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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 gestions 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 germbearing fragment of some exploded planet for its first beas suddenly as it flashed into light.

The other suggestion awakened no apparent response; it origin of life or force, unexplainable. 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 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 SPECIAL MACHINE WORK VERSUS MANIPULATIVE SKILL. 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 That these are desirable elements, even in the face of the to bring the subject within the range of popular science, so fact that their existence is operating to some extent to devortex motion, though they may but vaguely apprehend its these elements exist, it would be folly to deny. The very nature or its bearing on the drift of scientific speculation.

Fairly good illustrations of vortex motion (under friction) from water into air. Occasionally puffs of steam from the ." What matter," it may be asked, "when the necessity for funnel of a locomotive will show vortex rings; and the same skillful handwork no longer exists?" No matter, providing motion is also shown by the revolving ring of tobacco smoke that such be the case; but unfortunately it is not, because sometimes ejected by elever smokers. By means of a simple special machine work, no matter how well performed, can apparatus made of a cigar box, with a round hole in one end never equal the most skillful handwork. It can produce a fessor Tait produces vortex rings of great perfection and per- by almost exclude the finest of work from the market; and sistence. In the box, fumes of sal ammoniac are generated; this is what, in many cases, it does. This is, no doubt, all and by striking smartly the cloth-covered end of the box, things considered, a gain; but the detriment to manipulative very beautiful and durable cloud rings are driven out of the hand skill remains. This condition of things, however, has to revolve on a stick without advancing. In this case the watches, sewing machines, etc., may be made by special mafriction of the stick as it is drawn through the ring causes chinery of as good quality as an equal number of such artithe inner portion of the ring to move in the same direction; cles could, in the ordinary course of things, be made by as the ring, as a whole, is kept from moving forward, the hand. A single watch or sewing machine may, however, be motion of the inner surface forward is counteracted by a made by hand with a perfection that special machine work motion of the outer surface backward, the two resulting in cannot approach. But when we come to treat of work of a a revolution of the ring upon itself without any change in larger size, such as the manufacture of a lathe or a locomoits form or in its position in space. In the case of the smoker's 'tive, the term special machine work assumes an entirely new cloud ring, the friction of the lips holds back the outer por- aspect. For instance, an axle lathe may be called a special tion as it makes its exit, while by the breath the inner portion tool, because in it nothing but axles are turned. The skill is driven forward, and thus a vortex motion is created, which of the operator in this case requires to be just as great, since lasts until the cloud ring is dissipated or its motion is stopped his operations are not performed by the machine, and there by the friction of the air.

theory of the innermost constitution of matter; but the scien- mainly of arrangements designed to assist in the chucking tric imagination often finds the simplest things the most sug- and holding of the work, and in machines intended for cergestive, and sometimes reason can follow its most ambitious tain kinds of work respectively, such as planing, boring, flights with a perfect bridge of mathematical demonstration. turning, and slotting. These operations are performed with at has not yet been able to do so in this case it must be ad- the same cutting tools as of yore. The reason of this is that mitted; nevertheless, the conditions seem very favorable for the milling cutters, emery wheels, etc., which will answer ultimate success.

While studying the equations of motion in an incompressible frictionless fluid, some fifteen or sixteen years ago, adapt them to such work has resulted in inferior productions. Helmholtz demonstrated among other things that in such a Again, on small work three or four operations can be perfluid a vortex motion would be indestructible. The case is formed by one special machine without its being unhandy; purely hypothetical; we know of no such fluid, and if it ex- but on larger work, the attempt to construct a machine for isted vortex motion could not be originated in it, since fric-performing several operations produces unwieldiness, untion is essential to its production. But it is perfectly legiti- handiness, and usually failure. mate in mathematics to assume any imaginable conditions its peculiar individuality to all eternity.

Facts like these suggested to Sir William Thomson the small and moderate sized lathe work, the duty performed by

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 in volves enormous difficulties-with present means, insurwhich new ideas are popularly received. One of the sug- mountable 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 ginnings of life. It was a brilliant fancy, and caught the being persistent and indivisible, not by reason of its hardness popular eye at once; but being only a fancy, it vanished or solidity, but because its motion is indivisible. The origin of such motion remains of course unexplained, and, like the

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 vertex motion in way to a full understanding of the properties of matter 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.

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 most reading men have by this time at least heard of stroy the quality of our workmen, is undeniable; but that object of special tools is, in nearly all cases, to take the place of the most skillful workmen; and the skill required to opemay be seen in the cloud rings produced by the spontaneous rate a special machine is as a rule insignificant compared explosion of bubbles of phosphoretted hydrogen escaping with that necessary to perform its duties by handwork. and the other end closed with a tightly drawn cloth, Pro- quantity of good work at infinitely cheaper cost, and therecircular opening at the other end. A more tangible illustra- its limits; and these will be found in the nature of the work. tion of vortex motion may be seen in a soft rubber ring made. For example, a number of pieces of small work, such as exists the same field for his manipulative skill. Upon all but It seems a rong way from a puff of tobacco smoke to a small work, in fact, the special tools and appliances consist well upon small work, cannot be relied upon for large, as they will not cut true, and any attempts hitherto made to

Another element of consideration is that, while it is very and then investigate their properties and results; and having easy to cast or forge small work uniform in size and shape supposed a vortex motion to exist in a perfect fluid, it (and it does not matter if an occasional piece is lost from a is demonstrable that it would continue for ever, preserving | defect in its casting or forging), a defect or variation is much more liable to appear m a large casting; and as the loss Even in air and water, vortex rings behave curiously like would be a serious matter, it may, by a slight and often inatoms; they preserve their individuality to the end; they can-considerable variation, be made to serve. We have also to not be made to destroy each other, nor can they be divided. remember that the greater part of the fitting of work de-Though nothing more than a rotating cloud of smoke, the pends for its truth upon the file, for machine tools do not as sharpest knife cannot sever a vortex ring; it simply wriggles a rule cut the work sufficiently true. In lathe work, special around the knife and keeps its course unharmed. In a per- tools are confined to appliances, chucks, standard reamers, fect fluid, vortex filaments might be of any shape or degree gauges, etc.; and in work of a medium size, the use of these of complexity, yet that shape would persist for ever unalter- aids tends to make the operator more expert, and a more skillful workman. It is indeed to be remembered that in