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MATTER AS A MODE OF MOTION.

In his address as President of the British Science Association, in 1871, Sir William Thomson threw out two original suggestions, which prettily illustrate the different ways in which new ideas are popularly received. One of the suggestions was of no value whatever, yet it was immediately caught up and talked about the world over: we allude to the hypothesis that the earth might be indebted to a germ-bearing fragment of some exploded planet for its first beginnings of life. It was a brilliant fancy, and caught the popular eye at once; but being only a fancy, it vanished as suddenly as it flashed into light.

The other suggestion awakened no apparent response; it may be that it conveyed no meaning whatever to more than a dozen persons, in whose minds it germinated for years before it bore any fruit fit for transmission to the general public. Sir William had been discussing the question: "What is the inner mechanism of the atom?"—a question which must furnish the explanation not only of atomic elasticity but of chemical affinity and the difference of quality of the different chemical elements, at present mere mysteries in science—when he remarked that a fingerpost pointing the way to a full understanding of the properties of matter might be found in Helmholtz's exquisite theory of vortex motion.

This most pregnant suggestion fell, as we have said, without meaning on the ears of the multitude, and found no place in the popular discussion of the address which followed. At most—save among a few of the more advanced physicists and mathematicians—it may have given rise to the queries, what is vortex motion? and what is Helmholtz's theory? for which encyclopedias and textbooks furnished no answer. Even the latest and most scholarly of English encyclopedias makes no mention of vortex motion in its article on atomic theories. Thanks, however, to the speculations of the authors of "The Unseen Universe," a wider interest in Sir William's suggestion was aroused. Since then Professor Clifford has endeavored to remove the new theory from the narrow world of pure mathematics and make it intelligible to people of ordinary culture; and still later, Professor Tait, in his lectures on recent advances in physical science, has done still more to bring the subject within the range of popular science, so that most reading men have by this time at least heard of vortex motion, though they may but vaguely apprehend its nature or its bearing on the drift of scientific speculation.

Fairly good illustrations of vortex motion (under friction) may be seen in the cloud rings produced by the spontaneous explosion of bubbles of phosphoretted hydrogen escaping from water into air. Occasionally puffs of steam from the funnel of a locomotive will show vortex rings; and the same motion is also shown by the revolving ring of tobacco smoke sometimes ejected by clever smokers. By means of a simple apparatus made of a cigar box, with a round hole in one end and the other end closed with a tightly drawn cloth, Professor Tait produces vortex rings of great perfection and persistence. In the box, fumes of sal ammoniac are generated; and by striking smartly the cloth-covered end of the box, very beautiful and durable cloud rings are driven out of the circular opening at the other end. A more tangible illustration of vortex motion may be seen in a soft rubber ring made to revolve on a stick without advancing. In this case the friction of the stick as it is drawn through the ring causes the inner portion of the ring to move in the same direction; as the ring, as a whole, is kept from moving forward, the motion of the inner surface forward is counteracted by a motion of the outer surface backward, the two resulting in a revolution of the ring upon itself without any change in its form or in its position in space. In the case of the smoker's cloud ring, the friction of the lips holds back the outer portion as it makes its exit, while by the breath the inner portion is driven forward, and thus a vortex motion is created, which lasts until the cloud ring is dissipated or its motion is stopped by the friction of the air.

It seems a long way from a puff of tobacco smoke to a theory of the innermost constitution of matter; but the scientific imagination often finds the simplest things the most suggestive, and sometimes reason can follow its most ambitious flights with a perfect bridge of mathematical demonstration. It has not yet been able to do so in this case it must be admitted; nevertheless, the conditions seem very favorable for ultimate success.

While studying the equations of motion in an incompressible frictionless fluid, some fifteen or sixteen years ago, Helmholtz demonstrated among other things that in such a fluid a vortex motion would be indestructible. The case is purely hypothetical; we know of no such fluid, and if it existed vortex motion could not be originated in it, since friction is essential to its production. But it is perfectly legitimate in mathematics to assume any imaginable conditions and then investigate their properties and results; and having supposed a vortex motion to exist in a perfect fluid, it is demonstrable that it would continue for ever, preserving its peculiar individuality to all eternity.

Even in air and water, vortex rings behave curiously like atoms; they preserve their individuality to the end; they cannot be made to destroy each other, nor can they be divided. Though nothing more than a rotating cloud of smoke, the sharpest knife cannot sever a vortex ring; it simply wriggles around the knife and keeps its course unharmed. In a perfect fluid, vortex filaments might be of any shape or degree of complexity, yet that shape would persist for ever unalterable.

Facts like these suggested to Sir William Thomson the idea that maybe the ultimate atoms of matter are simply vortex rings or filaments in a frictionless fluid filling all space. The mathematical verification of this hypothesis involves enormous difficulties—with present means, insurmountable difficulties; but Sir William has pursued it far enough to show that it explains a great many of the physical properties of matter.

From this view the assumed solidity of the ultimate atoms of matter gives place to extreme fluidity, the vortex atom being persistent and indivisible, not by reason of its hardness or solidity, but because its motion is indivisible. The origin of such motion remains of course unexplained, and, like the origin of life or force, unexplainable.

Taken in connection with Lesage's theory of gravitation the vortex theory offers many advantages over every other theory of the nature of matter; and as Professor Tait has remarked, with a little further development it may be said to have passed its first trial, and, being admitted as a possibility, may be left to time and the mathematicians to settle whether it will really account for everything experimentally found.

Having arrived at the conception that what we call matter may be only more or less varied phases of vortex motion in a universal frictionless fluid, which fluid possesses in itself none of the attributes of matter, Professor Clifford goes further, and holds it to be a necessary supposition that even where there are no material molecules the universal fluid is full of vortex motion, the inter-material spaces differing from matter simply in having their vortices smaller and more closely packed. In this way the difference between matter and ether is reduced to a mere difference in the size and arrangement of their component vortex rings.

SPECIAL MACHINE WORK VERSUS MANIPULATIVE SKILL.

The mechanical manipulation practised in this country is distinguishable from that practised in Europe in that handwork is mostly displaced by machine work; and this is in every way desirable, because the labor of the mechanic is lightened, and he becomes less and less an exerter of brute force. Furthermore, our producing capacity is greatly increased, while the cost of production is proportionately diminished. That these are desirable elements, even in the face of the fact that their existence is operating to some extent to destroy the quality of our workmen, is undeniable; but that these elements exist, it would be folly to deny. The very object of special tools is, in nearly all cases, to take the place of the most skillful workmen; and the skill required to operate a special machine is as a rule insignificant compared with that necessary to perform its duties by handwork. "What matter," it may be asked, "when the necessity for skillful handwork no longer exists?" No matter, providing that such be the case; but unfortunately it is not, because special machine work, no matter how well performed, can never equal the most skillful handwork. It can produce a quantity of good work at infinitely cheaper cost, and thereby almost exclude the finest of work from the market; and this is what, in many cases, it does. This is, no doubt, all things considered, a gain; but the detriment to manipulative hand skill remains. This condition of things, however, has its limits; and these will be found in the nature of the work. For example, a number of pieces of small work, such as watches, sewing machines, etc., may be made by special machinery of as good quality as an equal number of such articles could, in the ordinary course of things, be made by hand. A single watch or sewing machine may, however, be made by hand with a perfection that special machine work cannot approach. But when we come to treat of work of a larger size, such as the manufacture of a lathe or a locomotive, the term special machine work assumes an entirely new aspect. For instance, an axle lathe may be called a special tool, because in it nothing but axles are turned. The skill of the operator in this case requires to be just as great, since his operations are not performed by the machine, and there exists the same field for his manipulative skill. Upon all but small work, in fact, the special tools and appliances consist mainly of arrangements designed to assist in the chucking and holding of the work, and in machines intended for certain kinds of work respectively, such as planing, boring, turning, and slotting. These operations are performed with the same cutting tools as of yore. The reason of this is that the milling cutters, emery wheels, etc., which will answer well upon small work, cannot be relied upon for large, as they will not cut true, and any attempts hitherto made to adapt them to such work has resulted in inferior productions. Again, on small work three or four operations can be performed by one special machine without its being unhandy; but on larger work, the attempt to construct a machine for performing several operations produces unwieldiness, unhandiness, and usually failure.

Another element of consideration is that, while it is very easy to cast or forge small work uniform in size and shape (and it does not matter if an occasional piece is lost from a defect in its casting or forging), a defect or variation is much more liable to appear in a large casting; and as the loss would be a serious matter, it may, by a slight and often inconsiderable variation, be made to serve. We have also to remember that the greater part of the fitting of work depends for its truth upon the file, for machine tools do not as a rule cut the work sufficiently true. In lathe work, special tools are confined to appliances, chucks, standard reamers, gauges, etc.; and in work of a medium size, the use of these aids tends to make the operator more expert, and a more skillful workman. It is indeed to be remembered that in small and moderate sized lathe work, the duty performed by