

sanitary literature of the day, you will see that it is chiefly devoted to the discussion of this special subject.

Sewer-gas is the modern Frankenstein monster, which has been created and turned loose upon the world by sanitary experts, who are now vainly struggling to control and repair its ravages.

And I would ask, Whether it is not our solemn duty to ourselves, to our children, and to the rising generation, steadfastly to resist the introduction into our midst of this most insidious evil; and to stamp out, as we would the plague, any system which is likely to conduce to the spreading of infectious disease, and the consequent lowering of the physical standard of the future population of New Zealand.

In conclusion, I would submit for your consideration three propositions, which embrace the practical deductions to be drawn from my previous remarks:—

1st. That under a proper system of surface, subsoil, and storm-water drainage, it will be found advantageous to discharge the house-drains into the storm-water channels through the street gutters.

2nd. That of the systems of closet at present in general use, that with moveable pans is the one best adapted for colonial towns, on the grounds of safety to public health, simplicity, and efficiency, and economy in cost both of construction and maintenance.

3rd. That it is desirable to prohibit, by legislation, the storage of excreta in sunk cesspools, and the placing of night-soil in any drain, public or private, in any township in New Zealand.

ART. V.—*On periodic vertical Oscillations in the Sun's Atmosphere, and their Connection with the Appearance and Disappearance of the Solar Spots.*

By H. SKEY.

[Read before the Otago Institute, 24th August, 1880.]

IN a former paper* I endeavoured to show a tendency to periodicity in the vertical oscillations of the earth's atmosphere, and to connect the pressure of the barometer and the state of the weather therewith. And, in opposition to the generally received opinion, the downward oscillation of the barometer was shown to correspond to the greatest elevation or crest of the atmosphere, while the upward and greatest reading of the barometer would correspond to the lowest elevation or trough of an aerial wave; the vibration

* See "Trans. N.Z. Inst.," Vol. III., p. 306,

from maximum to minimum taking about three and a half days. The lapse of a certain time always occurring between the time of the lowest reading of the barometer and the actual occasion of rain may be thus accounted for. The desirability was also suggested of a simultaneous set of barometric observations being made at the same place, but at different altitudes, in order to determine the action of these vertical oscillations by direct experiment.

It is gratifying to learn that Professor Loomis has lately made valuable experiments in this direction. He states, "that from observations on Mount Washington, Pike's Peak, etc., both the maxima and minima of atmospheric pressure generally occur later on as we rise above the surface, the retardation amounting to one hour for an elevation of from 900 feet to 1,300 feet." Now, assuming that the retardation is uniform, then an oscillation of three and a half days would correspond to an altitude of about seventeen miles, and the great bulk of the earth's atmosphere is proved to be below seventeen miles.

Similar oscillations can be clearly traced on the diagrams of the Sydney meteorological observations.

Doubtless the original impulses, or first swings, were through the agency of heat which caused the first uplifting of a portion of the atmosphere far above the mean line of elevation. When the descending oscillation occurs it will not stop at a point corresponding to mean height and pressure, but will by its momentum descend considerably below it, so that a barometer at the earth's surface will stand at a pressure far above the mean. The lower portions of the atmosphere are therefore compressed, and must necessarily by their increased elasticity have stored up a force sufficient to cause another ascending oscillation, which will again influence the barometer and the weather. Generally after a few such oscillations they become lost or masked by others.

Their range is about one-thirtieth of the whole pressure of the terrestrial atmosphere in medium latitudes, and they must I think, to a considerable extent, lead to the formation of clouds in the upward oscillation, and to the solution and disappearance of clouds in the downward one. These vertical oscillations are, however, only local as far as our terrestrial atmosphere is concerned; at least it is not proved that general ones, embracing the whole atmosphere, have been yet observed, though doubtless such have occurred in earlier times.

We will now consider if similar movements, not only local but general, cannot be traced in the sun's atmosphere and surroundings.

Modern observations tend more and more to extend the height of the solar atmosphere and surroundings; some astronomers even approaching

the conclusion that there is no upper limit; still it may be inferred that the great bulk of the sun's atmosphere is below a certain fixed limit. Now if a range of temperature of say 100° Fah., can account for the movements which at times take place in the earth's atmosphere, how much more readily must it be acknowledged that the commotions which have occurred on the solar globe in the remote past would be fully competent to produce an oscillatory motion in the sun's atmosphere.

But it may be asked what proof have we of these hypothetical oscillations, for we cannot take a barometer to the solar orb? It is not, however, improbable that the sun-spots may prove to be a solar barometer, so nicely adjusted, that we may, though at a distance of more than ninety-two millions of miles, study the meteorology of the sun. And it is to be hoped that this subject will not be thought uninteresting, when we consider that our own terrestrial meteorology is not only connected therewith, but absolutely dependent thereon. Many solar discoveries have been made during the last few years, but they appear to shroud the sun and its surroundings in still more numerous mysteries; no wonder, therefore, that various theories have been developed to attempt their explanation.

Amongst these mysteries may be mentioned:

1. The periodicity of the solar spots.
2. Their first appearance in each cycle along two belts more than 20° distant from the equator, and their gradual appearance nearer to the equatorial regions as the epoch of minimum is approached.
3. The acceleration of their rotation in proportion to their vicinity to the sun's equator.
4. Their greater prevalence north of the sun's equator.

Such are some of the greatest difficulties which beset every theory relating to the solar spots. As present theories do not I think explain these, I have ventured upon another, which, be it ever so plausible, will still require to be submitted to all possible tests, and if found untenable must be dismissed from our minds without further ceremony.

In attempting to explain such solar phenomena, we must bear in mind that a rhythmic motion characterizes not only the ponderous planets, but also the most attenuated comets. These bodies are so amenable to the laws of gravity, that their periods from aphelia to perihelia are calculable with wonderful exactness.

Now the law of gravitation comes into operation, not only when a comet is attracted by a sun into a very elongated orbit—having its perihelion passage very close to the sun, and its aphelion immensely distant—but it must also act on any other gaseous, or vapourous mass in his neighbourhood, which can be attracted sufficiently near a direct line to the

sun, so that it can act, by pressure, on the immediate atmosphere of the sun; and, after compression, it can then, by its increased elasticity, be rebounded off again.

It is important to distinguish between those parts of the sun's surroundings which are influenced and carried round by his rotation on his axis, and those other portions above the reach of his diurnal motion.

If the sun can draw a comet from the confines of the solar system, can he not also drag after him a large mass of atmosphere, even though it be at too great a distance to partake of his rotation? We know that comets have passed at times very near to the sun; and what is the difference between the regular return of such a comet—moving in a narrow ellipse, and, therefore, approximating to a line perpendicular to the solar surface—and a mass of matter, in gaseous and other states, moving to and fro, but exactly perpendicular to the surface?

Micrometrical measurements fail to detect any appreciable polar compression in the sun's disc; it is, therefore, probable that the photosphere, or luminous part of the sun, is nearly uniform in thickness or depth. Both the umbra and penumbra of the solar spots are now acknowledged to be below the surface of this photosphere. Now it can scarcely be admitted that solar storms are sufficient alone to account for the periodic formation of spots. Their general figure is more consonant with the idea that their production is assisted by the comparatively thin photosphere being squeezed yet thinner, and pushed away in certain places.

It appears also to be an established fact that when the spot frequency has passed rapidly or slowly from a minimum to the next maximum, it descends with a corresponding (relative) rapidity or slowness to the next minimum. This I think a certain characteristic of oscillations.

What, however, is the shape of the elastic medium hereby supposed to be in a state of oscillation? Even if the true atmosphere, or that portion of the sun's surroundings which actually revolves with the sun, is spherical, we can scarcely suppose the other portion to partake of that figure.

Circumstances appear strongly in favour of the idea of a flattened nebulous mass extending from the sun to the distant planets; for the planets moving for ages in one direction must flatten and draw out the more distant portions of the sun's atmosphere, and also those portions which we have good reasons for assuming are ejected in solar eruptions with such a velocity as to carry them too far from the sun to enable them to rotate diurnally around him.

We know how a light body like a comet is perturbed even by a satellite, and we know that the attenuated matter of a comet can generally hold together by gravity; it is therefore not unreasonable to assume that this

lenticular-shaped nebulous mass would in its central portions (or that which is in the same plane as the sun's motion) be dense compared with its other portions, not only from the pull which the planets generally exert, but also from its own gravity. Such central portions have a tendency to disturb the more equatorial regions of the sun's photosphere, especially if a downward oscillation of the lenticular mass is ever exerted.

That this lenticular mass is not however equidistant all round the sun, but exhibits an elongation in certain directions, has already been attempted to be shown.*

The barometric pressure of the earth's atmosphere is greatest in latitudes 20° to 35° both sides of its equator, and certainly the greater prevalence of sun-spots about the limiting parallels of 35° on both sides of the sun's equator is a curious coincidence. Moreover, storms or hurricanes do not occur often at the earth's equator, but 10° or 20° distant therefrom; this may possibly arise from the fact that no great difference of speed of the atmosphere in miles per hour can occur from the earth's rotation until we reach 10° or 20° of latitude; the earth's rotation appears to be an important element in their formation. In the earth's case, however, its equatorial parts receive an excess of heat, and from an *external* source, while in the case of the sun we do not know that a diversity of temperature exists in its different zones.

We can scarcely suppose, therefore, that heat or any other of the forces of nature could be exerted periodically so as to effect the thinning of the photosphere, except that of gravity exerted on an elastic medium.

We have thus dealt with the first of the theoretical difficulties of the solar spots, namely their periodicity; in the second difficulty, or their first appearing in each cycle along two belts more than 20° distant from his equator, we must take into consideration that a gradually increasing pressure, arising from a downward oscillation of a lenticular mass of matter near the plane of the sun's equator would not first affect those parts of the sun quite on the equator (although the greatest pressure might be there) but those parts a few degrees distant therefrom where the photospheric stratum could be pushed away as well as squeezed.

The first breaks in the continuity of the photosphere from solar storms would therefore show themselves in north and south latitudes, but later in the cycle the more equatorial parts of the photosphere would get pushed away towards both sides until it became in its turn more compressed and pushed away; spots would therefore gradually be formed nearer and nearer to the equator until those parts in the higher latitudes where they first appeared would be gaining in their thickness of photospheric matter, not

* "Trans. N.Z. Inst.," Vol. VII., Art. 15.

only from the equatorial side, but also from the polar sides, by the gradual back rush of photosphere. This would prevent the formation of spots in those parts.

Moreover, as the equatorial parts of the photosphere become gradually forced into a latitude having a slower motion of rotation, a certain gyratory commotion must ensue tending to break its continuity. These breaks would also, from this reason, be more likely to occur at the beginning of the cycle in the higher latitudes, where there would be greater difference in the comparative speed of the parallels.

The third difficulty, namely, the acceleration of their rotation in proportion to their vicinity to the equator, may be explained under the assumption of the flattened nebulous mass before alluded to, when we consider that all the parts of the sun's atmosphere, which rotate with him, must tend to travel at greater velocities the higher they are above the sun's surface. When, therefore, the higher parts, directly over the sun's equator, are caused to descend to the sun's surface, by either a general or local oscillation, they must travel faster than the sun's equator, and act like a constant wind blowing in the direction of the sun's motion. The same result will happen, though in a gradually reduced degree, as we depart from the equator; the solar spots will therefore travel at greater speed the nearer they are to the equatorial regions. After the downward oscillation is terminated, the upward one commences; but by this time the solar spots have mostly disappeared for the photosphere resumes its ordinary thickness.

This variation in the speed of different parallels of the photosphere, arising from the downward oscillation, must, I think, produce those agitations in the photosphere so apparent just before the appearance of spots, and most likely conspires to their formation. The general drift of the spots in lines of parallel, together with the common arrangement of a number of spots in lines parallel to the equator, appear hereby explained.

The very fact of the solar spots being proved, by observation, to travel faster in the equatorial parts, appears to prove the existence of a lenticular-shaped mass surrounding the sun; for a merely spherical atmosphere could not, by its downward oscillation, effect a change in their rotation.

Regarding the fourth difficulty, of the greater prevalence and size of sun-spots in northern latitudes, it is pretty certain that, owing to the intense heat of the sun's mass, a certain amount of adjustment must be already attained in its photosphere. If then gravity, at the sun's surface, is balanced by the expansive force of heat, any slight alteration in the pressure of his atmosphere must modify the equilibrium of all other forces there exerted. Can it be that the sun's own proper motion in space, in impinging on the interstellar medium, gives an additional pressure upon the sun's

photosphere? If so, the northern parts of the sun would be more affected than the southern, for his proper motion has been concluded by various methods to be in north polar declination.

Should the existence of periodic vertical oscillations in the atmospheres of the earth and sun be demonstrated, then we may be enabled to account for the spots which occur on the planet Jupiter, and the periodicity lately attributed to them; also, the periodic variability of many of the stars, and even of certain nebulae, H. II 278, and H. I-h 882, for instance, together with the curious alternation of visibility of a star and a connected nebula, as for example 80 "*Messier's Catalogue of Nebulae.*" There have also been cases in which nebulae have only lately made their appearance, and instances of previously well-known nebulae having entirely disappeared, the physical processes of which may be explained by vertical oscillations in elastic masses, which appear to be as universal in elastic media as gravity itself.

ART. VI.—*On the Permanency of Solar and Stellar Heat.*

By MARTIN CHAPMAN.

[*Read before the Wellington Philosophical Society, 10th October, 1880.*]

A FAVOURITE subject of speculation with physicists is the question of the manner in which the heat of the sun and other heavenly bodies of high temperature is maintained.

Various hypotheses are from time to time put forward, supported by speculations of more or less probability.

Some of these—as, for instance, the ingenious speculations of Mathew Williams ("*Fuel of the Sun*")—do not appeal to any processes of nature which we can see going on or put to any kind of test.

Professor Croll assumes the existence of dark, cold masses, whose velocity in space is vastly greater than that of any lucid orb. The collision of these generates heat by the conversion of molar motion. It is to be remarked of this hypothesis that the assumed velocities are such as we can never see on any lucid body; but Mr. Croll points out that this is only to be expected, as it is only by the destruction of this motion that the bodies can become visible. Such a source of heat would result in this:—that the heat generated would be gradually dissipated, so that the body would gradually cool down and become invisible.

Most of the received hypotheses assume molar collision of some kind, whether of large bodies or of meteoric rain on large bodies, the motion of translation being converted into heat.