LETTERS TO THE EDITOR.

Magnetic Storms and their Astronomical Effects.

THE earth is sometimes spoken of as a great magnet. Its magnetic condition, however, is not constant, but varies within rather wide limits. Some of the changes are periodic, while others are spasmodic and irregular. The sunspot period appears to be in some way related to the changes in the earth's magnetic condition; for, at the time when the spots are at their maximum in number, the so-called magnetic storms are most frequent and violent. There is a general agreement among meteorologists that the magnetic changes observed upon the earth are in some obscure manner due to the influence of the sun.

In meteorology, as elsewhere, when other explanations are unavailable, resource is found in electricity, especially so if electrical phenomena can be in some manner discovered to be involved; and this happens to be the case in a very great number of phenomena, not as causes, but as effects. Not infrequently it happens that some of the best-known laws of electricity are ignored, or are confounded with other laws of other forms of energy. This seems to be precisely the case in this phenomenon.

In his article upon meteorology, in the last edition of the "Encyclopædia Britannica," Balfour Stewart says, "We are thus driven to look to the upper regions of the earth's atmosphere as the most probable seat of the solar influence in producing diurnal magnetic changes; and it need hardly be said that the only conceivable cause capable of operating in such regions must be an electric current. Now, we know from our study of the aurora that there are currents in such regions, continuous near the pole, and occasional in lower latitudes." And yet a little further on he argues very properly that more knowledge seems to be needed before we can assert that there are currents of electricity in regions where conduction is impossible.

Now, a current of electricity always implies conduction, and conduction implies molecular contact. We are abundantly able to prove this: for with such vacua as can readily be produced, say, the millionth of an atmosphere, not only will electricity not traverse it, but even Crookes's phenomena cease. At the height of a hundred miles, the average free path of the molecules is measured by feet; and this renders it as certain as any thing we know in physics, that electrical currents are impossible there, and hence, whatever may be the explanation of the magnetic changes in the earth, they are not due to currents of electricity in those high regions.

Still the earth is a magnet. It has its poles, though these change their position. The bulk of the earth with which we are acquainted is made up of non-magnetic matter, having varying degrees of conductivity; the rocky part being very poor, while the oceans and moist soils are conductors to such a degree as to permit commercial use for telegraphic and other purposes, thus saving the cost of a return conductor. The larger part of the surface of the earth is, then, an electrical conductor. Whenever a conductor of electricity is rotated in a magnetic field, an electrical current is the result; and such current is maintained so long as the rotation is continued, the strength of the current depending upon several variables, the strength of the magnetic field, the degree of conductivity, and the rate of rotation.

That electrical currents are continually traversing the crust of the earth, has been established, since the telephone has provided us with an instrument delicate enough for observation, and employed by so many all over the earth.

To be sure, it was known before that earth-currents were sometimes present, for upon occasions they were so strong as to interfere with or stop telegraphic communication. Such interruptions were generally coincident with auroral displays, but sometimes occurred in the day-time, when auroral effects could not be seen if they chanced to be present. As these earth-currents have been found to be coincident with both magnetic disturbances and with spasmodic solar action, — for several observers have noted solar eruptions at times when the magnetometers gave evidence of magnetic changes in the field, and in one or two cases even determining that the rate of transmission of the sun's action was the same as that of light, — it follows that the earth acts as if it were rotating in the magnetic field of the sun.

If the sun be considered as a magnet, then its field extends to an indefinite distance in space, and the earth must be rotating in it; and, so far as the earth is a conductor, there should be currents in it: in fact, just what we discover. So far, the electricity is an effect, and not a cause, magnetism being the preceding physical state.

A conductor moving in a magnetic field in such a manner as to have electrical currents generated in it always suffers retardation of its motion, as is illustrated by letting a coin fall between the poles of a strong magnet, — a property utilized in modern galvanometers to bring the needle quickly to rest. Such currents are technically known as "Foucault's currents," and the energy they represent is at once transformed into heat in the conductor. The electricity is but the transient state intermediate between the retarded motion and the rise in temperature. This series of physical relations — viz., the rotation of a conductor in a magnetic field, the retardation of the motion, the electrical current, and the final transformation into heat of original energy of the mechanical motion — is a well-ascertained series of effects, which is universal; and thus it follows, that, so far as the earth has currents of electricity set up in it by the sun's action, so far its rotary motion is retarded, and also its temperature is increased, both effects not hitherto recognized so far as I know. Of course, the retardation of motion is very small indeed, but it must be taking place, and in time will bring the earth to a standstill. What the amount may be, there appears to be no way of determining, because there is no way of ascertaining the strength of the earth's currents, nor the earth's resistance, nor the strength of the magnetic field of the sun.

Furthermore, the retardation of other bodies in the solar system may be traced to the same physical conditions instead of frictional resistance of the ether, which has sometimes been hypothecated.

Lastly, if the magnetic condition of the earth varies, it follows that the magnetic field of the earth varies, and all bodies in that field are re-acted upon by it. The gases of the atmosphere at high altitudes have free paths comparable with those in Crookes's tubes, and might fairly be expected to exhibit similar phenomena if electrified and in a changing magnetic field. Their electrification need not be much of an assumption, when one considers what happens in a thunder-shower. Rotating molecules, if conductors of electricity, ought to have Foucault's currents in them when in a magnetic field, and they should therefore be heated. As there is no chance for conduction of the heat, the rate of vibration increases till incandescence is reached. The only way in which the molecule can unload its extra energy is by radiation.

The motions seen in auroras may thus be due to the changes in the magnetic field of the earth instead of to electrical currents circulating in the high air.

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College Hill, Mass., April 23.

Chrome Yellow considered as a Poison.

THE object of this note is to spread wide the facts that chrome yellow is a poison, and that its use in food-stuffs is by no means rare.

The cases reported up to this time, in which toxic action is assigned to lead chromate and to chrome yellow, — bodies which apparently all writers consider as identical, — are many more than a hundred. Seemingly the first report is to be found in the *Medical Times and Gazette* of Dec. 24, 1859, in which are set forth the cases of six school-lads who were seriously poisoned by eating Bath buns. These latter were shown to contain each "seven grains of chromate of lead," which had been used as coloring-matter in lieu of eggs. All of the six lads are stated to have recovered.

In 1874, Von Linstow was next to assign toxic action to these bodies. He attributed to them the deaths of two children, within his own practice, who had eaten possibly seven artificial bees which had served to ornament a cake. Each of these bees had been colored by about four milligrams of "neutral lead chromate." The cause of death was destruction of the coats of the œsophagus and stomach, with puncturing of the intestines. The cases are reported in Eulenberg's *Vierteljahrsschrift f. ger. Med.*, N.F. XX., and