Class I. *Ignited Columns.*	Class II. *Partially-ignited Columns.*
a. The apparatus described by Prof. Barratt, *Phil. Mag.*, April, 1867.	*a.* Described in Nature, vol. v. p. 30.
b. Described in this paper, Fig. 2, *et seq.*[1]	*b.* Described in a former communication, December 7, 1876.
	c. Described in this paper, Fig. 4, *et seq.*

I. *a* consists of a glass tube with a tapering jet. A V-shaped cut made across the end of the jet renders it more sensitive. If such a jet be connected to a water-supply it will be found to be segmental. If it has the V-shaped groove this will be more marked. The primary expansion lies in the groove in most cases. The only use of the latter is to render the column more certainly segmental.

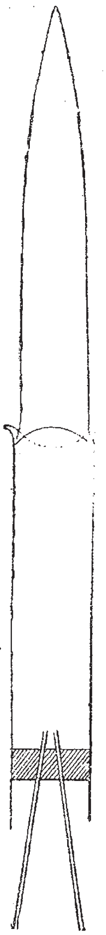

Fig. 5.

The column being segmental, consists (Experiment II., note) of two streams, one on each side the groove meeting at a very acute angle.

When there is no groove little irregularities in the orifice determine the segmentation of the column. The friction of the long, narrow jet and the ignition of the gas at the orifice retard the outflow, and to obtain a sufficient velocity the gas must issue under a considerable pressure[2] (one or two feet).

When excited it shortens and expands at *right angles to its primary expansion.*

I. *b* has been described (Fig. 2, *et seq.*). The jets meeting at a considerable angle, the column is flattened. It responds in the same manner as the preceding, but the primary expansion being very short, the responding expansion is usually the longer one.

II. *a* consists of a tapering jet placed a small distance below a piece of fine wire gauze. The gas is ignited above the gauze. It is very sensitive, but the intersection of the column by the gauze prevents the flame from taking any well-marked form when responding.

II. *b* is practically the same as the foregoing. The column being surrounded for a part of its length by the closed tube, remains unignited in this part.

The excited flame divides distinctly into two parts, which are in a plane at *right angles* to the primary expansion.

This division appears to arise from the tendency of the excited flame to form a flat expansion, and the edges being reflected from the inside of the tube, because the same jet when used without the tube and under a high pressure, does not divide, but produces a fan-shaped expansion.

II. *c* is shown in Fig. 4. The flame from B keeps the column beyond it heated to the ignition point. It is of interest as showing the use of the gauze in II. *a* and the tube in II. *c*, and further, that the value of the tube in the latter does not depend upon its resonance.

In Experiment IV. it is shown that a sensitive-flame, when emitting a note, sends out an expansion at right angles to the primary one, the same behaviour being observed when the flame is excited by an external sound. It therefore follows that if these actions are conversely related to each other, that a responding flame should emit a note. This will always be found to be the case; but the sound being usually very feeble, may escape observation unless some means be adopted to concentrate it (*vide* Experiment VII.).

The expansion occurs just above the intersection of the axes of the jets. Call these *a* and *b*. The two columns strive for a mastery of direction. *a* overcomes *b* and sends a tongue of flame through the primary expansion, but the partial stoppage of *b* causes an increase of pressure by which in turn it overcomes *a*, and sends a tongue of flame through the other side of the primary expansion, and so on. These movements succeeding each other with very great rapidity in a high note, and gas being highly elastic it is impossible to recognise them separately. Experiment XIII. shows how the impulses may be obtained so slowly as to be individually perceived.

When the gas pressure is so low that the column is quiescent, a sound is necessary to start the operation; and further the sound must so strike the component columns as to give one of them an advantage (*vide* Experiment VI.).

I have only referred to water columns as far as was necessary to illustrate the behaviour of gaseous ones. They should form a subject for separate consideration.

Summary.

1. A fluid column if sensitive to sound consists of two columns meeting at an angle (Experiment II. *note*).
2. The resultant of the two columns is an expansion (Experiments II. and III.).
3. A column so constituted will under favourable conditions emit a note (Experiment IV.).
4. If excited by an external sound, it takes the same form as when it spontaneously emits the sound (Experiment V.).
5. A column excited as in 3 and 4 sends out an expansion at an angle (usually a right angle) to the primary expansion.
6. The component column of a sensitive column must be at such unequal distances from the sounding body that they are not thrown into the same phase of vibration (Experiment VI. and *note*).
7. A gaseous column increases in sensitiveness with the pressure, *i.e.*, the velocity.
8. A gaseous column is lessened in velocity by ignition at its origin (Experiment VIII.). Hence—
9. A gaseous column when ignited is less sensitive than when unignited (Experiment IV.).

R. H. Ridout

[1] Lecomte has previously shown that the fish-tail burner is sensitive.

[2] By making a V-groove across the end of a partially-closed tube, this kind of jet becomes tolerably sensitive at a pressure of three inches

THE AURORA OBSERVATIONS OF THE AUSTRO-HUNGARIAN ARCTIC EXPEDITION, 1872-74, BY CARL WEYPRECHT

THE Austro-Hungarian Arctic Expedition of 1872–74 was in many respects an unfortunate one. Not only was the first winter occupied with an unintermitted struggle with the ice, which from hour to hour threatened to crush the ship, and rendered it imperative that everything should be in constant readiness for her sudden abandonment, but in the second year this had actually to take place, and, on account of their bulk, valuable records of scientific observation were unavoidably left behind, and among these was the carefully-kept journal of northern-light observations.

Under such discouraging conditions the mass of valuable observations which Lieut. Weyprecht has succeeded in collecting from the meteorological and magnetic journals and other sources, are interesting not only on account of their many positive contributions to our knowledge, but as an example of wonderful scientific industry and devotion.

Spite of the perpetual changes of the aurora, Weyprecht considers that its appearances may be classified under five distinct forms, viz., the *arch*, the *ribbon* or *streamer*, the *rays*, *crown*, and *haze* (*Bogen*, *Band*, *Fäden*, *Krone*, and *Dunst*). His description of these forms differs in several particulars from those common in lower latitudes, so that we may be excused for noticing them at some small length.

Arches (*Bögen*, *arcs*) are of regular form; the highest point closely coincides with the magnetic meridian and the ends cut the horizon at points equi-distant from it. They usually move either northward or southward, rising from the edge of a low dark segment near the horizon, or again vanishing into it. The rim of light which edges this dark segment is probably only a low and distant bow, or possibly the combined effect of all the remoter arches which are melted into each other by distance and perspective. This is the more likely since a bow is never observed to sink wholly below the horizon, but fades into this distant rim, and, conversely, from it, arches frequently arise and separate themselves as they get higher. Not unfrequently the arches sink back to the point from whence they arose; at other times they gradually fade away as they near the zenith, or after they have passed it. Very intense displays never take the form of regular arches.

While in low latitudes the arch is one of the most frequent of auroral forms, in the polar regions this post is occupied by the *ribbon* or *streamer* (*Band*), which resembles a torn and irregular arch, and may take any position or direction, one or both the ends being usually visible above the horizon. It takes the most varied and ever-changing forms, forcibly suggesting a pennon floating on the breeze, doubling and curling on itself in graceful and translucent folds, or again appearing as if torn into shreds blown by the wind. Weyprecht is inclined to believe that the wind actually has some influence on the northern lights, and notes that, after severe and widely-extended storms, the streamers are especially ragged and broken. While in the arch the light intensity changes but slowly, and simultaneously over the whole bow, the reverse is the rule with streamers, in which it varies irregularly, lightening in one place and fading in another. The rapidity of these changes is very varied. Sometimes a band will drift slowly across the northern or southern sky, without change of form or colour, for a long time together, and then suddenly flame up with rapid movement across the zenith to form a crown, to renew its play, or to vanish on the other side. Frequently pieces break off and form new bands, which spread over the whole heavens, and then again fade down to a single band of a new form, or perhaps carry on their game until the dawn drives them from the sky. In most cases the light of the streamers has a peculiar motion, resembling waves which roll continuously from one end of the band to the other. These waves are more intense and move more rapidly in proportion to the activity of the bands themselves. The streamers vary in their appearance, sometimes seeming to consist of a uniform light-material like most of the arches, at others of closely-packed perpendicular rays, with the intervals filled with the same light-material. Between these two extremes are all intermediate gradations. When the rays are visible each brightens as the wave passes over it, but does not change its position except by a slight lengthening, which gives the hopping or dancing motion which, no doubt, is the origin of the term "merry dancers." When, on the other hand, the streamers consist of simple "light-material," the waves cause a brightening and slight undulatory motion of the edge.

Admirable illustrations of these streamers, as they are occasionally seen in lower latitudes, may be found in Prof. Piazzi Smyth's Edinburgh astronomical observations, under the name of "multiple arcs," but they are already approximating to regular arches, from which they probably differ only in distance and altitude. This work also contains most valuable plates and observations of the auroral spectrum, as compared with that of twilight and the zodiacal light. The *threads* (*Fäden*, *rayons*) are fine rays of light directed from the magnetic zenith to the horizon, but not quite reaching either. They occur sometimes singly or in bundles, sometimes pretty uniformly distributed, and are very variable in length. Their breadth rarely exceeds one minute of arc, and they are separated from each other by dark spaces. Their motion is peculiar, and seldom rapid. They lengthen and shorten upwards or downwards, giving the impression that already existing threads are lighted up or fade. They also move slowly from west to east or east to west, and not unfrequently it seems rather that the light is transferred gradually from one thread to another than that the threads themselves actually move.

The threads are evidently in intimate connection with the streamers. Often they stretch from near the magnetic zenith like a fan or a veil of gold or silver threads, of which the streamer forms the broad lower border; singularly, however, they rarely actually reach it, but seem to fade away near its edge, only to reappear with greater brightness in the streamer itself. This phenomenon is seen in the most beautiful way where two bands appear at once, one over the other, and each with its proper fringe of threads, like a silvery veil, falling in the most graceful folds. It is, however, only occasionally that threads and streamer occur in combination, and in the feebler displays it is more usual to see fans of threads, or streamers alone than both at once.

The *crown*, as is well known, is the perspective effect produced round the magnetic zenith, towards which the auroral beams, following the lines of magnetic force, seem to converge. The intensity of the appearance is very variable, and at times becomes such that thousands of short broad flashes dart at once from or towards the centre, while the whole firmament is covered with widespread rays, which lengthen and shorten with a flickering motion. Broad bright flames leap about the centre as if driven by a fiery whirlwind, and all the heavens seem in flames. In general the more brilliant the appearance, the shorter is its duration, and though it sometimes happens that masses of light move for hours about the centre, yet in such cases the brilliancy and the motion are alike feeble.

As a rule a crown is formed whenever an aurora of pronounced form passes the magnetic zenith, *i.e.*, when the beams of which it is composed are parallel with the observer's line of sight. Faint auroræ, however, especially arches with slow motion and no rays, may pass the zenith without forming a crown, and, on the other hand, a feeble crown sometimes becomes visible without the passage of any noticeable band or arch. When, as sometimes happens, the streamer is formed of uniform "light-material" without distinct rays, rays are also absent from the crown, which consists merely of lambent flames flickering round the centre, and resembling those of alcohol burning on a flat surface.

The *haze* (*Dunst*), as its name implies, resembles a faint mist, from which, by moonlight, it is scarcely distinguishable, as its light is never intense.

With regard to *colour*, Weyprecht observed that in bands the red always formed the lower and green the upper part, the middle being whitish. The haze was frequently reddish, but dull greenish seems to have been the prevailing colour, which is compared to that of the electric spark. Most unfortunately the expedition was unprovided with any spectroscope suitable for such observations, so that on this most important point we have no information to record.

The intensity of the light was such that the smallest type was frequently legible, and larger could be read easily. Weyprecht proposes to measure the intensity of the aurora by observation of the legibility of print of different sizes.

With regard to the height of the northern lights above the earth's surface, Weyprecht is strongly of the opinion that they are much lower in the arctic regions than in lower latitudes, but was not able to make any direct measurements. Their brilliancy and distinctness, and, above all, their rapid movements, give the impression of nearness; and the observations of Parry, Farquharson, and others, lead to the same conclusion. On one or two occasions the aurora appeared to be below the light cirrus clouds, which do not attain a maximum height of more than 8,000 metres; but the observation was by no means certain.

Auroræ were also repeatedly visible when the sun was so little below the horizon that the height of the direct sun-rays in the zenith was not more than from six to twelve miles. If, as has been suspected, the auroral light depends on some form of mist for its basis, this would have been rendered visible had the height been such as to bring it into the sunlight; but if, as is generally supposed, it depends on the electrification of rare and transparent gases, this would not be the case; so that it seems difficult to draw any conclusion from these facts. Admitting, however, the conclusion, which is in itself probable enough, that in high latitudes the appearances are lower than with us, it will go far to explain many of the differences which may be noted between Weyprecht's description and what we are accustomed to see. Streamers such as he describes would, if far enough off, and owing their altitude to great elevation, appear like arches, as the lower edge is at an almost uniform height, the windings would disappear with distance, and we should have the appearance of a pretty regular arch of irregular brightness and with beams shooting from it towards the zenith, while the individual threads would be, as is indeed the case, rarely or never visible.

Weyprecht repeatedly observed clouds and mist which took the same forms as aurora, and strongly resembled it; but he does not think a case is made out for any real connection between the two phenomena. The stars, however, are decidedly obscured by an intense aurora, and many observations seem to point to some such connection. Several very interesting ones are quoted by the present writer in the article "Aurora" in the last edition of the *Encyc. Brit.* Weyprecht frequently uses the phrase "light-material" in speaking of the aurora, and it is evident that there must be some material basis to the phenomenon. This, he suggests, may be the minute ice crystals, which are the cause of mock suns and moons, appearances of daily occurrence in the polar regions. It seems certainly possible that these may be projected far above the earth, or even above the atmosphere by electrical repulsion, and may serve as carriers of electrical discharges, which would at once illuminate the particles and arrange them in the lines of magnetic force. If the aurora is really, as is commonly supposed, an electric discharge in a rarefied gas, it must admit of a very considerable range of density, since it is certain that even in the same aurora, different portions are at very different elevations. In the crown for instance, the beams are almost perpendicular, and must be often of very great length.

The aurora has frequently been supposed to be a sign of coming wind and stormy weather, but careful comparison of the meteorological records failed to establish any such connection. No sound could be attributed to the northern lights.

Weyprecht's observations confirmed the fact that there is a zone of maximum frequency and intensity of auroræ some distance south of the pole, and led further to the conclusion that the zone moves northward towards the winter solstice, and southward again towards the equinoxes. It is of course impossible to observe its course during the summer.

Observations of the daily period gave a maximum at 10 P.M., and a minimum at 11 A.M., which closely coincides with the results of other observers.

No very clear conclusion could be drawn as to a yearly period, since the length of the nights, the cloudiness of the sky, and above all, the before-mentioned shifting of the zone of maximum frequency so complicated the problem.

Want of space unfortunately forbids us to enter into any detailed discussion of Weyprecht's extensive magnetic observations. Many magnetic disturbances were unaccompanied by aurora, and on the other hand, some aurora produced little or no magnetic variation. Those appearances which have an indistinct outline and diffused light, and especially which have no rays and and no noticeable motion, scarcely affect the needle; while, on the contrary, those which appear to be low and near, which have distinct contour and rapid motion, and above all sharply defined rays, affect the needle vigorously. Broad darting lightning-like rays, with brilliant colours, red and green, cause the most violent disturbances.

HENRY R. PROCTER

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

WE are pleased to find that local schools of science are increasing their facilities for teaching practical chemistry to their students. During the summer the committee of the Birkbeck Institution (the first London Mechanics' Institute) has built a new chemical laboratory, to replace the somewhat inconvenient one which has done service for fifty years. The space available was very limited, but has been made the most of, and nineteen benches have been fitted up in a space of 36 feet by 10½ feet, besides the necessary accommodation for stores, &c. This effort to meet the requirements of students is all the more commendable, on account of the probability of the Institution remaining but a few years longer in its present home. Its success is so great that a new and larger building is absolutely necessary, and the building fund being raised amounts already to nearly a thousand pounds.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 16.—M. Fizeau in the chair.—The following papers were read:—On the cause of the periodic movements of flowers and leaves, and on heliotropism, by M. P. Bret.—On a new telephonic transmitter, by M. P. Dupont.—Remarks on a new proposal made with regard to the analysis of milk, by M. E. Marchand.—Description of a new apparatus for the transfer of gases from one vessel to another, by M. A. Blanc. The appatatus is constructed with the special view of avoiding any loss of gas on its being transferred over mercury.—Various communications regarding phylloxera, by MM. E. Fortier and Capbladoux.—On the intra-Mercurial planet seen in the United States during the solar eclipse of July 29 last, by Mr. Swift.—On the observations made of the transit of Mercury on May 6, 1878, at the Imperial Observatory of Rio de Janeiro, after the new method, by M. Emm. Liais.—On the form of the integrals of differential equations of the second degree in the neighbourhood of certain critical points.—On the compressibility of gases at high pressures, by M. E. H. Amagat.—New researches on the physiology of the vesicular epithelium, by MM. P. Cazenove and Ch. Lyon.—Note on the interior temperature of the globe, by Mr. W. Morris.—Note relating to an apparatus named galioscope, by M. A. Boillot. This apparatus is constructed to demonstrate the invariability of the direction of the plane of oscillation of a pendulum.—Note relating to a new thermohydrometer, by Mr. H. Douglas.

September 23.—M. Fizeau in the chair.—The following among other papers were read:—Dissociation of oxides of the family of platina, by MM. Saint Claire Deville and Debray. Osmium and ruthenium combine directly with oxygen, and the product of oxidation is volatile and forms at the highest temperatures. In this they are distinct from the other platinic metals, and come near arsenic and antimony, with which they might be placed among the metalloids. From experiments with oxide of iridium the authors show that, at a temperature below 1003·3°, it is decomposed in free air, and consequently that, at this temperature or any other higher, iridium is absolutely inoxidable in the air.—Memoir on a universal law relative to the dilatation of bodies, by M. Levy. This is designed to prove that the pressure which any body supports can only be a linear function of its temperature, so long as this body does not change its state; in other words, and under a physical form, if any body be heated with constant volume, the pressure which it exerts on the immovable walls of the inclosure containing it, can only increase, rigorously, in proportion to its temperature. This, he thinks, an absolutely rigorous corollary from the two fundamental propositions of the mechanical theory of heat, and of the hypothesis that the mutual actions of the atoms of bodies are directed in lines which join their points of application, and only depend on the distances of these points apart.—Nocturnal variations of the temperature at different altitudes recorded at the observatory of Puy-de-Dôme, by M. Alluard. He has traced, for each month since January, the curves of minimum, maximum, and mean temperatures of the two stations, and it appears that the two curves of minimum temperature often cut each other, both in summer and in winter, so that, often, at night, it is less cold at the top of the Puy-de-Dôme than at Clermont, the difference sometimes reaching five degrees. The curves of maximum temperature do not intersect; they are in general nearly parallel. The temperature at night, then, varies with the height, quite otherwise than during the day. A new meteorological station has been formed about midway between Clermont and the summit of Puy-de-Dôme, the three heights being thus—400 m., 1,000 m., and 1,470 m. It is purposed, too, to take observations on some of the numerous extinct volcanoes (in form of truncated cones) about the Puy-de-Dôme, the object being to study the atmosphere, layer by layer.—Discovery of a small planet at the observatory of Hamilton College, Clinton, by Mr. Peters.—On a new species of curves and of anallagmatic surfaces, by M. Picquet.—On the development of chilostoman bryozoa, by M. Barrois. This he finds *mesoblastic*, the exoderm gives rise to all the organs and plays the part of a veritable blastoderm.—M. Lancy presented a work by M. Ennes, surgeon in the Portuguese army, on "Men and Books of Military Medicine."

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