

LETTERS TO THE EDITORS

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The Problem of the Autonomy of Life

PROF. F. G. DONNAN'S review in NATURE of April 11 of my book "Science versus Materialism" embodies a few statements about order, organization and energy which ought not to pass without a challenge. He speaks, for example, of "the potency for producing order residing in the disequilibrium between the 'hot' radiation of the sun's photosphere and the relatively cool surface of this planet". Can a scientific man really believe that the difference in temperature between two surfaces (for this is all this statement amounts to) has a potency for producing order? The remark reads like a parody of present-day fashionable philosophies. Again, Prof. Donnan speaks of the "sun's enormous store of 'organized' energy", and one is bound to ask what his criterion of organization is, and for what reason he considers the energy in the sun to be more organized than energy elsewhere? Later he speaks of "this disequilibrium (and consequent potency for producing order)". This remark is made with special reference to "the part played by the electro-magnetic field and electro-magnetic radiation". So Prof. Donnan really does seem to believe that disequilibrium can by itself produce order, and that electro-magnetic phenomena have special virtues and accomplishments, such as powers of organization and orderliness.

The truth is, of course, that mere difference in temperature, mere radiation, mere disequilibrium, mere electro-magnetic fields, may be described as the cause of changes. Such changes may be ordered if there is something to guide the particles taking part in the change, but they will not be ordered if there is nothing to provide guidance, selection, control, discrimination. When we observe order or organization we have, therefore, to seek for two combined causes: the first is the source of energy, which is usually easy to find, the second is the source of the discrimination. This presents a formidable problem in science. It does so, for example, when we seek to understand the structure of living substance. It is poor science to evade this problem as Prof. Donnan wishes to do.

The *reductio ad absurdum* of Prof. Donnan's view of the potency of temperature differences and radiation would be the assertion that a number of nuts and bolts, connecting rods, piston rings, and other machine parts, would, by nothing more than sufficiently violent kicking, become a complete motor-car, and that this would not happen by chance once in a way, but as often as similar living forms are to be found.

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In his extremely interesting review in NATURE of April 11 of "Science versus Materialism" by Prof. Kapp, Prof. F. G. Donnan seems to be playing into the hands of the metaphysicians when he describes radiant energy as a "non-material entity". From his opening paragraph, Prof. Donnan would appear to

accept as a definition of 'materialist' one who regards all phenomena, whether pertaining to living or non-living things, as solely explainable in terms of "the existing concepts and laws of physics and chemistry". Certainly his rebuke of Prof. Kapp for suggesting that a non-material something else supports the assumption of a "doubly determined" pattern of life, is consistent with such a definition.

The only logical conclusion to be drawn from the findings of modern physicists is, in my opinion, that electro-magnetic radiations are, *au fond*, just as material as atoms. Physicists used to define matter as "that which affects the senses"; light, for them, was an "imponderable". But a light-wave acts on sense-organs as truly as a sound-wave or a kick on the shin. Either an electro-magnetic wave-train is of a material nature with properties investigable only by physico-chemical means, or it is not. If, as Prof. Donnan seems to imply, light radiation is 'non-material', what concept are we to form of it? There is only one antonym to the word 'material' that does not involve tautology, and that is 'spiritual', and to state that an entity is not of a material nature is to state that it is of a spiritual nature.

May I mention some findings of recent physicists that appear to me to militate against excluding radiations from the sphere of materiality?

(1) The fundamentals of matter (protons and electrons) behave, according to circumstances, as waves or particles; but the fundamentals of radiations (photons) likewise have both particulate and undulatory characteristics.

(2) Energy is transferable from atoms to radiations and from radiations to atoms.

(3) Mass and radiation are mutually convertible; thus, the total mass of the separate components of an atomic nucleus is not equal to the mass of the nucleus, but to that mass *plus* the 'energy of binding'. Again, in the hot interiors of the stars matter is steadily being transmuted to electro-magnetic radiations, and, according to Millikan, there is probably occurring in inter-galactic space a complementary synthesis of radiations into matter.

(4) When an electron collides with a photon, the former moves off in one direction with changed velocity; the photon proceeds in another direction with lower energy (longer wave-length and decreased frequency) but with the same velocity. Despite the modification of each entity, the combined momenta remain constant.

(5) One piece of matter can press on another; but radiations likewise exercise pressure on matter.

(6) Atoms have weight, but so have radiations, a weight "as real", says Sir James Jeans, "as a ton of coal". Like the apple, radiations are influenced by a gravitational field, and are "attracted" by a mass of matter.

These examples, which are platitudes to Prof. Donnan, are only brought forward to support my contention that an 'immaterial' entity cannot act upon, or be acted upon by, a 'material' entity, and neither can be begotten of the other. Finally, the very expression 'immaterial entity' is surely a contradiction in terms. If it is not, some new definition of 'non-material' that side-steps 'spiritual' is required.

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