

## A HYPOTHESIS RELATING TO THE NATURE OF THE ETHER AND GRAVITY.

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1. I DESIRE in this note to call attention to an explanation of the fact that the number of kinds of matter is finite, and to a hypothesis as to the cause of gravity, both of which are dependent on a conjecture concerning the nature of the so-called ether.

2. The explanation will be facilitated by taking first the analogous case in two dimensions. A two-dimensional planetary world might be represented by supposing that the inhabitants live on the rim of a disc (the planet) which rotates round another disc (the sun) under an attraction directed to it. We may suppose that this planetary system rests on a smooth plane, or other surface of constant curvature. Every material thing in such a world may be supposed to be of a small and constant thickness in the third dimension, and in that direction to rest on the supporting plane, which may be termed a plane medium.

The inhabitants would be conscious of the bodies in the plane in which they lived; they would handle and touch bodies on the rim of their disc, or on such places inside it as they could reach; they might recognize the existence of various forces of nature, such as the mutual attraction of two particles; but they would have no knowledge of anything outside the plane in which they lived, and the pressure of the plane medium, and even its existence, would be unknown to them. I proceed to show how the existence of this medium would explain certain difficulties which their physicists might experience.

3. Every material thing in such a world would rest on the plane medium, hence if it was set vibrating it would give up a part of its motion to the medium. These vibrations would spread out from the source of disturbance; and if the medium was elastic, would cause vibrations in the other bodies resting on it. Some or all of the vibrations so communicated would produce effects which the inhabitants could detect. In particular, these vibrations in the medium would enable attraction to be exercised, and would enable light, radiant heat, and electricity to be transmitted from one body to another without (so far as the inhabitants could tell) the presence of any intervening medium.

Now if the inhabitants were sufficiently intelligent they might be able to detect that light and radiant heat [and possibly electricity] were transmitted by vibrations transverse to the direction along which they were propagated, though of such vibrations they could realize only those which were in their own plane; moreover, they might determine experimentally that to transmit such vibrations an elastic incompressible medium—which we may call ether—was necessary; and yet they would have distinct evidence that between their disc and the solar disc there was no medium capable of resisting motion. The explanation of these conflicting results lies in the fact that their universe rested on an elastic plane of which necessarily they were unconscious, and that this elastic plane medium was the ether which transmitted the vibrations. Similarly the attraction of one particle on another might be caused by vibrations: probably wholly or in part of a longitudinal character, that is, along the direction in which the force is transmitted.

4. If the bodies in this two-dimensional universe rested on a homogeneous plane film, the intensity or amplitude of the disturbance at any point would vary inversely as the distance from the source of disturbance; if on a solid medium, they would vary inversely as the square of that distance. But, in general, wherever a body rested on the vibrating plane medium, some of the motion of the medium would be given up to the body, that is, the vibrations of the ether would be hindered when it was associated with matter.

5. Now suppose that the bodies in our universe have a uniform thickness in a fourth dimension, and that in that direction our universe rests on a smooth homogeneous body or medium. The transmission of energy—apparently without the presence of an intervening medium—may be then explained by supposing that the energy is caused by vibrations transmitted by the supporting space. If the thickness in the fourth dimension of the supporting space is small and uniform the law of propagation would be that of the inverse square of the distance, as is the case: if the supporting space was of four dimensions the law would be that of the inverse cube.

I suggest as a hypothesis worthy of investigation that the vibrations of this medium are the cause of light, radiant heat, electricity, and magnetism, these vibrations being transverse to the direction of propagation, and also that attraction is caused by vibrations, which may be partly

longitudinal and partly transversal, or possibly may be wholly longitudinal.

Should it be convenient to assume properties of the gravity-transmitting ether inconsistent with those of the light-transmitting ether, we may postulate the existence of one ether in the direction of a fourth dimension and another in that of a fifth dimension, or we may suppose that our space is between two such ethers just as a two-dimensional world might lie between two parallel planes.

6. This hypothesis first occurred to me by its affording a physical explanation of the fact that the number of kinds of matter is finite. I was not aware then that the idea had been proposed previously, but on looking over various books on hyper-space, I find that it has been stated explicitly by Mr. Hinton in almost exactly the same form as that in which I have presented it above (see his *Scientific Romances*, London, 1886, especially pp. 129-134, 151-153, 192-194). He adds some ingenious suggestions about twists, but I gather that he is interested more in its possible application to ethics and metaphysics than to physics: indeed he founds a theory of free will on it (pp. 196-198), and in his *New Era of Thought* argues that hyper-space is "the scientific basis of altruism and religion." I leave my note however as I originally wrote it, and refer the reader to the above works for Mr. Hinton's development of the idea.

I know but little of recent speculations on higher physics, and it is possible that the idea may be found also in other works. In that most ingenious book, *The Unseen Universe*, the authors seem to be continually on the verge of making the supposition, "What we generally call ether," say they, "may be not a mere medium, but a medium plus the invisible order of things, ... May we not at once say that when energy is carried from matter into ether, it is carried from the visible into the invisible, and that when it is carried from ether to matter it is carried from the invisible into the visible" (Second edition, Art. 198). But I am not aware that they suggested that the invisible universe exists in a material form and in our immediate vicinity in the direction of the fourth dimension.

7. No conjecture of this kind is worthy of investigation unless it accounts for—or at least is not inconsistent with—(i) the main results of spectrum analysis, inclusive of the fact that the number of kinds of the so-called elements is finite, and (ii) the Newtonian law of attraction.

8. In regard to (i), whatever view we may take of the constitution of matter, the results of spectrum analysis seem to shew that every molecule of matter in our space is in constant vibration, that the number of kinds of ultimate molecules is finite, and that every molecule of a given kind vibrates at the same rate. Now if all the molecules rest on a body (viz., the supporting medium), there is a physical connection between them. Hence, just as two clocks, whose rates are nearly the same, tend to go at the same rate if their cases are connected, so molecules set vibrating anyhow would fall into certain groups and all the members of each group would vibrate at the same rate. It was the possibility of obtaining such a physical connection that suggested to me the idea of a supporting medium in a fourth dimension. (See Maxwell's article *Atom*, *Collected Works*, Vol. II., p. 479)

The vibrations of each molecule would cause a disturbance in the supporting medium. This disturbance would spread out uniformly in all directions, and if the thickness in the fourth dimension of the medium is small and constant the intensity of the vibration would decrease as the square of the distance from the centre of disturbance, but the rate of vibration would remain unaltered as the waves spread out. Thus red light would be propagated as red light though its intensity would diminish. We must suppose that when an opaque body is interposed between a source of light and any other point, it deadens the vibrations in that part of the supporting medium on which it rests. Also we should expect to find (as, in fact, we do) that the vibrations of the ether are hindered when it is associated with matter (see above, Art. 4). Fluorescence can also be explained.

9. In regard to (ii), the intensity of the vibrations (whether wholly longitudinal, or wholly transversal in any of the three directions at right angles to the direction of propagation, or a combination of such motions) which cause gravity would vary inversely as the square of the distance from the attracting molecule, and if we define the mass of a molecule as proportional to the intensity of these vibrations (whatever be their kind) caused by it, then at any other points in space the intensity would vary directly as the mass of the molecule and inversely as the square of the distance. Hence, if we may assume that such vibrations of the medium spreading out from any centre would draw to that centre a particle of unit mass at any



point with a force proportional to the intensity of the vibration at that point, the Newtonian law of attraction would follow.

10. There is an initial objection to this explanation of gravity in the fact that the force of attraction between two bodies is not diminished sensibly by the presence of intervening bodies, whereas we should expect that the vibrations of the ether would be hindered whenever matter was resting on it, since some of the motion would be given up to this matter.

11. The theory that light is transmitted by the vibrations of an intervening medium was propounded by Hooke and Huygens, and is familiar to all students of physical optics. Sir William Thomson's molecular treatment of optics is given in his Baltimore Lectures, *Molecular Dynamics*, 1884, and has been discussed by F. Lindemann (*Schriften der physikalischökonomischen Gesellschaft*, Königsberg, 1888, Vol. XXIX).

The idea that the mechanism of gravity is to be explained by the vibrations of an intervening medium is old. It was held by Hooke (*Posthumous Works*, ed. Waller, London, 1705, pp. xiv, 184), and recently some of the mathematical analysis of the subject has been indicated by Sir William Thomson (*Philosophical Magazine*, June, 1871), Prof. Bjerknæs in 1871, 1875 and 1876 (*Repertorium der Mathematik Von Königsberger und Zeuner*, 1876, p. 268), Dr. Hicks (*Philosophical Transactions*, 1880, pp. 455-492), Mr. Leahy (*Cambridge Philosophical Transactions*, 1889, Vol. XIV, pp. 45-62), and Prof. Pearson (*Quarterly Journal of Mathematics*, 1885, Vol. XX, pp. 60-80, 184-201; *Proceedings of the London Mathematical Society*, 1889, Vol. XX, pp. 38-63).

It would seem from these investigations that the medium required for transmitting such vibrations must possess properties inconsistent with our experience of the space through which the energy appears to be transmitted. My object is to point out that this and similar difficulties are overcome if by moving an infinitesimal distance in a fourth dimension we arrive at a homogeneous elastic body.

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