whole. Though the quantity of organic substance diminished as the structure under examination was deeper, there still remained a visible amount in the water of 400 or 500 fathoms. It is probable therefore that even at the bottom of the ocean such organic substance may exist, not only in solution affording nutriment to animals inhabiting those dark abysses as Prof. Wyville Thomson has suggested, but also in the solid state. Plants of course cannot grow there on account of the absence of light."

"In order to determine whether any hitherto unknown element existed in these waters, I subjected the solid residue to examination with the spectroscope, volatilising the substances by the aid of a voltaic current and induction coil. A careful examination did not reveal the presence of any spectral lines other than those belonging to the well-known elementary substances in sea-water."

"The specimens of the bottom, obtained by attaching to the sounding line quills or wooden tubes, I have transmitted to Dr. Carpenter, who has kindly consented to examine them. In a letter recently received he says, 'As far as I can see they consist of the ordinary Atlantic mud, chalk in process of formation, with the ordinary types of deep-sea foraminifera.'"