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Telegraphic Address: PHUSIS, WESTRAND, LONDON.

The Fate of the Energy of the Universe: a Tangled Skein.

THE two outstanding conceptions of the nineteenth century were undoubtedly the principle of the conservation of energy, and the closely allied and supplementary principle of the dissipation of energy. Energy was conserved amid all its protean changes, but at each change its availability was lessened. On these two foundations rests the whole structure of thermodynamics. Neither of these conceptions stands exactly where it did, though a good deal of strong evidence will be required to shake the former. In a remarkable paper, read before the Cambridge Philosophical Society only a few months before his death, Prof. Liveing, at the age of ninety-five, threw out a challenge to the latter. Looking back over an active career covering in point of time almost the whole of what we now call science, the veteran felt that the dissipation of energy was not the whole truth. This universe could not be destined to subside into a tideless sea of unavailable energy, moved by no currents, stirred by no ripple, changeless and unchangeable. Somewhere, by some unknown process, the degraded energy must be undergoing a process of renewal and reintegration, to play its part once more in the physical world.

It is interesting to find from the report of a recent address given to the Radio Society by its distinguished president, Sir Oliver Lodge, that similar conclusions have been reached by still another scientific worker of long and ripe experience. In view of his more than youthful energy and freshness of outlook, it would be absurd to call Sir Oliver a veteran, but it cannot be denied that he has had a longer experience of scientific thought than most. His suggestions are always worthy of consideration, and, moreover, are always made in such concrete and positive form as to leave no doubt as to what they are.

Of the earlier parts of Sir Oliver's address it is not necessary to give any account. Towards the end of his discourse, however, after reviewing the principal facts of atomic structure, of photo-electricity, of thermionics, and of radio-telegraphy, he leaves the beaten track of accepted theory and experiment and launches forth on new and dangerous seas of thought. For Sir Oliver Lodge is not content with expressing a belief in the reintegration of energy; he also has a definite theory, or at least the beginnings of a theory, as to how this reintegration is accomplished.

Sir Oliver is at the present time the doughtiest of the champions of the ether, as against the mathematicians of the relativistic school, who, if they do not actually deny its existence, have at least no use for such a medium; and it may be that in times to come this

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insistence that a basis for the universe must be sought in a physical medium rather than in a set of equations will be regarded as not the least of his contributions to physics. To him the electron and the proton are local modifications of this all-embracing fluid; knots, or, perhaps, bubbles in the ether, a conception already made familiar by Sir Joseph Larmor. Thus matter, which is built up of protons and electrons, is just a manifestation of local peculiarities in the ether. The protons and electrons attract each other. "A little friction will disturb and separate them," Sir Oliver reminds us, "but they will get together again as soon as they can. Whenever they approach each other, they radiate. The more violent the clash, the more vigorous the radiation. Do they ever actually inextricably clash, and annihilate each other? It is not known that they ever do; there seems to be something which keeps them apart. Things on earth seem too staid and quiet to allow of an actual destructive clash, or anything like mutual extermination. But the operation is conceivable, and as we now know that some of the stars have a temperature to be reckoned in millions of degrees, strange and violent things may be going on there."

"We can," continues Sir Oliver, "at least contemplate the process and ask what would happen if they did; the answer is clear enough. The two opposite charges would vanish in a puff of radiation; all that would persist of them would be their energy; there is no destroying that. The energy would no longer be localised in specks of matter, it would now wholly and obviously belong to the ether." Sir Oliver thus accepts the transformation of matter into radiant energy, which has been postulated by Jeans and others to account for the intense radiation from the stars; and further suggests that the energy for this colossal output of radiation is supplied by the liberation of the potential energy stored up in the knots or strains in the ether which constitute electrical charges. "Dr. Jeans tells us that the sun loses 4,000,000 tons of matter every second. That is the rate at which it is radiating ether waves—converting matter into ether energy and radiating it away." It may be that Sir Oliver's theory from one point of view adds nothing to Einstein's postulate of the equivalence of matter and energy. It does, however, provide a conceivable picture of the method of transformation, and to the physicist who thinks in pictures rather than in formulæ, this is no small boon.

The crux of the address, however, lies in the succeeding paragraph. "What I want to ask is," says Sir Oliver. "is there any reciprocity about this process? Matter can turn into radiation. Can radiation turn into matter? I surmise that it can, but not under ordinary conditions. I guess that the waste radiation careering through space from all the innumerable suns and through innumerable millenniums must have some result. I imagine them to be generating matter in the far depths of space; which matter can then by gravitation fall together and reproduce or keep in maintenance the whole material cosmos. I see no ultimate dissipation of energy in the universe. I see energy passing from matter to ether and back again."

These singular speculations, which we have recorded so far as possible in the author's own words, open up interesting vistas. If, as Sir Oliver suggests, these knots possess the property of re-forming themselves when untied, they are indeed ethereal strains wafting to this tangled skein of which we form a part, the promise of an immortality not only in the future but also in the past. But, as Sir Oliver himself reminds us, speculation is comparatively useless unless it can be tested, and we are sure that he would not have published this unless he had glimpsed some way in which it might be put to the test of experiment. An address to a popular audience did not, perhaps, afford a suitable occasion for the fuller exposition of these matters, which we hope he will shortly give us. In the meantime we may be grateful to Sir Oliver Lodge for his challenge to lift our eyes to the wider horizons. It is good to be reminded, in this age of scientific progress, how little we really know.

Population and Evolution.

Malthus and his Work. By Dr. James Bonar. Second edition. Pp. viii+438. (London: G. Allen and Unwin, Ltd., 1924.) 12*s.* 6*d.* net.

"IN October 1838, that is, fifteen months after I had begun my systematic enquiry, I happened to read for amusement Malthus on Population, and being well prepared to appreciate the struggle for existence which everywhere goes on from long continued observation of the habits of animals and plants, it at once struck me that under these circumstances favourable variations would tend to be preserved, and unfavourable ones to be destroyed."

In these words, Darwin in the well-known autobiographical sketch acknowledged his debt to Malthus. It is also well known that Wallace made a similar acknowledgment. In a letter to Prof. Newton he referred to the matter as follows:

"The most interesting coincidence in the matter, I think, is, that I, as well as Darwin, was led to the theory itself through Malthus—in my case it was his elaborate account of the action of 'preventive checks' in keeping down the population of savage races to a tolerably fixed but scanty number. This had strongly impressed me, and it suddenly flashed upon me that all animals are necessarily thus kept down—'the struggle for existence'—while variations, of which I

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