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(i) that the quantities which define it are propagated through the æther with a single constant velocity, and (ii) that translatory uniform convection as a whole through the æther produces no modification in the field, then it is necessarily restricted to the special type of the electrodynamic field as formulated by Maxwell.

(2) A field of gravitation is included as the limiting form of such a type when the velocity of propagation becomes very great. As like source is now to attract like, the energy of the field must be kinetic and not elastic. The question of interaction between a field of gravitation and electric fields or rays of light is, of course, a separate and fundamental one, independent of theories of relativity, and is now being put to refined test by astronomical observation.

(3) If time were linked with space after the manner of a fourth dimension, relativity in electrodynamic fields would be secured as above, but the sources of the field could not be permanent particles or electrons. If physical science is to evolve on the basis of relations of permanent matter and its motions, time must be maintained distinct from space, and the effect of convection must continue to be thrown on to the material observing system in the form of slight modification of its structure.

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6. *How could a Rotating Body such as the Sun become a Magnet?*

By Sir Joseph Larmor.

The obvious solution by convection of an electric charge, or of electric polarisation is excluded; because electric fields in and near the body would be involved, which would be too enormous. Direct magnetisation is also ruled out by the high temperature, notwithstanding the high density. But several feasible possibilities seem to be open.

(1) In the case of the sun, surface phenomena point to the existence of a residual internal circulation mainly in meridian planes. Such internal motion induces an electric field acting on the moving matter: and if any conducting path around the solar axis happens to be open, an electric current will flow round it, which may in turn increase the inducing magnetic field. In this way it is possible for the internal cyclic motion to act after the manner of the cycle of a self-exciting dynamo, and maintain a permanent magnetic field from insignificant beginnings, at the expense of some of the energy of the internal circulation. Again, if a sunspot is regarded as a superficial source or sink of radial flow of strongly ionised material, with the familiar vortical features, its strong magnetic field would, on these lines, be a natural accompaniment: and if it were an inflow at one level compensated by outflow at another level, the flatness and vertical restriction of its magnetic field would be intelligible.

(2) Theories have been advanced which depend on a hypothesis that the force of gravitation or centrifugal force can excite electric polarisation, which, by its rotation, produces a magnetic field. But, in order to obtain sensible magnetic effect, there would be a very intense internal electric field such as no kind of matter could sustain. That, however, is actually got rid of by a masking distribution of electric charge, which would accumulate on the surface, and in part in the interior where the polarisation is not uniform. The circumstance that the two compensating fields are each enormous is not an objection; for it is recognised, and is illustrated by radioactive phenomena, that molecular electric fields are, in fact, enormous. But though the electric masking would be complete, the two distributions would not compensate each other as regards the magnetic effects of rotational convection: and there would be an outstanding magnetic field comparable with that of either distribution taken separately. Only rotation would count in this way; as the effect of the actual translation, along with the solar system, is masked by relativity.

(3) A crystal possesses permanent intrinsic electric polarisation, because its polar molecules are orientated: and if this natural orientation is pronounced, the polarisation must be nearly complete, so that if the crystal were of the size of the earth it would produce an enormous electric field. But, great or small, this field will become annulled by masking electric charge as above. The explanation of pyro-electric phenomena by Lord Kelvin was that change of temperature alters the polarisation, while the masking charge has not had

opportunity to adapt itself: and piezo-electric phenomena might have been anticipated on the same lines. Thus, as there is not complete compensation magnetically, an electrically neutralised crystalline body moving with high speed of rotation through the æther would be expected to produce a magnetic field: and a planet whose materials have crystallised out in some rough relation to the direction of gravity, or of its rotation, would possess a magnetic field. But relativity forbids that a crystalline body translated without rotation at astronomical speeds should exhibit any magnetic field relative to the moving system.

The very extraordinary feature of the earth's magnetic field is its great and rapid changes, comparable with its whole amount. Yet the almost absolute fixity of length of the astronomical day shows extreme stability of the earth as regards its material structure. This consideration would seem to exclude entirely theories of terrestrial magnetism of the type of (2) and (3). But the type (1), which appears to be reasonable for the case of the sun, would account for magnetic change, sudden or gradual, on the earth merely by change of internal conducting channels: though, on the other hand, it would require fluidity and residual circulation in deepseated regions. In any case, in a celestial body residual circulation would be extremely permanent, as the large size would make effects of ordinary viscosity nearly negligible.

During the meeting, Models of Crystals, devised by Miss Nina Hosali, *were shown, as to which the following statement was issued:—*

The object of these models is

(1) To illustrate the forms possible to crystals;

(2) To show as clearly as possible the different kinds of symmetry possessed by these forms; and

(3) To show how the forms are referred to crystallographic axes.

Each model illustrates one of the thirty-two classes of symmetry, and represents several crystal forms correctly orientated with regard to the crystallographic axes, the latter being shown by black threads. A model consists in the first place of a glass envelope whose shape is that of some simple crystal form, and within this envelope two or three other forms are represented by means of coloured silk threads stretched over frameworks of thin copper wire. By this means it is easy to make the forms intersect if necessary, and they are readily distinguished from one another by the use of differently coloured threads.

The symmetry elements of the class represented by any model are shown as follows:

(*a*) The traces of the *Planes of Symmetry* on the glass envelope are shown by *steel wires.*

(*b*) *Axes of Symmetry* are shown by *white threads.* (If an axis of symmetry and a crystallographic axis are coincident, the white and black threads representing them are twisted together.) The degree of symmetry possessed by an axis is indicated by small numbers attached to the thread near its ends.

(*c*) When simultaneous rotation about an axis and reflection across a perpendicular plane occur to produce *Alternating Symmetry*, the traces of the plane on the glass envelope are shown by *red and white twisted threads*, and the axis is shown by a *white thread*, its degree of symmetry being indicated by small numbers fixed to it and printed in red.

(*d*) When the symmetry elements are such that the forms are *Centro-Symmetrical* (i.e. when the faces occur in parallel pairs), a couple of *white beads* are placed at the centre of the model.

The set of twenty-four models here exhibited represents twenty-one out of the thirty-two classes and over seventy different forms. In many cases different varieties of the forms may be produced by rotating or inverting the models, or by reflecting them in a mirror, and, when these modificatious are taken account of, the number of forms shown is brought up to about 140.

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