are lying lengthwise of the dam, presumably intentionally placed in that position by the builders, but who can tell? The discarded food branches and other sticks drift and lodge against the upper side of the dam, and if that is raised such material would be incorporated in the dam and would lie lengthwise, just as it had lodged. I have sometimes wondered if the settling of a dam might not at times cause enough movement to twist the sticks from their original up-and-down stream positions to others at varying angles.

In one case where high water broke a dam the beavers closed the gap with sticks placed across it without any system whatever. They seemed to have just brought the material and dropped it, leaving it to adjust itself; but the opening was effectually closed and the dam as good as ever.

The strength of beaver dams is remarkable. I have seen several instances where high water has broken a dam, forced a section of it downstream and turned it to one side, leaving it still attached to the dam at one end.

Since 1913 I have kept up fairly continuous observations on the work of beaver on streams not far from my home, as well as observing the work of the animals wherever I have had an opportunity, and am continually coming upon some new thing, often something which makes one wonder why it was done. There is still plenty to be learned about beavers, or any other wild animal, for that matter.

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SPECIAL CORRESPONDENCE

A NEW CONNECTION BETWEEN MAGNETISM AND ELECTRICITY

UNDER the highly technical name of "Quantised Singularities in the Electromagnetic Field" there has just appeared a paper in the current issue of the *Proceedings* of the Royal Society of London (September, 1931), that promises to be of great importance. Dr. P. A. M. Dirac, its author, is one of the most brilliant of contemporary physicists. He is a fellow of Trinity College, Cambridge, and is at present a guest of Princeton University.

According to classical theory, magnetism is a property of certain bodies—how they behave. The molecules of a substance are regarded as elementary magnets because of the existence of a system of electric currents within each molecule. This is ascribed by modern physics as due to the orbital revolutions of the electrons inside the molecules. Under ordinary conditions there is a haphazard arrangement of these molecules or elementary magnets, and consequently no resultant magnetic effect is manifested. In order that the magnetic effect of each molecule be additive, the molecules as magnets must be orientated in the same direction. If all the molecules are orientated in the same direction the substance is said to be saturated with magnetism. Thus the magnetic character of a body is said to be due to its polarization, that is, to the regular arrangement of its molecules. This view permits one to correlate magnetism with the electric current instead of regarding it as a new phenomenon. One of the most forceful arguments for not regarding magnetism as the manifestation of a separate entity instead of a property, is that no one has ever succeeded in imposing upon a body a charge of either positive or negative magnetism only, although it is a familiar fact that one can charge any body either electro-positively or electro-negatively.

In trying to discover the reason for the existence of the electron, the smallest electric charge, Dirac found that his calculations led instead to a relation between the smallest electric charge and the smallest magnetic pole. This type of connection between electricity and magnetism has never been suspected and is quite foreign to the current idea of magnetism, which was sketched very briefly in the preceding paragraph. It means that modern quantum theory allows the existence of isolated magnetic poles, the strength of which must be quantised. Just as the charge of any particle must be an integral multiple of e, the smallest electric charge, so the strength of any isolated magnetic pole must be an integral multiple of the smallest magnetic pole. The elementary quantum pole u_0 is connected with the elementary electric charge e by the relation $\frac{hc}{eu_0}=2$ or $u_0=\frac{hc}{2e}$ (where c is the velocity of light and h is Planck's constant divided by 2π). This, of course, is not a perfectly symmetrical relation between electricity and magnetism. To be perfect it would have to be $u_0=e$. It would be unusual if nature did not take advantage of the possibility of discrete magnetic poles, the existence of which is consistent with the quantum theory. Why, then, have such objects never been observed? There is a relation in physics which gives the experimental value of the smallest charge of electricity, independent of any theories, as $\frac{hc}{e^2}=137$. When this is combined with the relation

given above we get $u_0 = \frac{137}{2} \times e$. That, is the attractive force between two one-quantum poles of opposite sign is $\left(\frac{137}{2}\right)^2$, or almost 5,000 times as great as between an electron and a proton!

If isolated magnetic poles were common, the universe would be quite different from what it is. Although electrons and protons which go to make up matter are very much more abundant than these magnetic poles, still there is a possibility that somewhere in the universe there may exist a new kind of substance, made up of these magnetic atoms, and containing much more energy than the matter we are familiar with. Professor O. W. Richardson discusses this possibility in *Nature* of October 3, and is of the opinion that although it would be rather difficult to create objects with the intrinsic energy of these magnetic poles, still there may be enough of them to account for such ultra-penetrating radiations that can not be explained in any other way. At any rate, cosmology will have to consider in the future the possibility of existence of these isolated magnetic poles. To the electron, proton, and photon which go to make up the universe, another entity, the magnetic pole, may have to be added. First electricity, and then light, and now magnetism have proved to be discontinuous!

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE APPARATUS FOR MERCURY DISTILLATION

FOR laboratories in which a considerable amount of pure mercury is used, for example, for the purpose of gas analysis, it is advantageous to have the equipment for redistillation. At the Animal Husbandry Division of the University of California in Davis we are using an inexpensive apparatus for mercury distillation which works very satisfactorily.

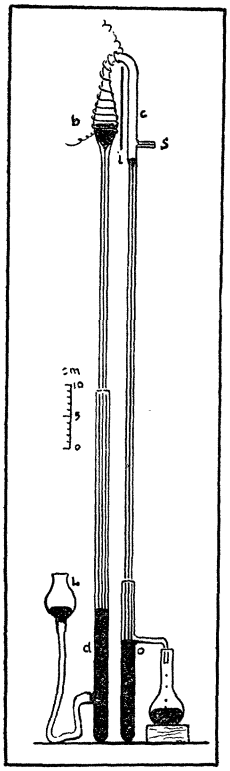

FIG. 1.

The distillation bulb of Pyrex glass b (see Fig. 1), which is 4 cm wide and 9 cm long, is connected at the top to a U tube 1.5 cm wide, which has a capillary side outlet S. The lower end of the U tube and that of the distillation bulb are each connected to a barometer tube of approximately three millimeters bore. Each of the two barometer tubes is put in a slightly wider glass tube, as shown in the sketch. The tube d on the left side contains impure mercury (which, however, is to be free of volatile contaminations) and is provided with a side outlet connected by a rubber hose to a leveling bulb L, which enables one to adjust the mercury level in the distillation bulb. The tube o on the right side contains clean mercury and has also a side outlet through which the distilled mercury overflows into a flask.

For the first start of the apparatus the outlet S is connected to a suction pump (we used an ordinary filter pump) so that the mercury rises in both barometer tubes, the impure mercury up into the bulb as shown in figure. The bulb is then heated electrically by a simple coil of resistance wire (we apply 320 watts). The wiring should begin at the height of the mercury level in the bulb. In this case the evaporation takes place only at the free surface of the mercury and there is no bumping and splashing. The wiring should be continued up to the top of the U tube, as otherwise a running back of the condensate occurs which decreases the efficiency of the apparatus. A piece of asbestos paper i protects the condenser tube from the heat of the electric coil. The cooling of the condenser by air alone has proved to be sufficient. After the mercury has evaporated for several minutes during suction the air in the apparatus is practically displaced by mercury vapor, then the outlet S is sealed. The apparatus is now ready for use *ad libitum* as it maintains its own vacuum. All one has to do is to add contaminated mercury to the leveling bulb L, to empty the clean mercury from the collecting bottle and to open the electric current in order to stop, or to close it in order to start the distillation. The apparatus does not need any further attention. It is vapor proof insofar as no hot mercury comes in contact with air. The contaminated mercury in L and d which by variations in pressure at the beginning of the distillation may get warm may be covered with water for safety. The apparatus as described distils 25 cc of mercury per hour.

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